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SOLUBILITY DATA SERIES

Volume 43

CARBON MONOXIDE

SOLUBILITY DATA SERIES

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SOLUBILITY DATA SERIES

Volume 43

CARBON MONOXIDE

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Carbon Monoxide Solubilities

FOREWORD

> *If the knowledge is*
> *undigested or simply wrong,*
> *more is not better.*

The Solubility Data Series is a project of Commission V.8 (Solubility Data) of the International Union of Pure and Applied Chemistry (IUPAC). The project had its origins in 1973, when the Analytical Chemistry Division of IUPAC set up a Subcommission on Solubility Data under the chairmanship of the late Prof. A.S. Kertes. When publication of the Solubility Data Series began in 1979, the Committee became a full commission of IUPAC, again under the chairmanship of Prof. Kertes, who also became *Editor-in-Chief* of the Series. The Series has as its goal the preparation of a comprehensive and critical compilation of data on solubilities in all physical systems, including gases, liquids and solids.

The motivation for the Series arose from the realization that, while solubility data are of importance in a wide range of fields in science and technology, the existing data had not been summarized in a form that was at the same time comprehensive and complete. Existing compilations of solubility data indeed existed, but they contained many errors, were in general uncritical, and were seriously out-of-date.

It was also realized that a new series of compilations of data gave educational opportunities, in that careful compilations of existing data could be used to demonstrate what constitutes data of high and lasting quality. As well, if the data were summarized in a sufficiently complete form, any individual could prepare his or her own evaluation, independently of the published evaluation. Thus, a special format was established for each volume, consisting of individual data sheets for each separate publication, and critical evaluations for each separate system, provided sufficient data from different sources were available for comparison. The compilations and, especially, the evaluations were to be prepared by active scientists who were either involved in producing new data, or were interested in using data of high quality. With minor modifications in format, this strategy has continued throughout the Series.

In the standard arrangement of each volume, the Critical Evaluation gives the following information:

(i) A text which discusses the numerical solubility information which has been abstracted from the primary sources in the form of compilation sheets. The text concerns primarily the quality of the data, after consideration of the purity of the materials and their characterization, the experimental method used, the uncertainties in the experimental values, the reproducibility, the agreement with accepted test values, and, finally, the fitting of the data to suitable functions, along with statistical tests of the fitted data.

(ii) A set of recommended data, whenever possible, including weighted averages and estimated standard deviations. If applicable, one or more smoothing equations which have been computed or verified by the evaluator are also given.

(iii) A graphical plot of the recommended data, in the form of phase diagrams where appropriate.

The Compilation part consists of data sheets which summarize the experimental data from the primary literature. Here much effort is put into obtaining complete coverage; many good data have appeared in publications from the late nineteenth and early twentieth centuries, or in obscure journals. Data of demonstrably low precision are not compiled, but are mentioned in the Critical Evaluation. Similarly, graphical data, given the uncertainty of accurate conversion to numerical values, are compiled only where no better data are available. The documentation of data of low precision can serve to alert researchers to areas where more work is needed.

A typical data sheet contains the following information:

(i) list of components: names, formulas, Chemical Abstracts Registry Numbers;
(ii) primary source of the data;
(iii) experimental variables;
(iv) compiler's name;
(v) experimental values as they appear in the primary source, in modern units with explanations if appropriate;
(vi) experimental methods used;
(vii) apparatus and procedure used;
(viii) source and purity of materials used;
(ix) estimated error, either from the primary source or estimated by the compiler;
(x) references relevant to the generation of the data cited in the primary source.

Each volume also contains a general introduction to the particular type of system, such as solubility of gases, of solids in liquids, etc., which contains a discussion of the nomenclature used, the principles of accurate determination of solubilities, and related thermodynamic principles. This general introduction is followed by a specific introduction to the subject matter of the volume itself.

The Series embodies a new approach to the presentation of numerical data, and the details continue to be influenced strongly by the perceived needs of prospective users. The approach used will, it is hoped, encourage attention to the quality of new published work, as authors become more aware that their work will attain permanence only if it meets the standards set out in these volumes. If the Series succeeds in this respect, even partially, the Solubility Data Commission will have justified the labour expended by many scientists throughout the world in its production.

January, 1989

J.W. Lorimer,
London, Canada

PREFACE

This volume in the Solubility Data Series contains tabulations, collections, and critical evaluations of original data for the solubility of carbon monoxide in a variety of liquid solvents. Most of the studies reported were made at temperatures around ambient, and for partial pressures of carbon monoxide around 101.3 kPa. Some data, however, are for temperatures as low as 93 K and as high as 573 K, and for pressures up to 101 MPa.

Within this volume, material is arranged according to solvent class, with solubility data for low pressures and high pressures collected together. To introduce each section a critical evaluation has been written, incorporating comments for each individual solvent in that class. In only a few cases, however, has there been a sufficient number of detailed studies to enable the evaluators to recommend a set of solubility values for carbon monoxide in a particular solvent.

Carbon monoxide is a toxic, flammable, colorless gas, formed when carbon or any carbon-based fuel burns with a deficiency of oxygen. Its discovery is attributed to Joseph Marie Francois de Lassone (1776), who obtained it by heating a mixture of charcoal and zinc oxide. Commercially, carbon monoxide is usually obtained from "producer-gas" (25% carbon monoxide) and "water-gas" (40% carbon monoxide), in a combined cycle blowing air and steam alternately through incandescent coke. In the laboratory, common preparation methods involve the dehydration of formic acid by concentrated sulfuric acid, or the reaction of concentrated sulfuric acid with oxalate or with hexacyanoferrate(II). Very pure carbon monoxide can be made by decomposing nickel tetracarbonyl at 200°C.

For over at least a century, carbon monoxide has had a variety of uses. It has been a fuel (a component of early "town-gas" or "coal-gas"), a reducing agent (large amounts utilised in metallurgy), and more recently a feedstock for the manufacture of many organic chemicals. This latter application is largely a result of research into the structure and properties of carbonyl complexes of transition metals. A recognition of the special π-bonding ability of carbon monoxide as a ligand for transition metals in low oxidation state opened up a large area of modern inorganic chemistry, and led to the production of the efficient catalytic systems already producing large tonnages of organic chemicals annually.

Emissions of carbon monoxide, principally from motor vehicle exhausts, are a primary source of air pollution. Efforts to monitor and reduce emissions of this pollutant are now being made worldwide because of its hazard to health. The toxicity of carbon monoxide is actually a consequence of its ability to form the π-bonds referred to above. For the normal physiological function of transporting oxygen, the dioxygen molecules are reversibly bonded to iron atoms in hemoglobin. The carbon monoxide - hemoglobin complex, however, is about 300 times more stable than the oxygen-hemoglobin complex. Thus inhalation of carbon monoxide leads to the formation of carboxy-hemoglobin in the blood, starving it, and the cells it supplies, of vital oxygen. Progressively headache, dizziness, nausea, unconsciousness, and eventual death may occur.

The solubility of carbon monoxide in biological fluids is a primary consideration in the toxicity process. Also the solubility of carbon monoxide in appropriate aqueous and non-aqueous solvents needs to be known in order to understand and improve methods of conversion of carbon monoxide into various organic chemicals, and methods of controlling carbon monoxide pollution. Such solubility data have been collected and evaluated in this volume.

Carbon monoxide melts at 68.09 K and boils at 81.65 K under 101.3 kPa pressure. It has a critical temperature, pressure, and density of 132.9 K, 3.496 MPa, and 301.0 kg m^{-3} respectively. Its triple point is 68.1 K, 15.39 kPa; its autoignition temperature 925 K. The molar volume is 22.408 dm^3 at 273.15 K, 101.325 kPa, so that no correction for non-ideality of the gas needs to be made for the purposes of calculating solubility data from measurements made around ambient temperatures and pressures.

This volume contains data on the solubility of carbon monoxide taken from a search of the world's chemical literature through to the end of 1988. (The editor would be grateful to learn of any articles which were missed in the search). Its publication is timely in view of current concern about carbon monoxide as an atmospheric pollutant, and in view of the role which carbon monoxide is likely to play in the future, as chemical feedstocks may have to change in response to supply and demand patterns, and as alternative energy sources are developed, especially coal gasification technology. For all of these applications, and for numerous others, well documented and critically evaluated gas solubility data will be of tremendous benefit. As a historical survey, this volume also indicates where data are not available, and shows where original investigations are required. More work needs to be done to corroborate some of the published data, to extend their temperature and pressure ranges, and to investigate other solvents for such a common and important a gas as carbon monoxide.

The editor would like to express his gratitude to fellow members of the I.U.P.A.C. Commission on Solubility Data for their help and advice; to Dundee Institute of Technology for partly supporting travel connected with the project and for providing some of the library facilities required; and to Carolyn Dowie, Lesley Flanagan, and Ann Ramsay, who were involved in typing the final manuscript.

Robert W. Cargill,

Dundee, U.K.

May 1989.

THE SOLUBILITY OF GASES IN LIQUIDS

R. Battino, H. L. Clever and C. L. Young

INTRODUCTION

The Solubility Data Project aims to make a comprehensive search of the literature for data on the solubility of gases, liquids and solids in liquids. Data of suitable accuracy are compiled into data sheets set out in a uniform format. The data for each system are evaluated and where data of sufficient accuracy are available values recommended and in some cases a smoothing equation suggested to represent the variation of solubility with pressure and/or temperature. A text giving an evaluation and recommended values and the compiled data sheets are published on consecutive pages.

DEFINITION OF GAS SOLUBILITY

The distinction between vapor-liquid equilibria and the solubility of gases in liquids is arbitrary. It is generally accepted that the equilibrium set up at 300K between a typical gas such as argon and a liquid such as water is gas liquid solubility whereas the equilibrium set up between hexane and cyclohexane at 350K is an example of vapor-liquid equilibrium. However, the distinction between gas-liquid solubility and vapor-liquid equilibrium is often not so clear. The equilibria set up between methane and propane above the critical temperature of methane and below the critical temperature of propane may be classed as vapor-liquid equilibrium or as gas-liquid solubility depending on the particular range of pressure considered and the particular worker concerned.

The difficulty partly stems from our inability to rigorously distinguish between a gas, a vapor, and a liquid, which has been discussed in numerous textbooks. We have taken a fairly liberal view in these volumes and have included systems which may be regarded, by some workers, as vapor-liquid equilibria.

UNITS AND QUANTITIES

The solubility of gases in liquids is of interest to a wide range of scientific and technological disciplines and not solely to chemistry. Therefore a variety of ways for reporting gas solubility have been used in the primary literature and inevitably sometimes, because of insufficient available information, it has been necessary to use several quantities in the compiled tables. Where possible, the gas solubility has been quoted as a mole fraction of the gaseous component in the liquid phase. The units of pressure used are bar, pascal, millimeters of mercury and atmosphere. Temperatures are reported in Kelvin.

EVALUATION AND COMPILATION

The solubility of comparatively few systems is known with sufficient accuracy to enable a set of recommended values to be presented. This is true both of the measurement near atmospheric pressure and at high pressures. Although a considerable number of systems have been studied by at least two workers, the range of pressures and/or temperatures is often sufficiently different to make meaningful comparison impossible.

Occasionally, it is not clear why two groups of workers obtained very different sets of results at the same temperature and pressure, although both sets of results were obtained by reliable methods and are internally consistent. In such cases, sometimes an incorrect assessment has been given. There are several examples where two or more sets of data have been classified as tentative although the sets are mutually inconsistent.

Many high pressure solubility data have been published in a smoothed form. Such data are particularly difficult to evaluate, and unless specifically discussed by the authors, the estimated error on such values can only be regarded as an "informed guess".

Many of the high pressure solubility data have been obtained in a more general study of high pressure vapor-liquid equilibrium. In such cases a note is included to indicate that additional vapor-liquid equilibrium data are given in the source. Since the evaluation is for the compiled data, it is possible that the solubility data are given a classification which is better than that which would be given for the complete vapor-liquid data (or vice versa). For example, it is difficult to determine coexisting liquid and vapor compositions near the critical point of a mixture using some widely used experimental techniques which yield accurate high pressure solubility data. For example, conventional methods of analysis may give results with an expected error which would be regarded as sufficiently small for vapor-liquid equilibrium data but an order of magnitude too large for acceptable high pressure gas-liquid solubility.

It is occasionally possible to evaluate data on mixtures of a given substance with a member of a homologous series by considering all the available data for the given substance with other members of the homologous series. In this study the use of such a technique has been very limited.

The estimated error is often omitted in the original article and sometimes the errors quoted do not cover all the variables. In order to increase the usefulness of the compiled tables estimated errors have been included even when absent from the original article. If the error on *any* variable has been inserted by the compiler this has been noted.

PURITY OF MATERIALS

The purity of materials has been quoted in the compiled tables where given in the original publication. The solubility is usually more sensitive to impurities in the gaseous component than to liquid impurities in the liquid component. However, the most important impurities are traces of a gas dissolved in the liquid. Inadequate degassing of the absorbing liquid is probably the most often overlooked serious source of error in gas solubility measurements.

APPARATUS AND PROCEDURES

In the compiled tables brief mention is made of the apparatus and procedure. There are several reviews on experimental methods of determining gas solubilities and these are given in References 1-7.

METHODS OF EXPRESSING GAS SOLUBILITIES

Because gas solubilities are important for many different scientific and engineering problems, they have been expressed in a great many ways:

The Mole Fraction, $x(g)$

The mole fraction solubility for a binary system is given by:

$$x(g) = \frac{n(g)}{n(g) + n(l)}$$

$$= \frac{W(g)/M(g)}{[W(g)/M(g)] + [W(l)/M(l)]}$$

here n is the number of moles of a substance (an *amount* of substance), W is the mass of a substance, and M is the molecular mass. To be unambiguous, the partial pressure of the gas (or the total pressure) and the temperature of measurement must be specified.

The Weight Per Cent Solubility, wt%

For a binary system this is given by

$$\text{wt\%} = 100\, W(g)/[W(g) + W(l)]$$

where W is the weight of substance. As in the case of mole fraction, the pressure (partial or total) and the temperature must be specified. The weight per cent solubility is related to the mole fraction solubility by

$$x(g) = \frac{[\mathrm{wt}\%/M(g)]}{[\mathrm{wt}\%/M(g)] + [(100 - \mathrm{wt}\%)/M(1)]}$$

The Weight Solubility, C_w

The weight solubility is the number of moles of dissolved gas per gram of solvent when the partial pressure of gas is 1 atmosphere. The weight solubility is related to the mole fraction solubility at one atmosphere partial pressure by

$$x(g) \text{ (partial pressure 1 atm)} = \frac{C_w M(1)}{1 + C_w M(1)}$$

where M(1) is the molecular weight of the solvent.

The Moles Per Unit Volume Solubility, n

Often for multicomponent systems the density of the liquid mixture is not known and the solubility is quoted as moles of gas per unit volume of liquid mixture. This is related to the mole fraction solubility by

$$x = \frac{n\, v^{o}(1)}{1 + n\, v^{o}(1)}$$

where $v^{o}(1)$ is the molar volume of the liquid component.

The Bunsen Coefficient, α

The Bunsen coefficient is defined as the volume of gas reduced to 273.15K and 1 atmosphere pressure which is absorbed by unit volume of solvent (at the temperature of measurement) under a partial pressure of 1 atmosphere. If ideal gas behavior and Henry's law is assumed to be obeyed,

$$\alpha = \frac{V(g)}{V(1)} \, \frac{273.15}{T}$$

where V(g) is the volume of gas absorbed and V(1) is the original (starting) volume of absorbing solvent. The mole fraction solubility is related to the Bunsen coefficient by

$$x(g, 1\ \mathrm{atm}) = \frac{\alpha}{\alpha + \dfrac{273.15}{T}\,\dfrac{v^{o}(g)}{v^{o}(1)}}$$

where $v^{o}(g)$ and $v^{o}(1)$ are the molar volumes of gas and solvent at a pressure of one atmosphere. If the gas is ideal,

$$x(g) = \frac{\alpha}{\alpha + \dfrac{273.15R}{v^{o}(1)}}$$

Real gases do not follow the ideal gas law and it is important to establish the real gas law used for calculating α in the original publication and to make the necessary adjustments when calculating the mole fraction solubility.

The Kuenen Coefficient, S

This is the volume of gas, reduced to 273.15K and 1 atmosphere pressure, dissolved at a partial pressure of gas of 1 atmosphere by 1 gram of solvent.

The Ostwald Coefficient, L

The Ostwald coefficient, L, is defined at the ratio of the volume of gas absorbed to the volume of the absorbing liquid, all measured at the same temperature·

$$L = \frac{V(g)}{V(l)}$$

If the gas is ideal and Henry's Law is applicable, the Ostwald coefficient is independent of the partial pressure of the gas. .It is necessary, in practice, to state the temperature and total pressure for which the Ostwald coefficient is measured. The mole fraction solubility, x, is related to the Ostwald coefficient by

$$x(g) = \frac{RT}{P(g)\ L\ v^{o}(l)} + 1 \qquad {}^{-1}$$

where P is the partial pressure of gas. The mole fraction solubility will be at a partial pressure of P(g).

The Absorption Coefficient, β

There are several "absorption coefficients", the most commonly used one being defined as the volume of gas, reduced to 273.15K and 1 atmosphere, absorbed per unit volume of liquid when the total pressure is 1 atmosphere. β is related to the Bunsen coefficient by

$$\beta = \alpha(1-P(l))$$

where P(l) is the partial pressure of the liquid in atmosphere.

The Henry's Law Contant

A generally used formulation of Henry's Law may be expressed as

$$P(g) = K_H\, x(g)$$

where K_H is the Henry's Law constant and x the mole fraction solubility. Other formulations are

$$P(g) = K_2 C(l)$$

or

$$C(g) = K_c C(l)$$

where K_2 and K_c are constants, C the concentration, and (l) and (g) refer to the liquid and gas phases. Unfortunately, K_H, K_2 and K_c are all sometimes referred to as Henry's Law constants. Henry's Law is a limiting law but can sometimes be used for converting solubility data from the experimental pressure to a partial gas pressure of 1 atmosphere, provided the mole fraction of the gas in the liquid is small, and that the difference in pressures is small. Great caution must be exercised in using Henry's Law.

The Mole Ratio, N

The mole ratio, N, is defined by

$$N = n(g)/n(l)$$

Table 1 contains a presentation of the most commonly used inter-conversions not already discussed.

For gas solubilities greater than about 0.01 mole fraction at a partial pressure of 1 atmosphere there are several additional factors which must be taken into account to unambiguously report gas solubilities. Solution densities or the partial molar volume of gases must be known. Corrections should be made for the possible non-ideality of the gas or the non-applicability of Henry's Law.

TABLE 1. Interconversion of parameters used for reporting solubility.

$$L = \alpha(T/273.15)$$

$$C_w = \alpha/v_o\rho$$

$$K_H = \frac{17.033 \times 10^6 \rho(\mathrm{soln})}{\alpha\, M(1)} + 760$$

$$L = C_w\, v_{t,gas}\, \rho$$

where v_o is the molal volume of the gas in $cm^3\ mol^{-1}$ at 0°C, ρ the density of the solvent at the temperature of the measurement, ρ_{soln} the density of the solution at the temperature of the measurement, and $v_{t,gas}$ the molal volume of the gas ($cm^3\ mol^{-1}$) at the temperature of the measurement.

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Revised: December 1984 (CLY)

APPENDIX I. Conversion Factors k and k^{-1}.

	k 1 (non-SI Unit) = k (SI Unit)	k^{-1} 1 (SI Unit) = k^{-1} (non-SI Unit)
LENGTH		SI Unit, m
Å (angstrom)	1×10^{-10} (*)	1×10^{10} (*)
cm (centimeter)	1×10^{-2} (*)	1×10^{2} (*)
in (inch)	254×10^{-4} (*)	$3\ 937\ 008 \times 10^{-5}$
ft (foot)	$3\ 048 \times 10^{-4}$ (*)	$3\ 280\ 840 \times 10^{-6}$
AREA		SI Unit, m^2
cm^2	1×10^{-4} (*)	1×10^{4} (*)
in^2	$64\ 516 \times 10^{-8}$ (*)	$1\ 550\ 003 \times 10^{-3}$
ft^2	$9\ 290\ 304 \times 10^{-8}$ (*)	$1\ 076\ 391 \times 10^{-5}$
VOLUME		SI Unit, m^3
cm^3	1×10^{6} (*)	1×10^{6} (*)
in^3	$16\ 387\ 064 \times 10^{-12}$ (*)	$6\ 102\ 374 \times 10^{-2}$
ft^3	$2\ 831\ 685 \times 10^{-8}$	$3\ 531\ 467 \times 10^{-5}$
l (litre)	1×10^{-3} (*)	1×10^{3} (*)
UKgal (UK gallon)	$45\ 461 \times 10^{-7}$	$21\ 997 \times 10^{-2}$
USgal (US gallon)	$37\ 854 \times 10^{-7}$	$26\ 417 \times 10^{-2}$
MASS		SI Unit, kg
g (gram)	1×10^{-3} (*)	1×10^{3} (*)
t (tonne)	1×10^{3} (*)	1×10^{-3} (*)
lb (pound)	$45\ 359\ 237 \times 10^{-8}$ (*)	$2\ 204\ 623 \times 10^{-6}$
DENSITY		SI Unit, kg m^{-3}
g cm^{-3}	1×10^{3} (*)	1×10^{-3} (*)
g l^{-1}	1 (*)	1 (*)
lb in^{-3}	$2\ 767\ 991 \times 10^{-2}$	$3\ 612\ 728 \times 10^{-11}$
lb ft^{-3}	$1\ 601\ 847 \times 10^{-5}$	$6\ 242\ 795 \times 10^{-8}$
lb UKgal^{-1}	$99\ 776 \times 10^{-3}$	$100\ 224 \times 10^{-7}$
lb USgal^{-1}	$1\ 198\ 264 \times 10^{-4}$	$8\ 345\ 406 \times 10^{-9}$
PRESSURE	SI Unit, Pa (pascal, kg m^{-1} s^{-2})	
dyn cm^{-2}	1×10^{-1} (*)	1×10 (*)
at (kgf cm^{-2})	$980\ 665 \times 10^{-1}$ (*)	$1\ 019\ 716 \times 10^{-11}$
atm (atmosphere)	101 325 (*)	$9\ 869\ 233 \times 10^{-12}$
bar	1×10^{5} (*)	1×10^{-5} (*)
lbf in^{-2} (p.s.i.)	$6\ 894\ 757 \times 10^{-3}$	$1\ 450\ 377 \times 10^{-10}$
lbf ft^{-2}	$47\ 880 \times 10^{-3}$	$20\ 886 \times 10^{-6}$
inHg (inch of mercury)	$3\ 386\ 388 \times 10^{-3}$	$2\ 952\ 999 \times 10^{-10}$
mmHg (millimeter of mercury, torr)	$1\ 333\ 224 \times 10^{-4}$	$7\ 500\ 617 \times 10^{-9}$
ENERGY	SI Unit, J (joule, kg m^2 s^{-2})	
erg	1×10^{-7} (*)	1×10^{7} (*)
cal$_{IT}$ (I.T. calorie)	$41\ 868 \times 10^{-4}$ (*)	$2\ 388\ 459 \times 10^{-7}$
cal$_{th}$ (thermochemical calorie)	$4\ 184 \times 10^{-3}$ (*)	$2\ 390\ 057 \times 10^{-7}$
kW h (kilowatt hour)	36×10^{5} (*)	$2\ 777\ 778 \times 10^{-13}$
l atm	$101\ 325 \times 10^{-3}$ (*)	$9\ 869\ 233 \times 10^{-9}$
ft lbf	$1\ 355\ 818 \times 10^{-6}$	$7\ 375\ 622 \times 10^{-7}$
hp h (horse power hour)	2 684 519	$3\ 725\ 062 \times 10^{-13}$
Btu (British thermal unit)	$1\ 055\ 056 \times 10^{-3}$	$9\ 478\ 172 \times 10^{-10}$

An asterisk (*) denotes an exact relationship.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Water; H_2O; [7732-18-5]

EVALUATOR:

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June 1987

CRITICAL EVALUATION:

From Henry in 1803 to Rettich *et al.* in 1982 there have been only eleven papers reporting on the solubility of carbon monoxide, a common and biologically important gas, in water at a partial pressure of gas of 101.3 kPa. The Editor of this volume considered both Henry's work (1) and Cassuto's work (2) to be too imprecise to even compile and this evaluator agrees with that judgement. A value from a paper by Lubarsch (3) was also not compiled because of unclear experimental conditions. The data of Jung *et al.* (4) were presented only in graphical form, and are considered in the evaluation of high pressure solubilities in water.

The modern measurements of Rettich *et al.* (5) are of high-precision (a standard deviation of 0.04%) and are the current standard against which we are evaluating all other measurements of this system. Bunsen's work (6) is mainly of historical interest, being on the average 6% low. There were three papers published around the turn of the century. Just's two values (7) are about 8% low. Christoff's single value (8) is about 3% low. It appears on a data sheet for water and sulfuric acid mixtures. Winkler's extensive data (9) are about 3% low on the average. His precision is about 1% and his data go 25 K higher than those of Rettich *et al.*, but in the range where the two sets of data overlap the differences are too large to give Winkler's higher temperature measurements much weight. The only modern measurements are those of Power (10) and Power and Stegall (11). The single value of the first paper (10) is low by about 8%, and the three values in the second paper (11) range from 6% low by about 1% high (compared to Rettich *et al.*). The only reliable data which are currently available are those of Rettich *et al.* (5) and these are the data which we are recommending.

Rettich *et al.* (5) fit their data to the smoothing equation

$$\ln (H_{1,2}/\text{Pa}) = 126.753761 - 152.599953/(T/100\ \text{K}) - 67.8429542 \ln (T/100\ \text{K}) + 7.04595356\ (T/100\ \text{K})$$

with a standard deviation in terms of percentage of 0.043%.

$H_{1,2}\ (T,P_{s,2})$ is the Henry's coefficient at the thermodynamic temperature T and the saturation vapor pressure of the solvent $P_{s,2}$.

The following table gives smoothed recommended values at 5 K intervals from 273.15 to 328.15 K based on the above equation. Note that the mole fractions in the table are for 1 atm partial pressure of gas and that the standard state for the thermodynamic functions is also 1 atm. The limiting value of the Ostwald coefficient, L^∞, is defined by

$$L^\infty = \lim_{c_l^L \to 0} (c_l^L/c_l^V)\ \text{equil}$$

where the c's are molar concentrations of the gas in the liquid or gas phase as indicated by the superscript.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Water; H_2O; [7732-18-5]

EVALUATOR:

Rubin Battino
Chemistry Department
Wright State University
Dayton, OH 45435 USA

1987, June

CRITICAL EVALUATION: cont...

T/K	$10^{-9}\, H_{1,2}(T,P_{s,2})$ / Pa	$10^5 x_1$	$10^2 L^\infty$	ΔG_2° / kJ mol^{-1}	ΔH_2° / kJ mol^{-1}	ΔS_2° / J K^{-1} mol^{-1}	$\Delta C_{p,2}^\circ$ / J K^{-1} mol^{-1}
273.15	3.4478	2.9388	3.6555	23.70	-16.51	-147	244
278.15	3.9105	2.5911	3.2824	24.42	-15.30	-143	238
283.15	4.3756	2.3157	2.9854	25.13	-14.13	-139	232
288.15	4.8354	2.0955	2.7476	25.81	-12.98	-135	226
293.15	5.2825	1.9181	2.5563	26.47	-11.86	-131	221
298.15	5.7104	1.7744	2.4023	27.12	-10.78	-127	215
303.15	6.1133	1.6575	2.2783	27.74	- 9.72	-124	209
308.15	6.4864	1.5621	2.1791	28.35	- 8.69	-120	203
313.15	6.8259	1.4844	2.1004	28.95	- 7.69	-117	197
318.15	7.1291	1.4213	2.0390	29.52	- 6.71	-114	191
323.15	7.3943	1.3787	1.9923	30.09	- 5.77	-111	185
328.15	7.6206	1.3296	1.9583	30.63	- 4.86	-108	180

References

1. Henry, W. *Phil. Trans.* 1803, 93, 29, 274.
2. Cassuto, L. *Phys. Z.* 1904, *5*, 233.
3. Lubarsch, O. *Ann. Phys. (Leipzig)* 1889, *37*, 524.
4. Jung. J.; Knacke, O.; Neuschutz, D. *Chem. Ing. Tech.* 1971, *43*, 112.
5. Rettich, T.R.; Battino, R.; Wilhelm, E. *Ber. Bunsenges. Phys. Chem.* 1982, *86*, 1128.
6. Bunsen, R.W. *Ann.* 1855, *93*, 1-50.
7. Just, G. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1901, *37*, 342.
8. Christoff, A. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1906, *55*, 622.
9. Winkler, L.W. *Chem. Ber.* 1901, *34*, 1408.
10. Power, G.G. *J. Appl. Physiol.* 1968, *24*, 468.
11. Power, G.G.; Stegall, H. *J. Appl. Physiol.* 1970, *29*, 145.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bunsen, R. W.

Ann. 1855, *93*, 1-50.

Phil. Mag. 1855, *9*, 116-30, 181-201.

Ann. Chim. Phys. [3] 1855, *43*, 496-508 (long abstract).

VARIABLES:

T/K = 279.0-295.2
p_1/kPa =

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature $t/{}^\circ\mathrm{C}$	T/K	Mol Fraction $10^5 x_1$	Bunsen Coefficient $10^2\alpha/\mathrm{cm^3(STP)cm^{-3}atm^{-1}}$	Ostwald Coefficient $10^2 L/\mathrm{cm^3\ cm^{-3}}$
5.8	279.0	2.30	2.8636	2.92
8.6	281.8	2.18	2.7125	2.80
9.0	282.2	2.16	2.6855	2.77
17.4	290.6	1.92	2.3854	2.54
18.4	291.6	1.86	2.3147	2.47
22.0	295.2	1.85	2.2907	2.48

The mole fraction solubility at 101.325 kPa carbon monoxide partial pressure was calculated by the compiler using a carbon monoxide molar volume of 22,400 $\mathrm{cm^3}$ (STP) $\mathrm{mol^{-1}}$.

The Ostwald coefficients and Kelvin temperatures were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Bunsen method.

The second paper cited is a complete English translation of the first paper. The third paper is a long abstract of the first paper. These data were published two other places by Bunsen (ref 1 and 2).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid on magnesium formate

(2) Water. Distilled.

ESTIMATED ERROR:

$\delta T/\mathrm{K} = \pm\ 0.1$
$\delta\alpha/\alpha = \pm\ 0.03 - 0.05$ (compiler)

REFERENCES:

1. Bunsen, R. W. *Arch. Sci. Phys. Nat.* [1] 1855, *28*, 235.

2. Bunsen, R. W. *Gasometrische Methoden*, 2nd. ed., Braunschweig, 1858, p. 212.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.2, 298.2
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^5 x_1$	Bunsen Coefficient $10^2\alpha/\mathrm{cm^3 (STP) cm^{-3} atm^{-1}}$	Ostwald Coefficient $10^2 L/\mathrm{cm^3 cm^{-3}}$
293.2	2.08	2.41	2.586
298.2	1.90	2.20	2.404

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoside. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Water. No information.

ESTIMATED ERROR:

$\delta L/L$ = 0.03 (compiler)

REFERENCES:

1. **Timofejew, W.**
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1890, *6*, 141.
2. **Steiner, P.**
Ann. Phys. (Leipzig), 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Winkler, L. W.

Chem. Ber. 1901, *34*, 1408-22.

VARIABLES:

T/K = 273.17 - 353.15
p_1/kPa = 61.979 - 141.007

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

The temperatures and Bunsen coefficients below are the average values given by Winkler from the experimental data on the following page.

Temperature		Mol Fraction	Bunsen Coefficient	Ostwald Coefficient
t/°C	T/K	10^5x_1	$10^2\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	$10^2L/\text{cm}^3\ \text{cm}^{-3}$
0.10	273.25	2.838	3.529	3.530
10.04	283.19	2.263	2.813	2.916
20.01	293.16	1.868	2.319	2.489
30.04	303.19	1.613	1.997	2.217
39.88	313.03	1.440	1.777	2.036
49.98	323.13	1.315	1.615	1.911
60.00	333.15	1.217	1.488	1.815
79.97	353.12	1.183	1.430	1.796

The mole fraction solubility at 101.325 kPa carbon monoxide partial pressure was calculated by the compiler using a carbon monoxide molar volume of 22,400 cm^3 (STP) mol^{-1}.

The Ostwald coefficients and Kelvin temperatures were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The original Bunsen absorption method (ref 1) was used. The details of the apparatus and method used by Winkler are described in earlier paper (ref 2).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of concentrated sulfuric acid on sodium or lead formate. The gas was washed with lye (KOH) solution.

(2) Water. Distilled.

ESTIMATED ERROR:

δT/K = ± 0.01
$\delta\alpha/\alpha$ = ± 0.01 (compiler)

REFERENCES:

1. Bunsen, R. W. *Gasometrische Methoden*, 2nd. ed., Braunschweig, 1858.
2. Winkler, L. W. *Chem. Ber.* 1893, *24*, 89, 3602.

COMPONENTS:

(1) Carbon momoxide; CO; [630-08-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Winkler, L. W.

Chem. Ber. 1901, *34*, 1408-22.

EXPERIMENTAL VALUES:

Temperature		Pressure	Water Volume	Carbon Monoxide Volume (STP)	Bunsen Coefficient
$t/^{\circ}C$	T/K	p_1/mmHg	v_2/cm^3	v_1/cm^3	$10^2\alpha/cm^3(STP)cm^{-3}atm^{-1}$
0.17	273.32	733.43	2113.04	71.63	3.513
0.17	273.32	733.40	2113.04	71.68	3.515
0.17	273.32	733.51	2113.04	71.59	3.511
0.07	273.22	465.08	1868.89	40.49	3.540
0.02	273.17	464.88	1868.89	40.58	3.550
0.02	273.17	464.96	1868.89	40.52	3.544
10.02	283.17	782.19	2113.33	60.96	2.803
10.01	283.16	782.32	2113.33	60.86	2.797
10.02	283.17	782.22	2113.33	60.94	2.802
10.10	283.25	490.16	1869.17	34.10	2.829
10.03	283.18	490.10	1869.15	34.04	2.824
10.07	283.22	490.18	1869.16	34.04	2.824
20.03	293.18	831.59	2116.45	53.56	2.313
20.01	293.16	831.53	2116.44	53.54	2.312
20.00	293.15	831.22	2116.44	53.70	2.320
19.97	293.12	515.39	1871.88	29.39	2.315
20.02	293.17	515.21	1871.90	29.52	2.326
20.02	293.17	515.18	1871.90	29.54	2.328
29.97	303.12	882.36	2121.74	49.19	1.997
30.03	303.18	882.60	2121.78	49.20	1.997
30.08	303.23	882.92	2121.81	49.14	1.994
30.02	303.17	600.97	1953.44	30.91	2.001
30.02	303.17	601.00	1953.44	30.90	2.000
30.02	303.17	601.21	1953.44	30.67	1.985
30.10	303.25	539.93	1876.65	26.68	2.001
30.07	303.22	540.02	1876.64	26.68	2.001
30.07	303.22	539.92	1876.64	26.62	1.997
39.77	312.92	936.00	2128.86	46.54	1.775
39.68	312.83	935.65	2128.79	46.53	1.775
39.62	312.77	935.25	2128.74	46.59	1.778
40.00	313.15	630.99	1960.14	28.97	1.780
39.99	313.14	631.03	1960.14	28.94	1.779
39.97	313.12	631.23	1960.12	28.80	1.769
40.02	313.17	566.44	1883.06	24.88	1.773
39.97	313.12	566.16	1883.03	24.99	1.782
39.95	313.10	566.25	1883.02	24.91	1.780
50.04	323.19	995.39	2138.07	45.16	1.613
50.00	323.15	994.70	2138.03	45.34	1.620
50.03	323.18	995.48	2138.06	45.02	1.608
49.88	323.03	593.47	1890.88	23.71	1.606
49.92	323.07	593.20	1890.92	23.95	1.623
49.98	323.13	593.38	1890.97	23.93	1.621
60.04	333.19	1057.14	2148.55	44.65	1.494
59.95	333.10	1057.49	2148.51	44.47	1.488
59.91	333.06	1057.64	2148.42	44.32	1.483
80.00	353.15	677.53	1922.61	24.32	1.419
79.95	353.10	676.81	1922.56	24.65	1.440

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Power, G. G.

J. Appl. Physiology 1968, *24*, 468-474.

VARIABLES:

T = 310.15 K
p/kPa = 42 - 95

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P_{CO}/mmHg	P_{CO}/kPa	Bunsen coefficient, α
310.15	318	42.4	0.0189
	318	42.4	0.0189
	318	42.4	0.0193
	318	42.4	0.0186
	318	42.4	0.0187
	340	45.3	0.0189
	340	45.3	0.0189
	709	94.5	0.0188
	711	94.8	0.0189
	711	94.8	0.0186
	711	94.8	0.0191
	711	94.8	0.0190
	711	94.8	0.0191
	315	42.0	0.0185
	315	42.0	0.0189

Average .. 0.0189 ± 0.0002

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Liquid samples were equilibrated with gas and then the dissolved gas was stripped out under vacuum and measured in a manometric Van Slyke apparatus.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.03$.

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Power, G.G.; Stegall, H.

J. Appl. Physiology 1970, *29*, 145-9

VARIABLES:

$T/K = 285.15 - 310.15$
$p = 101.3$ kPa

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	Bunsen coefficient, α	S.D.*	No. of measurements
310.15	0.01880	0.00007	5
298.15	0.02215	0.00006	5
285.15	0.02750	0.00006	5

* Standard deviation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

5 to 12 cm^3 samples placed in a stirrer cell and gas, saturated with water vapor passed through water for 30-60 mins. Samples of saturated liquid withdrawn and transferred to Van Slyke apparatus. Dissolved gas removed under reduced pressure.

SOURCE AND PURITY OF MATERIALS:

1. Matheson sample, purity better than 99.7 mole per cent.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Rettich, T. R.; Battino, R.; Wilhelm, E.

Ber. Bunsenges. Phys. Chem. 1982, *86*, 1128-32.

VARIABLES:

$T/\mathrm{K} = 278.147 - 323.102$

$p_1/\mathrm{kPa} = 58.88 - 108.75$

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Pressure		Henry's Constant		Mol Fraction
	p_1/atm^a	p_1/kPa^b	H/atm^a	$H/\mathrm{GPa}^{c,d}$	$10^5 x_1{}^{a,e}$
278.147	0.8126	82.34	38589	3.91005	2.5914
283.152	0.8663	87.78	43174	4.37462	2.3162
283.159	0.8676	87.91	43187	4.37589	2.3155
288.167	0.9188	93.10	47783	4.84162	2.0928
293.150	0.9373	94.97	52137	5.28282	1.9180
298.141	0.9486	96.12	56288	5.70337	1.7766
298.145	0.9183	93.05	56336	5.70824	1.7751
303.144	0.5811	58.88	60388	6.11881	1.6560
303.158	0.9764	98.93	60350	6.11497	1.6570
308.147	0.9565	96.92	63978	6.48260	1.5630
308.152	1.0012	101.45	63991	6.48389	1.5627
313.139	0.7959	80.64	67400	6.82935	1.4837
318.162	1.0062	101.95	70380	7.13124	1.4209
323.102	1.0733	108.75	72935	7.39010	1.3711

[a] Values calculated by the compiler.

[b] Given as $10^{-3}P/\mathrm{Pa}$ in paper. [c] Given as $10^{-9}H/\mathrm{Pa}$ in paper.

[d] Henry's constant evaluated at saturation pressure of the solvent from:

$$H/\mathrm{atm} = \lim_{x_1 \to 0} (f_1/x_1) \quad \text{where } f_1 \text{ is the fugacity.}$$

[e] Mole fraction calculated for unit fugacity of 1 atm (101.325 kPa).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus used was modelled after that of Benson, Krause, and Peterson (ref 1). Degassed water is flowed in a thin film over the surface of a one dm^3 sphere to contact the gas. After equilibrium is attained the solution is sealed in a chamber of calibrated volume. The dissolved gas is extracted and its amount determined by a direct PVT Measurement. A sample of the gas phase is analyzed in an identical manner. From the results, the saturation pressure of the solvent and Henry's constant are calculated in a thermodynamically rigorous manner, applying all non-ideal corrections.

The authors smoothing equation, which fits their data to 0.04 %, is:

$$\ln (H/\mathrm{Pa}) = 126.753761 - 152.599953/(T/100\ \mathrm{K}) - 67.8429542 \ln (T/100\ \mathrm{K}) + 7.04595356(T/100\ \mathrm{K}).$$

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Research grade. 99.99 mol per cent minimum purity.

(2) Water. Reverse osmosis "house distilled" water was further purified by passage through a series of Illco-Way ion-exchangers and a 1.2 μm pore size Millipore filter. Water resistivity greater than 5 x 10^4 Ωm.

ESTIMATED ERROR:

$\delta H/H = \pm 0.0004$

$\delta T/\mathrm{K} = \pm 0.01$

REFERENCES:

1. Benson, B. B.; Krause, D.; Peterson, M. A. *J. Soln. Chem.* 1979, *8*, 655.

COMPONENTS:	EVALUATOR.
1. Carbon monoxide; CO; [630-08-0] 2. Water; H_2O; [7732-18-5]	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

The high pressure solubility of carbon monoxide in water

Four groups of workers have measured the solubility of carbon monoxide in water at temperatures up to 573 K and pressures between 0.1 and 9 MPa. The data of Jung *et al.*(1) are the most comprehensive, covering 298-573 K and pressures up to 9 MPa. In the evaluator's opinion, they are also the most reliable as demonstrated in the comparison table 1 below. Unfortunately their original paper gave results only in the form of graphs from which the numerical data have been compiled. The data sheet should be consulted for details.

The values from Granzhan (2) at 5.06 MPa and 298-348 K appear to be high by about a factor of two, and should be rejected. The values from Dake and Chaudhari (3) at 2-6.3 MPa do not show a minimum around 348 K as expected, and compare favourably with those of Jung *et al.* only around 448 K. The data of Taqui Khan and Halligudi (4) at 3 MPa appear to be too low except for the value at 403.15 K.

For comparison in the following table, all values were converted on the data sheets to the mol fraction solubility at 1 MPa, assuming the validity of Henry's law. This assumption appears to be justified from the experimental work for the pressure range of the measurements.

Table 1. Comparison of data from different sources on the solubility of carbon monoxide in water

T/K	$10^4 x_1$ at p_1 = 1 MPa				10^5 x_1 at p_1 = 0.1 MPa
	Jung (1)	Granzhan (2)	Dake (3)	T. Khan (4)	Rettich (5)
298.15	1.76	2.37	1.43		1.775
323.15	1.42	2.57			1.371
343.15				1.10	
348.15	1.28	2.77	1.62		
373.15	1.31			1.16	
398.15	1.49		1.8		
403.15				1.51	
448.15	2.17		2.0		
498.15	4.02				

References

1. Jung, J.; Knacke, O.; Neuschutz, D. *Chemie-Ing-Techn.* 1971, *43*, 112.
2. Granzhan, V.A. *Tr. Gos. Nauchno-Issled. Proektn. Inst. Azotu Prom-sti Prod. Org. Sint.* 1974, *27*, 5.
3. Dake, S.B.; Chaudhari, R.V. *J. Chem. Eng. Data* 1985 *30*, 400.
4. Taqui Khan, M.M.; Halligudi, S.B. *J. Chem. Eng. Data* 1988, *33*, 276.
5. Rettich, T.R.; Battino, R; Wilhelm, E. *Ber. Bunsenges Phys. Chem.* 1982, *86*. 1128.

COMPONENTS:

1. Carbon monoxide; CO; [130-08-0]
2. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Jung, J.; Knacke, O.; Neuschutz, D.

Chemie-Ing.-Techn. 1971, *43*, 112-116.

VARIABLES:

T/K: = 298-573
p_1/MPa = 0.1 - 9

PREPARED BY:

E. Wilhelm

EXPERIMENTAL VALUES:

T/K	K_H/GPa	$10^4 x_1$ at 1MPa
298.15	5.67	1.76
323.15	7.05	1.42
348.15	7.82	1.28
373.15	7.62	1.31
398.15	6.70	1.49
423.15	5.64	1.77
448.15	4.59	2.18
473.15	3.48	2.87
498.15	2.49	4.02
523.15	1.72	5.81
548.15	1.15	8.70
573.15	0.76	13.2

For each temperature the authors measured the solubility (mole fraction and Kuenen coefficient) as a function of pressure up to about 9 MPa (graphical presentation only). From the low-pressure results they determined Henry's Law constants and plotted K_H against temperature. From such a graph (figure 9 of the source publication) the compiler read the K_H and T data, and then calculated mol fractions for a reference pressure of 1MPa, assuming $p_1 = K_H x_1$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static 2.5 dm^3 cell fitted with stirrer. After equilibrium is established, samples are removed and analysed by volumetric method. Details in source.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide contained about 0.4% hydrogen and traces of nitrogen, methane and carbon dioxide.

(2) Water: no details given.

ESTIMATED ERROR:

δT/K = ± 0.2, δP/MPa = ± 0.02
δK_H = ± 5% (estimated by compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Granzhan, V.A.

Tr. Gos. Nauchno-Issled. Proektn. Inst. Prom-sti Org. Synt. 1974, *27*, 5-9.

VARIABLES:

$T/K = 298\text{-}348$
$p_1/MPa = 5.06$

PREPARED BY:

Yu.P.Yampol'skii

EXPERIMENTAL VALUES:

T/K	Solubility at p_1 = 5.06 MPa $cm^3(STP)\ g^{-1}$	 10^2x_1
298	1.5	1.2
323	1.6	1.3
348	1.8	1.4

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Measurements were made in the apparatus originally described in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon Monoxide. Purity ⩾99.9%

(2) Water. Bidistilled.

ESTIMATED ERROR:

Solubility: ± 5%
Pressure ± 1 atm (± 2%)

REFERENCES:

1. Krichevskii, I.R.; Zhavoronkov, N.M.; Tsiklis, D.S. *Zh. fis. chim* (USSR), 1937, *9*, 317.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Dake, S.B.; Chaudhari, R.V.

J. Chem. Eng. Data 1985, *30*, 400-403.

VARIABLES:

T/K = 298-448
p_1/MPa = 2 - 6.3

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/MPa	$10^3 S$/kmol m^{-3}	$10^4 x_1$ *	$10^4 x_1$ at 1MPa**
298	2.026	1.607	2.90	1.43
	4.052	3.17	5.71	1.41
	6.078	4.82	8.69	1.43
348	2.127	1.87	3.45	1.62
	4.183	3.71	6.84	1.63
	6.209	5.49	10.01	1.61
398	2.198	2.05	3.92	1.78
	4.254	4.11	7.85	1.84
	6.260	5.98	11.41	1.82
448	2.218	2.19	4.36	1.97
	4.355	4.46	8.88	2.04
	6.331	6.47	12.88	2.03

* calculated by compiler from S values
** calculated by compiler for reference pressure of 1MPa, assuming $p_1 = Kx_1$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas to saturation under pressure in an autoclave of 2 dm^3 capacity, maintained at the required temperature. A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure, where the volume of the desorbed gas is measured by displacement of gas-saturated water at constant temperature (1).

Vapour pressures of solvent are used to calculate partial pressure of gas in autoclave.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: generated by dehydration of formic acid; purity $>$ 99.5%.

(2) Water: distilled.

ESTIMATED ERROR:

$\delta S = \pm 3\%$ (authors)

REFERENCES:

1. Radhakrishnan, K.; Ramachandran, P.A.; Brahme, P.H.; Chaudhari, R.V. *J. Chem. Eng. Data* 1983, *28*, 1

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Water; H_2O; [7732-18-5]	Taqui Khan, M.M.; Halligudi, S.B. *J. Chem. Eng. Data* 1988, *33*, 276-278.
VARIABLES:	**PREPARED BY:**
T/K = 343-403 p_1/MPa = 3	R.W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/MPa	$10^6 H$/kmol m^{-3}kPa^{-1}	$10^4 x_1$ *	$10^4 x_1$ at 1MPa **
343	3.171	6.00	3.50	1.10
353	3.155	6.07	3.54	1.12
363	3.132	6.13	3.58	1.14
373	3.101	6.19	3.60	1.16
383	3.059	6.75	3.90	1.28
393	3.004	7.31	4.18	1.39
403	2.932	7.86	4.42	1.51

* calculated by compiler from H values

** calculated by compiler for reference pressure of 1MPa, assuming $p_1 = Kx_1$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas under pressure in an autoclave of 300 cm^3 capacity at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure where the volume of gas is measured by displacement of gas-saturated water at constant temperature (1).

Corrections are made for vapour pressures of solvent, and for the solubility of the gas at atmospheric pressure.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from British Oxygen Co., purity > 99.6% by GC analysis.

(2) Water: distilled.

ESTIMATED ERROR:

δP_1 = 3 kPa
δT = 0.1K
δH = ± 3% (authors)

REFERENCES:

1. Chaudhary, V.R.; Parande, M.G.; Brahme, P.H. *Ind. Eng. Chem. Fundam.* 1982, *21*, 472.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Sea Water

EVALUATOR:

Denis A. Wiesenburg
Geochemical and Environmental Research Group
Department of Oceanography
Texas A&M University
College Station, Texas 77843 USA

1989, May

CRITICAL EVALUATION:

AN EVALUATION OF THE SOLUBILITY OF CARBON MONOXIDE IN SEA WATER

There are only two reports of the solubility of carbon monoxide in sea water (1, 2). The two reports both cover a wide range of temperatures, but the sea water salinity range is limited in both reports. The main differences between the two, however, are in their technique and the partial pressure of carbon monoxide used. Douglas (1) reports 48 solubility measurements for three chlorinities (15.38, 18.60, 20.99‰) for several different temperatures between 274.03 and 202.85 K. Chlorinity can be related to salinity through the expression Salinity (‰) = 1.80655 x Chlorinity (‰). The carbon monoxide solubility measurements of Douglas are estimated to have an accuracy of 0.6% and calculations of the relative standard deviation (RSD) at each temperature varied from 0.05 - 0.55% with an average RSD of 0.23%. There was no systematic variation in the data with either chlorinity or temperature and the RSD of the data at each chlorinity was identical to the average of the data set, 0.23%. Schmidt (2) reports 24 solubility values over the temperature range of 272.71-297.42 K at a salinity of 31.6‰ (chlorinity = 17.5‰). The carbon monoxide solubility measurements of Schmidt (1) are estimated to have a standard error of 7%. The difference between the methods used by Schmidt (2) and Douglas (1) are significant. Douglas (1) used a modification of the microgasometric technique of Scholander (3) and a carbon monoxide partial pressure of 101.325 kPa. Schmidt (2) saturated sea water using a glass purging cylinder and a standard gas with a carbon monoxide partial pressure of 9.7×10^{-4} kPa (9.6 ppmv). The levels of carbon monoxide in the equilibrated sea water were too low to measure volumetrically and were measured with a HgO technique (4). The extrapolation from these extremely low pressures to 101.325 kPa for the Bunsen solubility determination probably causes the high error in the method. As a result of this error, the data of Schmidt (2) are not considered reliable.

The solubility data of Douglas (1) is of high enough precision that it can be used to derive a predictive equation. Douglas' data were combined with the distilled water data of Winkler (5), without weighting, to derive a smoothing equation. The combined data sets have been fitted (6) by the method of least squares to an equation developed by Weiss (7) which expresses solubility as the natural logarithm of the Bunsen coefficient, α, and is consistent with both the integrated form of the van't Hoff equation and the Setchenow salt effect relation. The equation for carbon monoxide is valid from 273.15 to 303.15 K and a salinity range, S, of 0 to 40‰. The smooth equation reproduced the combined carbon monoxide data with a root-mean-square deviation of 1.3×10^{-4} units (~ 0.42%). The equation is

$$\ln \alpha = -47.6148 + 69.5068\ (100/T) + 18.7397 \ln (T/100)$$

$$+ S\ [0.045657 - 0.040721\ (T/100) + 0.0079700\ (T/100)^2]$$

where S is the salinity in parts per thousand. Wiesenburg and Guinasso (6) give an extensive table of carbon monoxide Bunsen coefficients calculated from the above equation.

Although the Bunsen solubility coefficients are well defined by the above equation, for practical purposes, oceanographers require the atmospheric equilibrium solubility values in their work. Weiss (7) has proposed an equation similar to the above which expresses the atmospheric equilibrium solubility from moist air at 1 atm total pressure, in units of volume (STP) dm^{-3}, as a function of salinity and temperature. In working with samples from the depths of the ocean, it is also advantageous to express

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Sea Water	EVALUATOR: Denis A. Wiesenburg Geochemical and Environmental Research Group Department of Oceanography Texas A&M University College Station, Texas 77843 USA 1989, May

CRITICAL EVALUATION:

atmospheric solubilities in terms of mol kg^{-1}, which are pressure and temperature independent (7, 8). Weiss' atmospheric solubility equation is based on the assumption of a constant atmospheric concentration of carbon monoxide. Since carbon monoxide is variable in the atmosphere, Weiss' (7) equation has been modified (6) to include atmospheric concentration as a variable. The combined data sets for carbon monoxide (1,6) have been fitted (6) to the equations

$$\ln c_1/\mathrm{nl\ dm^{-3}} = \ln f_g - 169.4951 + 263.5657\ (100/T)$$

$$+ 159.2552 \ln (T/100) - 25.4967\ (T/100)$$

$$+ S\ [\ 0.051198 - 0.044591\ (T/100) + 0.0086462\ (T/100)^2]$$

$$\ln m_1/\mathrm{nmol\ kg^{-1}} = \ln f_g - 175.6092 + 267.6796\ (100/T)$$

$$+ 161.0862 \ln (T/100) - 25.6218\ (T/100)$$

$$+ S\ [\ 0.046103 - 0.041767\ (T/100) + 0.0081890\ (T/100)^2]$$

where f_g is the mole fraction of carbon monoxide in dry air. In these calculations carbon monoxide was assumed to be an ideal gas. Vapor pressure for pure water was calculated using the equation of Bridgeman and Aldrich (9) and corrected for salinity effects using the expression of Robinson (10). Knudsen's (11) formula was used to calculate densities. These two equations can be used to measure the atmospheric equilibrium solubility of carbon monoxide under any given conditions of temperature, salinity, and atmospheric concentration. Using an atmospheric carbon monoxide mole fraction of 0.11×10^{-6} (12), the equations reproduce the individual calculated atmospheric solubilities with a root-mean-square deviation of 0.45%.

References

1. Douglas, E. *J. Phys. Chem.* 1967, *71*, 1931-1933.
2. Schmidt, U. *Tellus* 1979, *31*, 68-74.
3. Scholander, P.F. *J. Biol. Chem.* 1947, *167*, 235-250.
4. Schmidt, U; Seiler, W. *J. Geophy. Res.* 1970, *75*, 1713.
5. Winkler, I.W. *Z. Phys. Chem. Abt. A*, 1908, *55*, 344-354.
6. Wiesenburg, D.A.; Guinasso, N.L., Jr. *J. Chem. Eng. Data* 1979, *24*, 356-360.
7. Weiss, R.F. *Deep-Sea Res.* 1970, *17*, 721.
8. Kester, D. in "Chemical Oceanography" v. 1 2nd Edition, J.P. Riley and G. Skirrow, eds. Academic Press, New York, 1975, pp. 498-556.
9. Bridgeman, O.C.; Aldrich, E.W. *J. Heat Transfer* 1964, *86*, 279.
10. Robinson, R.A. *J. Mar. Biol. Assoc. U.K.* 1954, *33*, 449.
11. Knudsen, M. Hydrographical Tables, G.E. Gad, Copenhagen, 1901.
12. Robinson, E; Robbins, R.C. *Suppl. Rept., Stanford Res. Inst., Project PR-6755* 1969, *27*.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Sea Water

ORIGINAL MEASUREMENTS:

Douglas, E. *J. Phys. Chem.* 1967, *71*, 1931-1933.

VARIABLES:

T/K: 274.03 - 303.85
CO P/kPa: 101.325 (1 atm)
Chlorinity (^{o}/oo): 15.38 - 20.99

PREPARED BY:

Denis A. Wiesenburg

EXPERIMENTAL VALUES:

Chlorinity ^{o}/oo					
15.38		18.60		20.99	
Temp/K	Bunsen Coefficient α	Temp/K	Bunsen Coefficient α	Temp/K	Bunsen Coefficient α
274.65	0.02904	275.35	0.02744	274.03	0.02753
274.65	0.02895	275.35	0.02758	274.03	0.02759
274.65	0.02894	275.35	0.02747	274.03	0.02755
279.61	0.02606	279.65	0.02485	279.25	0.02452
279.61	0.02590	279.65	0.02488	279.25	0.02440
279.61	0.02597	279.65	0.02512	279.25	0.02440
283.15	0.02422	283.29	0.02329	283.19	0.02274
283.15	0.02415	283.29	0.02328	283.19	0.02269
283.15	0.02420	283.28	0.02326	283.19	0.02267
288.11	0.02216	288.40	0.02127	288.40	0.02085
288.11	0.02225	288.40	0.02125	288.40	0.02075
288.11	0.02217	288.40	0.02129	288.40	0.02060
293.01	0.02049	293.23	0.01982	293.01	0.01925
293.01	0.02043	293.23	0.01974	293.01	0.01925
293.01	0.02050	293.23	0.01976	293.01	0.01914
297.75	0.01913	298.23	0.01832	298.38	0.01775
297.75	0.01920	298.23	0.01829	298.38	0.01779
297.75	0.01910	298.23	0.01826	298.38	0.01783
303.15	0.01782	303.85	0.01725	303.20	0.01684
303.15	0.01802	303.85	0.01732	303.20	0.01686
303.15	0.01780	303.85	0.01712	303.20	0.01679

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility determinations were made using the Scholander microgasometric technique as modified by Douglas (1). Gas-free sea water is brought into contact with pure carbon monoxide in a reaction vessel with a volume capable of accommodating 8 ml of water (2). The vessel is operated in a water bath in a constant temperature room. Rapid mechanical shaking for 30 min. allowed equilibration between the carbon monoxide and sea water. The amount of gas absorbed and the volume of sea water were measured volumetrically with a micrometer buret. Bunsen solubility coefficients were calculated from the observed volumes.

SOURCE AND PURITY OF MATERIALS:

1. Carbon monoxide. Source not given. Purity determined to be at least 99.7% by one method and >99% by another.
2. Sea Water. Gas-free sea water was obtained by vacuum extraction over mercury, millipore filtered and stored at 277^{o}K.

ESTIMATED ERROR:

$\delta T/K = 0.02$

$\delta Cl/^{o}/oo = 0.05$

REFERENCES:

1. Douglas, E.
   J. Phys. Chem. 1964, *68*, 169.
2. Douglas, E.
   J. Phys. Chem. 1965, *69*, 2608.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Sea Water

ORIGINAL MEASUREMENTS:

Schmidt, U. *Tellus*, 1979, *31*, 68-74.

VARIABLES:

T/K: 272.71 - 297.42
P/kPa: 9.7×10^{-4}
Salinity $^{o}/oo$: 31.6

PREPARED BY:

Denis A. Wiesenburg

EXPERIMENTAL VALUES:

Temp/K	Salinity $^{o}/oo$ 31.6 Bunsen Coefficient α
272.96	0.02927
272.71	0.02895
273.03	0.02779
272.78	0.02746
277.89	0.02590
278.36	0.02586
277.98	0.02538
278.13	0.02500
282.91	0.02402
282.78	0.02386
282.92	0.02375
282.96	0.02308
287.52	0.02257
287.72	0.02274
287.62	0.02205
287.63	0.02164
293.09	0.02101
292.88	0.01962
294.47	0.02045
294.81	0.02051
297.35	0.01948
297.42	0.01949
297.37	0.01907
297.39	0.01867

These data were digitized by the compiler from Figure 2 of the paper.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility determinations were made using a 3 L glass purging cylinder jacketed by a water bath for temperature control. The sea water was purged with a very low partial pressure mixture of CO and H_2 at a flow rate of 1 L min^{-1} for 30 min. A 0.2 L sample of equilibrated water was sucked into an evacuated sample cylinder and equilibrated with CO-free air at 1 atm. The water volume and air volume were measured volumetrically. The CO content of the equilibrated air was determined using the HgO method (1,2). This value was used along with the volumes of air and water in the sample cylinder to calculate the solubility coefficient.

SOURCE AND PURITY OF MATERIALS:

1. Carbon monoxide. No information given.
2. Sea Water. Artificial sea water.

ESTIMATED ERROR:

$\delta\alpha = \pm 7\%$ (estimated by author)
$\delta T/K$ no information given

REFERENCES:

1. Schmidt, U.; Seiler, W. *J. Geophys. Res.* 1970, *75*, 1713.
2. Seiler, W.; Junge, C. *J. Geophys. Res.* 1970, *75*, 2217.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Electrolytes 3. Water; H_2O; [7732-18-5]	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

Few workers have measured the solubility of carbon monoxide in aqueous solutions of simple electrolytes. Two papers deal with sulfuric acid, and one with its sodium salt also. One recent paper contained some information about aqueous copper(I) chloride and magnesium chloride, but no comment can be made about this system because the report of this work by Anserova and Ksandrov (1) was not available outside the USSR at the time of requesting it.

Eight papers report more extensively on acetates, carbonates, and/or formates of copper(I) - ammonium solutions which have been used industrially at various times as absorbents for carbon monoxide gas.

1. Carbon monoxide + sulfuric acid [7664-93-9] + water

Christoff (2) measured the solubility of carbon monoxide at 293.15 K and 101.3 kPa in water, concentrated sulfuric acid, and in two mixtures of these substances. The values given on the data sheet may be accepted tentatively. The Sechenov salt effect parameters $k_{sc\alpha}$ (= k_{scL}) are 0.073 and 0.043 $dm^3 \ mol^{-1}$ at c_2 = 4.63 and 9.52 mol dm^{-3} respectively.

2. Carbon monoxide + sodium sulfate [7757-82-6] + sulfuric acid [7664-93-9] + water

The single measurement at 298.15 K by Kobe and Kenton (3) is classed as tentative.

3. Carbon monoxide + cuprammonium carbonate or formate or acetate, + water.

Several solvent systems for carbon monoxide have been based upon the copper(I) - ammonia complex ion in solution, along with different oxo-anions. Interest in these systems has stemmed from their use in absorbing carbon monoxide from gas streams at low temperature, and releasing it at high temperature. Applications range from the purification of hydrogen (made from carbon monoxide and steam) required to synthesise ammonia, to, more recently, the purification of carbon monoxide itself for catalytic conversion to a number of organic compounds of commercial importance.

The work of Hainsworth and Titus (4) in 1921 was the first detailed study. Two different cuprammonium carbonate solutions were investigated and a data sheet has been prepared although their paper gave results only in the form of graphs. Similar work was done by Larson and Teitsworth (5) a year later on carbonate and formate solutions. Data have been compiled for one of the formate solutions only. It was not possible to compile data on the other nine solutions studied by these authors, because, firstly, the data were given only as points on small-scale, crowded graphs, and, secondly, comparison of the available tabulated and graphed data revealed that the scales on the axes of these graphs were incorrectly calibrated.

Both of these studies were made at temperatures between 273 and 333 K, and partial pressures of carbon monoxide varied up to about 3.5 bar or 1.2 bar. The conclusion reached by these authors is that the absorption of carbon monoxide is proportional to the concentration of copper(I) in solution. When formate was substituted for carbonate the capacity of the solutions for gas absorption was unchanged. However formate inhibited precipitation of copper from the solution. The compiled data of these authors can be taken as tentative, but treated with caution.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Electrolytes
3. Water; H_2O; [7732-18-5]

EVALUATOR:

Robert W. Cargill,
Department of Molecular
and Life Sciences,
Dundee Institute of Technology,
Bell Street, Dundee DD1 1HG, U.K.

March 1989

CRITICAL EVALUATION:

Another paper, by Balla Béla and Kineses Gyula (6), may be referred to for this copper carbonate/formate - ammonia system. Similar conclusions were reached about the equivalence of formate and carbonate so long as the ammonia content of the solutions was the same. No data sheet was compiled, however, because the results were presented only on a small scale graph. Partial pressures of gas were 1-10 atm.

Tsiklis and Kofman (7) investigated three solutions containing copper(I) and copper(II) along with ammonia and carbonate, at 273-333 K, and partial pressures of carbon monoxide of 0.1 to 10 bar. Similar work by Ivanov *et al* (8) at these temperatures and pressures included acetate along with carbonate in some solutions. The gas phase was carbon monoxide in mixture with hydrogen and nitrogen at a total pressure of about 300 bar. The data from these papers may also be taken as tentative. With a large number of variables in the compositions and concentrations of the solutions it is not possible to make exact comparisons between the results from different authors, and the individual data sheets must be consulted for details.

A consecutive series of papers by Ksandrov and Strongin (9) also dealt with this type of solvent system. Lactate was an additional anion included in the study. However, data have not been obtained from these Russian papers because they were inaccessible at the time of searching.

In addition to the above, Korbutova *et al.* (10) and Vylivok *et al.* (11) investigated the effects of composition and temperature on the solubility of carbon monoxide in several solutions containing copper(I), copper(II), ammonia, carbon dioxide, and acetic acid at 283-313 K and partial pressures up to 1 bar. These authors concluded that the reaction occurring in these solutions could be represented by the equation

$$[Cu(NH_3)_3H_2O]^+ + CO + NH_3 \rightleftharpoons [Cu(NH_3)_4(H_2O)CO]^+.$$

Vylivok *et al.* used a gas mixture of carbon monoxide with carbon dioxide and showed that the absorption of carbon dioxide into the solution affected its free ammonia content, and this in turn altered the carbon monoxide solubility, unless the ammonia in solution was present in excess. Unfortunately, meaningful data sheets could not be compiled from these papers because the units of solubility measurement and some of the conditions were not clearly stated.

References

1. Anserova, N.N.; Ksandrov N.V.; *Deposited Doc.* 1982 *SPSTL* 811, Khp-D82 (10 pages, Russian). (*Chem. Abs. 100*, 145835).
2. Christoff, A. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1906, *55*, 622.
3. Kobe, K.A.; Kenton, F.H. *Ind. Eng. Chem., Anal. Ed.* 1938, *10*, 76.
4. Hainsworth, W.R.; Titus, E.Y. *J. Amer. Chem. Soc.* 1921, *43*, 1.
5. Larson, A.T.; Teitsworth, C.S. *J. Amer. Chem. Soc.* 1922, *44*, 2878.
6. Balla Béla; Kincses Gyula *Nehezvegyipari Kutato Intezet Kozlemenyei* 1959, *1*, 207.
7. Tsiklis, D.S.; Kofman, A.N. *Khim. Prom.* 1956, 398.
8. Ivanov, D.; Shishkov, D; Kirova, Z. *Godishnik Khim. Technol. Inst.* 1961, 55.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Electrolytes 3. Water; H_2O; [7732-18-5]	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

9. Ksandrov, N.V.; Strongin , G.M. *Tr. Khim. Khim. Tekhnol* 1967, *1*, 20-24, 25-30, 31-37, 45-48.
(*Chem. Abs.* *68*, 117543, 117541; *69*, 62009, *70*, 71513).

10. Korbutova, Z.V.; Furmanov, A.S.; Furmer, I.E.
Zh. Prikl. Khim. 1974, *47*, 2389;
J. Appl. Chem. (USSR) 1974, *47*, 2459.

11. Vylivok, T.V.; Furmanov, A.S.; Furmer, I.E.
Zh. Prikl. Khim. 1974, *47*, 2499;
J. Appl. Chem. (USSR) 1974, *47*, 2571.

Footnote

Wilson *et al.* (12) investigated the solubility of a mixture of six gases which included carbon monoxide in aqueous ammonia, over 310-478 K, and at total pressures between 230 kPa and 6900 kPa. These data have been compiled in *Volume 32* of the *Solubility Data Series (Hydrogen Sulfide)*, 75-77.

12. Wilson, G.M.; Gillespie, P.C.; Owens, J.L.
Proc. 64th Ann. Conv. Gas Processors Association, 1985, 282-288.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Sulfuric acid; H_2SO_4; [7664-93-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Christoff, A.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1906, *55*, 622-634.

VARIABLES:

T/K = 293.15
p_1/kPa = Atmospheric
H_2SO_4/wt % = 0 - 95.6

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Sulfuric Acid		Ostwald Coefficient
t/°C	T/K	H_2SO_4/wt %	m_2/mol kg^{-1}	L/cm^3cm^{-3}
20	293.15	0.0	0.0	0.02482
		35.82	5.69	0.01140
		61.62	16.37	0.009582
		95.6	222.	0.02327

The compiler calculated the acid molality values.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus was an Ostwald type (ref 1) with a lead capillary tube through which the gas flows to the absorption flask, gas buret, and gasometer.

The acid solution was degassed by boiling under reflux. The author estimates a one percent change in the acid concentration due to the degassing procedure. The adsorption flask was filled with solvent, the gas was introduced, and the system shaken until equilibrium was reached.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by heating sulfuric acid and sodium formate.

(2) Sulfuric acid. Merck. Specific gravity 1.271, 1.523, and 1.839 for the 35.82, 61.62, and 95.6 wt % acid, respectively.

(3) Water. Distilled.

ESTIMATED ERROR:

δT/K = ± 0.02 for solvent
± 0.5 for gas
Barometric fluctations were stated to be negligible.

REFERENCES:

1. Ostwald, W.
Lehrbuch der allgem. Chemie (2 Aufl.), *1*, 615.

COMPONENTS:

(1) Carbon Monoxide; CO; [630-08-0]

(2) Sulfuric acid; H_2SO_4; [7664-93-9]

(3) Sodium sulfate; Na_2SO_4; [7757-82-6]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kobe, K. A.; Kenton, F. H.

Ind. Eng. Chem., Anal. Ed. 1938, *10*, 76 - 77.

VARIABLES:

T/K: 298.15
p_1/kPa: 101.325 (1 atm)

PREPARED BY:

P. L. Long
H. L. Clever

EXPERIMENTAL VALUES:

Temperature t/°C	Temperature T/K	Solvent Volume V/cm^3	Carbon monoxide Volume Absorbed v_1/cm^3	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
25	298.15	99.54	0.39		
		99.54	0.38	0.0036	0.0039

The solvent is a mixture of 800 g H_2O

200 g Na_2SO_4 (anhydrous)

40 ml H_2SO_4 (Conc., 36 normal)

Thus the molality of the solution is

$$m_2/\text{mol kg}^{-1} = 0.90\ (H_2SO_4)$$

$$m_3/\text{mol kg}^{-1} = 1.76\ (Na_2SO_4)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus is described in detail in an earlier paper (1). The apparatus consists of a gas buret, a pressure compensator, and a 200 cm^3 absorption bulb and mercury leveling bulb. The absorption bulb is attached to a shaking mechanism.

The solvent and the gas are placed in the absorption bulb. The bulb is shaken until equilibrium is reached. The remaining gas is returned to the buret. The difference in the final and initial volumes is taken as the volume of gas absorbed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Source not given. Purity stated to be 99+ per cent.

(2, 3) Sulfuric acid and sodium sulfate. Sources not given. Analytical grade.

(4) Water. Distilled.

ESTIMATED ERROR:

$\delta\alpha/cm^3 = \pm 0.001$ (authors)

REFERENCES:

1. Kobe, K. A.; Williams, J. S. *Ind. Eng. Chem., Anal. Ed.* 1935, *7*, 37.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Copper(I) ammonium carbonate; [33113-08-5]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Hainsworth, W. R.; Titus, E. Y.

J. Amer. Chem. Soc. 1921, *43*, 1-11.

VARIABLES:

$T/K = 274 - 333$

$p_1/kPa = 24 - 346$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

SOLVENT I: $[Cu^+] = 0.612$, $[NH_3] = 2.76$, $[CO_2] = 1.075$ mol dm^{-3}

Temperature		pressure		Ostwald coefficient	pressure		Ostwald coefficient
$t/°C$	T/K*	p_1/cm Hg	p_1/kPa*	$L/cm^3\ cm^{-3}$	p_1/cm Hg	p_1/kPa*	$L/cm^3\ cm^{-3}$
1	274.15	48	64	7.9	183	244	11.2
		72	96	9.3	204	272	11.4
		105	140	10.1	227	303	11.6
		137	183	10.8	259	345	11.9
		177	236	11.2			
6	279.15	50	67	7.1	149	199	10.2
		72	96	8.3	193	257	10.7
		138	184	10.1	256	341	11.3
11	284.15	53	71	6.3	166	221	9.4
		73	103	7.3	198	264	9.8
		90	120	7.9	200	267	9.8
		102	134	8.3	222	296	10.1
		137	183	9.1	244	325	10.4
22	295.15	74	99	5.3	150	200	7.3
30	303.15	74	99	3.8	164	219	5.8
		106	141	4.6			
45	318.15	72	96	2.3	139	185	3.1
		117	156	2.9			

* calculated by compiler.

All values of p_1 and L read off graph in source by compiler.

contd.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas enclosed between two columns of mercury was equilibrated by bubbling through a sample (6 - 10 cm^3) of solvent over a period of several hours, while measurements of volume were made at the desired pressure.

Allowance was made for vapour pressure of the solvent. For pressures below 500 mmHg, the carbon monoxide was diluted with nitrogen, introducing a slight error. For temperatures above 40°C, a simpler version of the apparatus was used.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: experiment 1: 98% CO, 0.4% O_2, 1.6% N_2; experiment 2: 99.75% CO, 0.05% O_2, 0.2% N_2.

(2,3) Solvent composition/mol dm^{-3}:

	Cu^+	Cu^{2+}	total NH_3	total CO_2
No I	0.612	(trace)	2.76	1.075
No II	0.719	0.035	6.82	1.389

Details of preparation and analysis in source.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$

$\delta L/L = \pm 0.02$ below 40°C

± 0.04 above 40°C (compiler)

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Copper(I) ammonium carbonate; [33113-08-5] 3. Water; H_2O; [7732-18-5]	Hainsworth, W. R.; Titus, E. Y. *J. Amer. Chem. Soc.* 1921, *43*, 1-11.

EXPERIMENTAL VALUES (continued):

SOLVENT II: $[Cu^+] = 0.719$, $[Cu^{2+}] = 0.035$, $[NH_3] = 6.82$, $[CO_2] = 1.389$ mol dm^{-3}

Temperature		pressure		Ostwald coefficient	pressure		Ostwald coefficient
t/°C	*T*/K*	p_1/cm Hg	p_1/kPa*	*L*/cm^3 cm^{-3}	p_1/cm Hg	p_1/kPa*	*L*/cm^3 cm^{-3}
1	274.15	16	21	13.9	70	93	16.2
		24	32	14.7	71	94	16.3
		25	33	14.9	102	136	16.6
		37	49	15.7	151	201	16.7
		39	52	15.6	213	284	16.8
		57	76	16.1			
11	284.15	18	24	12.6	65	87	15.0
		23	31	13.1	74	99	15.2
		27	36	13.4	81	108	15.4
		30	40	13.7	84	112	15.5
		44	59	14.4	101	135	15.7
		54	72	14.7	174	232	16.1
		60	80	14.9	217	289	16.3
40	313.15	116	155	10.5	215	287	12.6
		173	231	11.7			
50	323.15	135	180	8.0	179	239	9.2
60	333.15	154	205	5.9			

* calculated by compiler.

All values of p_1 and *L* were read off graph in source by compiler.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Copper(I) ammonium formate; [64815-77-6]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Larson, A.T., Teitsworth, C.S.

J. Amer. Chem. Soc. 1922, *43*, 2878-2885.

VARIABLES:

T/K = 273-333
p_1/kPa = 1.6 - 50

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

Temperature		Pressure		Bunsen coefficient (+)
t/°C	T/K*	p_1/mmHg	p_1/kPa*	α/cm^3 (STP) cm^{-3}atm^{-1}
0	273.15	12	1.60	4.59
		33	4.40	8.29
		73	9.73	11.56
		166	22.1	14.20
20	293.15	62	8.26	3.85
		141	18.8	6.67
		239	31.9	9.08
		369	49.2	11.10
40	313.15	64	8.53	1.17
		128	17.1	1.91
60	333.15	185	24.7	0.90
		331	44.1	1.49

* calculated by compiler

(+) authors state that the volume of gas absorbed was calculated for 0°C and 760mmHg; from evidence available compiler believes this to be the Bunsen coefficient.

Note: The above data are tabulated and plotted on graphs in source. Data for 9 other solvent compositions are given only on graphs. These could not be meaningfully compiled because careful comparison showed that the pressure axis in figure 3, and both axes in figure 2 have scales which are incorrectly calibrated.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Carbon monoxide was stirred magnetically into a 10 cm^3 sample of solution in an absorption pipette, contained in a thermostatted water bath. Equilibrium was attained within a few minutes. The volume of gas absorbed was measured by manometer readings. Allowance was made for the vapour pressure of the solvent.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from formic acid + conc H_2SO_4; purified and stored in copper ammonium formate solution; released on heating.

(2,3) Solvent composition/mol dm^{-3} [Cu] 0.84, [NH_3] 6.52, [HCO_2H] 3.04. Details of preparation in source.

ESTIMATED ERROR:

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Cuprammonium carbonate; [33113-08-5]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Tsiklis, D.S.; Kofman, A.N.

Khim.Prom. 1956, 398-403.

VARIABLES:

$T/K = 273\text{-}333$
$p_1/\text{kPa} = 10\text{-}1000$

PREPARED BY:

Yu.P.Yampol'skii

EXPERIMENTAL VALUES:

Solubility: cm^3 (at STP) of carbon monoxide per cm^3 solvent

Solution No.	p_1/atm	273.1 K	293.1 K	313.1 K	333.1 K
1	0.1	5.0	3.0	2.0	0.8
	0.5	17.4	11.2	8.0	2.8
	1.0	21.2	18.0	12.8	5.2
	5.0	31.6	27.5	23.5	17.0
2	0.1	19.5	9.8	3.7	1.3
	0.5	30.0	22.9	13.0	6.0
	1.0	32.0	27.5	18.8	10.0
	5.0	34.0	32.7	29.6	23.0
	10.0	34.2	33.6	31.8	27.7
3	0.1	1.8	1.0	0.3	-
	0.5	8.8	4.2	1.3	0.8
	1.0	15.4	8.6	2.7	1.3
	5.0	33.3	27.0	11.0	5.6

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

For 3 different solvent compositions, the solubility of carbon monoxide was measured by a static method in a rocking autoclave of stainless steel. The total pressure in the gas phase was 50 kg cm^{-2} for solution 1, and 300 kg cm^{-2} for solutions 2 and 3. The partial pressure of carbon monoxide in the gas was varied as shown above.

SOURCE AND PURITY OF MATERIALS:

Composition of solutions/mol dm^{-3}

Solution No.	1	2	3
$[Cu^+]$	1.12	0.91	1.64
$[Cu^{2+}]$	0.40	0.71	0.85
$[NH_3]$	10.7	10.7	8.9
$[CO_2]$	3.4	-	4.4

ESTIMATED ERROR:

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Cuprammonium acetate; [23087-46-9]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ivanov, D.; Shishkov, D.; Kirova, Z.

Godishnik Khim. Technol. Inst. 1961, 55-72.

VARIABLES:

T/K = 283-313
p_1/kPa = 20-607

PREPARED BY:

Yu.P.Yampol'skii

EXPERIMENTAL VALUES:

Solubility: cm^3 of carbon monoxide per cm^3 of solvent

Solution No.	p_1^*/kg cm^{-2}	283.1 K	293.1 K	313.1 K
1	0.2	15.3	10.9	3.2
	0.4	23.0	17.6	5.8
	0.8	29.7	26.3	10.0
	2.0	35.8	32.4	18.8
	4.0	38.4	36.4	25.4
	6.0	-	-	27.0
2	0.2	5.43	3.5	1.92
	0.4	9.15	6.5	3.40
	0.8	14.7	10.9	6.30
	2.0	22.60	18.5	12.2
	4.0	27.20	24.10	18.2
	6.0	-	27.00	22.5
3	0.2	10.0	4.5	3.7
	0.4	16.1	10.9	6.7
	0.8	23.0	17.3	11.4
	2.0	31.4	26.3	20.0

* 1 kg cm^{-2} = 98.07 kPa

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Measurements were made using installation described in ref.I. included thermostated moveable autoclave, which enable liquid and gas phases to mix.

The gas phase consisted of a mixture of hydrogen, nitrogen, and carbon monoxide ("generator gas") at a total pressure of 300 kg cm^{-2}, within which the partial pressure of carbon monoxide was as shown above.

SOURCE AND PURITY OF MATERIALS:

Composition of the solutions/mol It dm^3

Solution No.	1	2	3
[Cu^+]	1.85	1.54	1.82
[Cu^{2+}]	0.27	0.25	0.29
[NH_3]	8.56	7.60	10.70
[CO_2]	-	1.93	1.47
[CH_3COOH]	2.38	1.82	1.65
pH	11.90	9.36	11.52

ESTIMATED ERROR:

REFERENCES:

I. Tsiklis, D.; Kofman, A. *Trudy GIAP*, 1956, 5, 54-70.

COMPONENTS:	EVALUATOR:
1. Carbon Monoxide; CO; [630-08-0] 2. Organic (aromatic) solvent 3. Copper(I) tetrachloroaluminate (III); $CuAlCl_4$; [27803-79-8]	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. May 1989

CRITICAL EVALUATION:

The complex salt, copper(I) tetrachloroaluminate(III), dissolved in an aromatic solvent, usually toluene, can specifically and reversibly absorb carbon monoxide. This system is the basis of the industrial COSORB method for purification of carbon monoxide (1), a method which has several operational and cost advantages over the older aqueous cuprous - ammonium salt solution systems referred to in the previous section of this volume. The solubility of carbon monoxide in this non-aqueous salt solution is therefore of some practical interest, and data have been compiled from three recently published papers.

Because of the different temperatures, pressures, and concentrations studied by the different authors, very limited comparison between their results has been possible, and no set of data can be recommended at this stage. Each should be taken very tentatively until further confirmation is available. An overall comparison shows that the solubility of carbon monoxide increases with pressure and with concentration of the copper salt, and decreases with temperature and with the amount of substitution on the benzene ring of the solvent molecule.

1. Copper(I) tetrachloroaluminate(III) + benzene; C_6H_6; [71-43-2].

Copper(I) tetrachloroaluminate(III) + 1,2-dimethylbenzene; C_8H_{10}; [95-47-6].

The data of Sato *et al.* (2) at 303 K are the only ones available for these systems.

2. Copper(I) tetrachloroaluminate(III) + toluene; C_7H_8; [108-88-3].

Sato *et al.* (2) and the Engineering Research Group of Chekiang University (3) have provided data for this solvent at about the same temperatures and pressures, 273-323 K and 0.3-1.4 atm. The salt concentrations used by the Chekiang Group appear to be much higher than those of Sato *et al*, and their Ostwald coefficients appear to be very high and could be in doubt. It is unfortunate that incomplete specification of all the variables makes a thorough comparison impossible. Korbutov *et al.* (4) also studied this solvent, at 313-353 K and at higher pressures of 0.2-1.2 MPa. The data sheet from their work contains two graphs taken from their paper. Appropriate extrapolation of some of their data to the conditions of the work of Sato *et al.* shows that some agreement exists between them, although this cannot be specified quantitatively.

Harai *et al.* (5) also investigated properties of this system, and showed that the addition of polystyrene to the solvent prevented any deterioration in its efficiency as an absorber of carbon monoxide, due to the presence of water in the solute gas streams. This was a comparative kinetic study, however, and no equilibrium solubilities of carbon monoxide were available. A recent paper by Budner and Morawiec (6) deals with absorption of carbon monoxide in a toluene solution of the cuprous aluminate salt along with biphenyl $C_{12}H_{10}$, and aniline, $C_6H_5NH_2$, over 293-363 K. Quantitative data for the solubility of carbon monoxide were not obtained from this paper either.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Organic (aromatic) solvent 3. Copper(I) tetrochloroaluminate (III); $CuAlCl_4$; [27803-79-8]	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology. Bell Street, Dundee DD1 1HG, U.K. May 1989

CRITICAL EVALUATION:

References

1. Haase, D.J.; Walker, D.G.
Chem. Eng. Prog. 1974, *70*, 74.

2. Sato, T.; Toyada, I.; Yamamori, Y.; Yonemoto, T.; Kato, H.; Tadaki, T.
J. Chem. Eng. Japan 1988, *21*, 192.

3. Separate Engineering Research Group of Chekiang University
Che-Chiang Ta Hsueh Hsueh Pao 1980, *1*, 24.

4. Korbitov, S.V.; Turina, L.S.; Karpova, Y.G.; Leites, I.A.
Chim. Prom. (Moscow) 1988, 178.

5. Harai, H.; Komiyama, M.; Hara, S.
Makromol. Chem. Rapid Commun. 1981, 2, 495.

6. Budner, Z.; Morawiec, B.
Przem. Chem. 1988, *67*, 73.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Benzene; C_6H_6; [71-43-2]
3. Copper(I) tetrachloroaluminate (III); $CuAlCl_4$; [27803-79-8]

ORIGINAL MEASUREMENTS:

Sato, T.; Toyoda, I.; Yamamori, Y.; Yonemoto, T.; Kato, H.; Tadaki, T.

J. Chem. Eng. Japan 1988, *21*, 192-198.

VARIABLES:

T/K = 303
p_1/kPa = 5.1 - 140
c_3/mol m^{-3} = 100, 1000

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature/K	conc'n $CuAlCl_4$/ mol m^{-3}	solubility $10^6 H$/ mol m^{-3} Pa^{-1}	Bunsen coefficient α/ cm^3(STP)cm^{-3}atm^{-1}
303	100	17.17	0.0391
	1000	15.10	0.0344

Bunsen coefficients calculated by compiler assuming ideal gas behaviour and that Henry's law applies.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solvent was degassed by boiling. Carbon monoxide was mixed with dry nitrogen and saturated with solvent vapour, then stirred into the solvent at constant temperature. The pressure change was followed with a pressure sensor, and mass balances were calculated. From these, the total uptake of carbon monoxide by the solvent, and the solubility itself were calculated.

The apparatus is based on that of Loprest (1).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from cylinder, passed through silica gel and activated alumina.

(2) Benzene: dehydrated with sodium sulphate.

(3) $CuAlCl_4$: reagent grade CuCl and $AlCl_3$ dissolved and homogenised by stirring.

ESTIMATED ERROR:

$\delta H/H = \pm 5\%$ (compiler)

REFERENCES:

1. Loprest, F. J.; *J. Phys. Chem.* 1957, *61*, 1128.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methylbenzene (toluene); C_7H_8; [108-88-3]
3. Copper(I)tetrachloroaluminate(III); $CuAlCl_4$; [27803-79-8]

ORIGINAL MEASUREMENTS:

Separate Engineering Research Group of Chekiang University,

Che-Chiang Ta Hsueh Hsueh Pao 1980, *1* , 24-37.

VARIABLES:

Temperature, pressure, absorbent composition.

PREPARED BY:

Shiqing Bo

EXPERIMENTAL VALUES:

Solubility of CO in C_7H_8-$CuAlCl_4$ at 293.15 K*

Absorbent composition x_{CuAlCl_4} (mole fraction)	Partial pressure of CO p_{CO}/atm	Ostwald Coefficient** L
0.33	1.00	49.5
0.33	0.82	45.7
0.33	0.60	40.0
0.33	0.45	36.7
0.33	0.28	26.5
0.33	0.05	6.4
0.22	1.00	35.0
0.22	0.32	33.7
0.22	0.60	25.3
0.22	0.45	23.4
0.22	0.28	16.9

* Total pressure = 1 atm. Other gaseous component(s) not specified.

** Ostwald coefficient calculated by compiler.

(contd)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Flowing deabsorbing method. The liquid absorbent weighed and added to absorption vessel of the bubbling type. The entire system evacuated. Gas was fed through drying tubes and a flowmeter to the thermostated absorption vessel. The gas(es) after absorption led to another flowmeter or to a gas collection chamber for analyses. Equilibrium established when the readings from the two flowmeters and CO% before and after absorption were the same. Deabsorption by raising temperature to ≤98°C. Deabsorbed gases collected and analysed for CO, by GC. Pressure measured with a Hg manometer. Solvent not degassed but caused virtually no error because of high solubility. Measurements for industrial purposes (1).

SOURCE AND PURITY OF MATERIALS:

(1) No information given.

(2,3) CuCl and $AlCl_3$ mixed (1.01 : 1.00) and stirred under N_2. Solid mixture (dry powder) added to C_7H_8 and stirred for 2 h, then filtered. The total amount of O_2 and H_2O controlled below 10 ppm throughout the process.

ESTIMATED ERROR:

REFERENCES:

1. Hasse, D.J.; *Chem. Eng.* 1975, *82(16)*, 52.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methylbenzene (toluene); C_7H_8; [108-88-3]
3. Copper(I)tetrachloroaluminate(III); $CuAlCl_4$; [27803-79-8]

ORIGINAL MEASUREMENTS:

Separate Engineering Research Group of Chekiang University,

Che-Chiang Ta Hsueh Hsueh Pao 1980, *1* , 24-37.

EXPERIMENTAL VALUES contd

Solubility of CO (waste gas from a steel plant*) in C_7H_8-$CuAlCl_4$

Density of liquid phase d_{20}/g cm^{-3}	Temperature T/K	Ostwald Coefficient** L
1.085	293.15	16.7
1.085	303.15	15.0
1.085	313.15	13.5
1.148	293.15	22.5
1.148	303.15	19.5
1.148	313.15	16.6
1.235	273.15	37.2
1.235	293.15	30.1
1.235	303.15	24.7
1.235	313.15	18.7
1.235	323.15	17.2
1.298	303.15	29.9
1.298	313.15	23.7
1.352	293.15	41.1

* Total pressure = 1 atm. CO = 62.4%; CO_2 = 14.2%; O_2 = 0.5%; others (not specified) = 22.9%. The authors stated that the existence of gases other than CO has virtually no influence on solubility of CO.

** Ostwald coefficient calculated by compiler. x_1 not calculated because no values of "molar volume" of liquid phase available.

Correlation between CO solubility V_{CO}, CO partial pressure p_{CO}, temperature t/°C, and liquid phase density d/g cm^{-3}, given by

$$V_{CO} = \frac{[(109.0 - 1.44t)d + 1.274t - 96.29][1 + 0.624\exp(\frac{3710}{273 + t} - 12.03)]p_{CO}}{0.624[1 + p_{CO}\exp(\frac{3710}{273 + t} - 12.03)]}$$

where V_{CO} is the volume at STP of CO absorbed by 1 cm^3 absorbent.

Maximum deviation = ±3.35%, average error = ±1.89%. Applicable for temperature = 20-50°C, p_{CO} = 0-1 atm, and xCuAlCl$_4$ = 0.20-0.33.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methylbenzene (toluene); C_7H_8; [108-88-3]
3. Copper(I)tetrachloroaluminate(III); $CuAlCl_4$; [27803-79-8]

ORIGINAL MEASUREMENTS:

Korbutov, S. V.; Turina, L. S.; Karpova, Yu. G.; Leites, I. A.

Chim. Prom. (Moscow) 1988, 178-180.

VARIABLES:

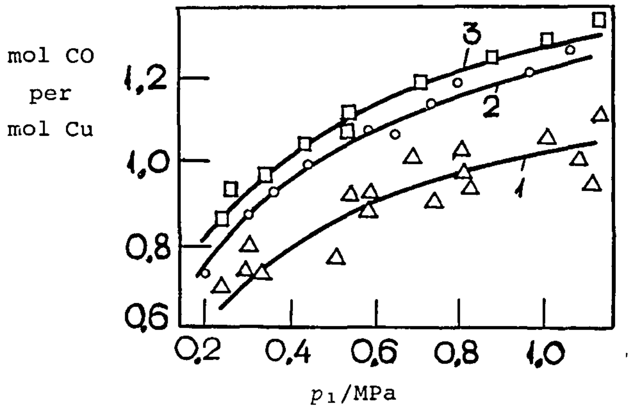
T/K = 313 - 353
p_1/MPa = 0.2 - 1.1
c_3/mol dm^{-3} = 0.6 - 2.5

PREPARED BY:

Yu.P.Yampol'skii

EXPERIMENTAL VALUES:

The solubility of carbon monoxide in 3 different solvent compositions at a temperature of 313 K, is shown below.



Absorption isotherms of CO at 313 K in solvents of composition (1) 0.6; (2) 1.8; (3) 2.5 mol dm^{-3} $CuAlCl_4$ in toluene.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility was determined according to the method described in ref. 1.

SOURCE AND PURITY OF MATERIALS:

(1) not specified.

(2,3) Solutions of $CuAlCl_4$ were prepared in the atmosphere of dry nitrogen using previously purified and dried reagents: toluene, cuprous chloride and anhydrous aluminium chloride.

ESTIMATED ERROR:

Error of solubility determination ±5%.

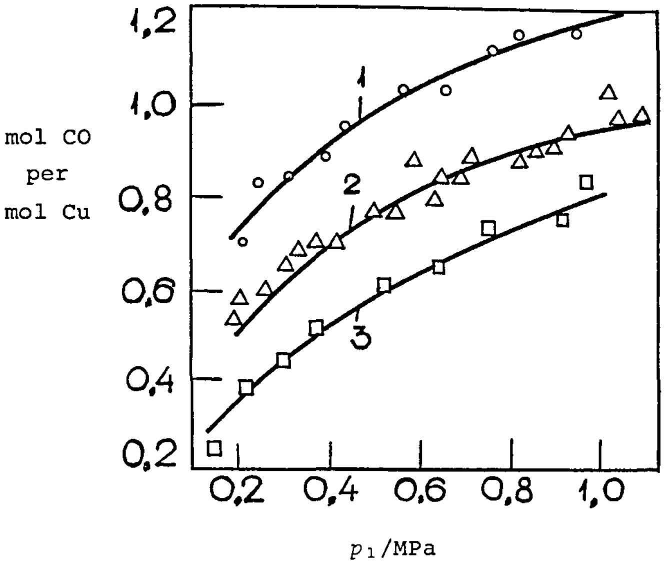
REFERENCES:

1. Dudakov, L. P.; Leites, I. L. *Chim. Prom.* (Moscow) 1987, 32.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Methylbenzene (toluene); C_7H_8; [108-88-3] 3. Copper(I)tetrachloroaluminate(III); $CuAlCl_4$; [27803-79-8]	Korbutov, S. V.; Turina, L. S.; Karpova, Yu. G.; Leites, I. A. *Chim. Prom.* (Moscow) <u>1988</u>, 178-180.

EXPERIMENTAL VALUES (continued):

The solubility of carbon monoxide in a solvent containing 1.8 mol dm^{-3} $CuAlCl_4$ in toluene, at 3 different temperatures, is shown below.



Absorption isotherms of CO in 1.8 mol dm^{-3} $CuAlCl_4$ in toluene, at (1) 313 K; (2) 333 K; (3) 353 K.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methylbenzene or toluene; C_7H_8; [108-88-3]
3. Copper(I) tetrachloroaluminate (III); $CuAlCl_4$; [27803-79-8]

ORIGINAL MEASUREMENTS:

Sato, T.; Toyoda, I.; Yamamori, Y.; Yonemoto, T.; Kato, H.; Tadaki, T.

J. Chem. Eng. Japan 1988, *21*, 192-198.

VARIABLES:

T/K = 274 - 313
p_1/kPa = 5.1 - 140
c_3/mol m^{-3} = 100, 1000

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature/K	conc'n $CuAlCl_4$/ mol m^{-3}	solubility 10^6H/ mol m^{-3} Pa^{-1}	Bunsen coefficient α/ cm^3(STP)$cm^{-3}atm^{-1}$
274	100	32.67	0.0743
283	100	21.51	0.0489
293	100	13.52	0.0308
303	100	8.51	0.0194
303	1000	8.63	0.0196
313	1000	5.51	0.0125

Bunsen coefficients calculated by compiler assuming ideal gas behaviour and that Henry's law applies.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solvent was degassed by boiling. Carbon monoxide was mixed with dry nitrogen and saturated with solvent vapour, then stirred into the solvent at constant temperature. The pressure change was followed with a pressure sensor, and mass balances were calculated. From these, the total uptake of carbon monoxide by the solvent, and the solubility itself were calculated.

The apparatus is based on that of Loprest (1).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from cylinder, passed through silica gel and activated alumina.

(2) Toluene: dehydrated with sodium sulphate.

(3) $CuAlCl_4$: reagent grade CuCl and $AlCl_3$ dissolved and homogenised by stirring.

ESTIMATED ERROR:

$\delta H/H = \pm 5\%$ (compiler)

REFERENCES:

1. Loprest, F. J.; *J. Phys. Chem.* 1957, *61*, 1128.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1,2 -Dimethylbenzene or o-xylene; C_8H_{10}; [95-47-6]
3. Copper(I) tetrachloroaluminate (III); $CuAlCl_4$; [27803-79-8]

ORIGINAL MEASUREMENTS:

Sato, T.; Toyoda, I.; Yamamori, Y.; Yonemoto, T.; Kato, H.; Tadaki, T.
J. Chem. Eng. Japan 1988, *21*, 192-198.

VARIABLES:

$T/K = 303$
$p_1/kPa = 5.1 - 140$
$c_3/mol\ m^{-3} = 1000$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature/K	conc'n $CuAlCl_4$/ mol m^{-3}	solubility $10^6 H$/ mol m^{-3} Pa^{-1}	Bunsen coefficient α/ $cm^3(STP)cm^{-3}atm^{-1}$
303	1000	7.30	0.0166

Bunsen coefficients calculated by compiler assuming ideal gas behaviour and that Henry's law applies.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solvent was degassed by boiling. Carbon monoxide was mixed with dry nitrogen and saturated with solvent vapour, then stirred into the solvent at constant temperature. The pressure change was followed with a pressure sensor, and mass balances were calculated. From these, the total uptake of carbon monoxide by the solvent, and the solubility itself were calculated.

The apparatus is based on that of Loprest (1).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide; from cylinder, passed through silica gel and activated alumina.

(2) Xylene: dehydrated with sodium sulphate.

(3) $CuAlCl_4$: reagent grade CuCl and $AlCl_3$ dissolved and homogenised by stirring.

ESTIMATED ERROR:

$\delta H/H = \pm 5\%$ (compiler)

REFERENCES:

1. Loprest, F. J.; *J. Phys. Chem.* 1957, *61*, 1128.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Organic solvents 3. Water; H_2O; [7732-18-5]	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. May 1989

CRITICAL EVALUATION:

Very few investigations have been made of the solubility of carbon monoxide in solvents consisting of water mixed with an organic compound. There are only three papers giving data to evaluate, for eight different solvent systems, each at pressures above 2 MPa. There is very limited scope for comparison between different sets of data, and it is not possible to recommend any values. Further work on these systems, and fresh work on other related ones, would be worthwhile.

1. Methanol [67-56-1] and water

Granzhan (1) measured the solubility at 298 K and 348 K for a pressure of 5.06 MPa. Dake and Chaudhari (2) covered 298-448K in their study, at a partial pressure of carbon monoxide of 2-6 MPa. The whole range of solvent composition was covered in each case.

Comparison between the two sets of data at 298 K and 348 K shows that Granzhan's values are about 10% higher than corresponding values from Dake and Chaudhari. It is probable that the data of Dake and Chaudhari are the more reliable, since their data for methanol and for water themselves as solvents for carbon monoxide at high pressures correspond better to those of other workers than do Granzhan's.

2. Ethanol [64-17-5] and water

Lubarsch (3) published a paper in 1889 on the solubility of carbon monoxide (and oxygen and hydrogen also) in water-ethanol mixtures at 293 K and 1 atm partial pressure. It was not possible to extract meaningful data from this paper because the experimental details were vague and the solubility units unclear.

The data of Dake and Chaudhari (2) on this system at 2-6 MPa and 298-448 K may be accepted tentatively.

3. Allyl alcohol (2-propen-1-ol) [107-18-6] and water

Taqui Khan and Halligudi (4) studied the solubility of carbon monoxide at a total pressure of 3.202 MPa between 373 K and 403 K over the whole range of composition of this solvent. Their data need to be used with caution since their values for carbon monoxide in water from this series of experiemnts deviated from other published data.

4. Acetic acid (ethanoic acid) [64-19-7] and water

In some respects the data of Granzhan (1) at 5.06 MPa and 298 K and 348 K complement those of Dake and Chaudhari (2) at 2-6 MPa and 298-448 K. However comparison shows that Granzhan's values are about 10% lower than corresponding ones from Dake and Chaudhari. It is the evaluator's opinion that the data of Dake and Chaudhari for this system can be accepted tentatively, although their values for acetic acid itself appear to be somewhat low, perhaps because the acetic acid was not totally free from water.

5. Propionic (propanoic) acid [79-09-4] and water

The data of Dake and Chaudhari (2) for this system may be accepted tentatively, but confirmation is highly desirable.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Organic solvents 3. Water; H_2O; [7732-18-5]	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology. Bell Street, Dundee DD1 1HG, U.K. May 1989

CRITICAL EVALUATION:

6. Methyl acetate [79-20-9] and water

Granzhan's work (1) gives the only data for this system at 298 K and 348 K, and 5.06 MPa. The two solvent components themselves, and two mixtures were studied. Because the data on the individual components do not compare very favourably with other published data, the values are classed as doubtful.

7. Diethylamine (N-ethylethanamine) [109-89-7] and water

8. Triethylamine (N, N-diethylethanamine) [121-44-8] and water

Taqui Khan and Halligudi (4) measured the solubility of carbon monoxide in several mixtures of each of these amines with water at partial pressures near 3.2 MPa over 343-373 K. The composition range for triethylamine-water is confined to the water-rich region. All of the data for these systems need further confirmation because of the uncertainty which surrounds their values for water as solvent.

References

1. Granzhan, V.A.
   Tr. Gos. Nauchno-Issled. Proektn. Inst. Prom-sti. Org. Synt. 1974, *27*, 5.
2. Dake, S.B.; Chaudhari, R.V.
   J. Chem. Eng. Data 1985, *30*, 400.
3. Lubarsch, O.
   Ann. Physik. 1889, *37*, 524-525.
4. Taqui Khan, M.M.; Halligudi, S.B.
   J. Chem. Eng. Data. 1988, *33*, 276.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methanol; CH_4O; [67-56-1]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Dake, S. B.; Chaudhari, R. V.

J. Chem. Eng. Data 1985, *30*, 400-403.

VARIABLES:

$T/K = 298 - 448$
$p_1/MPa = 1.5 - 7.2$
$x_2 = 0 - 1.0$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

methanol mole fraction, x_2	298 K		348 K		398 K		448 K	
	p_1/ MPa	$10^2 S$/ kmol m^{-3}	p_1/ MPa	$10^2 S$/ kmol m^{-3}	p_1/ MPa	$10^2 S$/ kmol m^{-3}	p_1/ MPa	$10^2 S$/ kmol m^{-3}
0	2.026	1.607	2.127	1.87	2.198	2.05	2.218	2.19
	4.052	3.17	4.183	3.71	4.254	4.11	4.355	4.46
	6.078	4.82	6.209	5.49	6.260	5.98	6.331	6.47
0.18	2.026	2.41	2.157	2.81	2.279	3.26	2.410	3.66
	4.052	4.78	4.183	5.49	4.305	6.12	4.386	6.69
	6.078	7.23	6.209	8.12	6.331	9.02	6.483	9.91
0.47	2.026	5.89	2.289	7.14	2.623	9.02	2.826	9.99
	4.052	11.61	4.518	14.33	5.065	16.65	5.298	18.53
	6.078	17.32	6.736	20.71	6.979	23.17	7.161	24.91
0.80	1.519	8.84	1.651	10.71	1.772	12.19	1.894	13.70
	3.039	17.86	3.241	20.98	3.373	23.30	3.575	25.53
	5.065	29.91	5.318	34.73	5.520	38.17	5.693	41.20
1.0	1.519	13.62	1.651	15.71	1.772	18.30	1.894	20.31
	3.039	27.45	3.231	31.25	3.423	35.09	3.575	38.39
	5.065	45.76	5.318	51.38	5.520	56.69	5.693	61.6

A Henry's solubility constant, H/kmol m^{-3} kPa^{-1}, was calculated by the authors, and data correlated within 4.3% with the following equation: (Note that this H is the inverse of the conventional Henry's constant)

$$\ln H = -11.16 - 199.6/T - 25.73x_2(1/298 - 1/T) + 3.543 \ln(1+x_2)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas to saturation under pressure in an autoclave of 2 dm^3 capacity, maintained at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure, where the volume of the desorbed gas is measured by displacement of gas-saturated water at constant temperature (1).

Vapour pressures of solvent mixtures are given, used to calculate partial pressure of gas in autoclave.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: generated by dehydration of formic acid; purity >99.5%.

(2) Methanol: from BDH Laboratories, freshly distilled; purity >99%.

(3) Water: distilled.

ESTIMATED ERROR:

$\delta S = \pm 3\%$ (authors)

REFERENCES:

1. Radhakrishnan, K.; Ramachandrar, P. A.; Brahme, P. H.; Chaudhari, R. V. *J. Chem. Eng. Data* 1983, *28*, 1.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Ethanol; C_2H_6O; [64-17-5]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Dake, S. B.; Chaudhari, R. V.

J. Chem. Eng. Data 1985, *30*, 400-403.

VARIABLES:

T/K = 298 - 448
p_1/MPa = 1.5 - 7
x_2 = 0 - 1.0

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

ethanol mole fraction, x_2	298 K		348 K		398 K		448 K	
	p_1/ MPa	10^2S/ kmol m^{-3}	p_1/ MPa	10^2S/ kmol m^{-3}	p_1/ MPa	10^2S/ kmol m^{-3}	p_1/ MPa	10^2S/ kmol m^{-3}
0	2.026	1.607	2.127	1.87	2.198	2.05	2.218	2.19
	4.052	3.17	4.183	3.71	4.254	4.11	4.355	4.46
	6.078	4.82	6.209	5.49	6.260	5.98	6.331	6.42
0.135	2.026	2.14	2.238	2.68	2.461	3.30	2.664	3.75
	4.052	4.29	4.254	5.09	4.386	5.85	4.497	6.38
	6.078	6.47	6.290	7.54	6.462	8.62	6.635	9.42
0.38	2.026	4.64	2.228	5.67	2.451	6.79	2.664	8.04
	4.052	9.20	4.244	10.80	4.436	12.19	4.458	13.75
	6.078	13.70	6.311	16.07	6.513	18.03	6.716	20.36
0.75	2.026	10.76	2.228	13.97	2.461	17.19	2.603	20.09
	4.052	21.47	4.224	26.20	4.386	30.58	4.487	34.37
	6.078	32.36	6.280	39.06	6.452	45.09	6.655	51.07
1.0	2.026	16.74	2.228	21.87	2.400	26.87	2.583	32.14
	4.052	33.03	4.254	41.96	4.426	49.77	4.609	56.92
	6.078	49.55	6.280	61.60	6.452	72.54	6.635	82.14

A Henry's solubility constant, H/kmol m^{-3} kPa^{-1}, was calculated by the authors, and data correlated within 3.8% with the following equation: (Note that this H is the inverse of the conventional Henry's constant)

$$\ln H = -11.11 - 211.0/T + 160.2x_2(1/298-1/T) + 3.447 \ln(1+x_2)$$

AUXILIARY INFORMATION

METHOD APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas to saturation under pressure in an autoclave of 2 dm^3 capacity, maintained at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure, where the volume of the desorbed gas is measured by displacement of gas-saturated water at constant temperature (1).

Vapour pressures of solvent mixtures are given, used to calculate partial pressure of gas in autoclave.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: generated by dehydration of formic acid; purity >99.5%.

(2) Ethanol: from BDH Laboratories, freshly distilled; purity >99%.

(3) Water: distilled.

ESTIMATED ERROR:

δS = ±3% (authors)

REFERENCES:

1. Radhakrishnan, K.; Ramachandrar, P. A.; Brahme, P. H.; Chaudhari, R. V. *J. Chem. Eng. Data* 1983, *28*, 1.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 2-Propen-1-ol, (allyl alcohol); C_3H_6O; [107-18-6]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Taqui Khan, M. M.; Halligudi, S. B.
J. Chem. Eng. Data 1988, *33*,
276-278.

VARIABLES:

T/K = 373 - 403
p_1/MPa = 3.2
x_2 = 0 - 1.0

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

mol frn x_2	373 K p_1/MPa	373 K 10^6H/kmol m^{-3} kPa^{-1}	383 K p_1/MPa	383 K 10^6H/kmol m^{-3} kPa^{-1}	393 K p_1/MPa	393 K 10^6H/kmol m^{-3} kPa^{-1}	403 K p_1/MPa	403 K 10^6H/kmol m^{-3} kPa^{-1}
0	3.101	6.19	3.059	6.75	3.004	7.31	2.932	7.86
0.05	3.100	7.66	3.058	8.34	3.003	9.02	2.931	9.69
0.10	3.099	9.13	3.057	9.92	3.002	10.72	2.929	11.52
0.15	3.098	10.60	3.056	11.51	3.001	12.43	2.928	12.35
0.20	3.097	12.07	3.055	13.10	3.000	14.14	2.927	15.17
0.50	3.096	20.88	3.052	22.63	2.994	24.38	2.921	26.13
0.80	3.092	29.69	3.047	32.16	2.989	34.63	2.914	37.09
1.00	3.090	35.56	3.045	38.51	2.985	41.46	2.909	44.40

The data correlated within 3.6% with the equation

$$\ln H = -11.82 - 249.23/T - 25.89x_2(1/303-1/T) + 3.52 \ln(1+x_2)$$

Note that this H is the inverse of the conventional Henry's constant.

AUXILIARY INFORMATION

METHOD APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas under pressure in an autoclave of 300 cm^3 capacity at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure where the volume of gas is measured by displacement of gas-saturated water at constant temperature (1).

Corrections are made for vapour pressures of solvent mixtures, and for the solubility of the gas at atmospheric pressure.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from British Oxygen Co, purity >99.6% by GC analysis.
(2) Allyl alcohol: AR grade, distilled before use, purity >99.5% by GC analysis.
(3) Water: distilled.

ESTIMATED ERROR:

δp_1 = 3 kPa
δT = 0.1 K
δH = ±3% (authors)

REFERENCES:

1. Chaudhary, V. R.; Parande, M. G.; Brahme, P. H. *Ind. Eng. Chem. Fundam.* 1982, *21*, 472.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methanol; CH_4O; [67-56-1] or
2. Acetic acid; $C_2H_4O_2$; [64-19-7]
or
2. Methyl acetate; $C_3H_6O_2$ [79-20-9]

3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Granzhan, V.A.
Tr. Gos. Nauchno-Issled. Proektn. Inst. Prom-sti Org. Synt.
1974, *27*, 5-9.

VARIABLES:

T/K = 298-348
P_1/MPa = 5.06

PREPARED BY:

Yu.P.Yampol'skii

EXPERIMENTAL VALUES:

Mol fraction of water x_3	Solubility at P_1 = 5.06 MPa			
	298K		348K	
	$cm^3(STP)\ g^{-1}$	10^3x_1	$cm^3(STP)\ g^{-1}$	10^3x_1
Methanol and water				
0.0	11.8	16.6	14.6	20.4
0.2	8.6	11.1	9.8	12.6
0.4	5.5	6.5	6.8	7.9
0.6	3.4	3.6	4.3	4.5
0.8	2.2	2.1	2.7	2.5
1.0	1.5	1.2	1.8	1.4
Acetic acid and water				
0.0	3.2	8.4	5.7	15.1
0.2	3.0	6.8	4.3	9.9
0.4	2.4	4.7	3.4	6.4
0.6	2.0	3.1	2.8	4.3
0.8	1.8	2.2	2.2	2.6
1.0	1.5	1.2	1.8	1.4
methyl acetate and water				
0.0	11.2	35.7	13.8	43.7
0.15	9.6	27.4	12.7	35.9
0.25	8.5	21.5	11.6	30.0
1.0	1.5	1.2	1.8	1.4

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Measurements were made in the apparatus originally described in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon Monoxide. Purity ⩾99.9%.

(2) Solvents. "Pure for analysis".

(3) Water. Bidistilled.

ESTIMATED ERROR:

Solubility: ± 5%
Pressure ± 1 atm (± 2%)

REFERENCES:

1. Krichevskii, I.R.; Zhavoronkov, N.M.; Tsiklis, D.S.
Zh. fis. chim (USSR), 1937, *9*, 317.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Ethanoic acid (acetic acid); $C_2H_4O_2$; [64-19-7]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Dake, S. B.; Chaudhari, R. V.

J. Chem. Eng. Data 1985, *30*, 400-403.

VARIABLES:

T/K = 298 - 448
p_1/MPa = 1.5 - 7
x_2 = 0 - 1.0

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

ethanoic acid mole fraction x_2	298 K		348 K		398 K		448 K	
	p_1/ MPa	$10^2 S$/ kmol m^{-3}	p_1/ MPa	$10^2 S$/ kmol m^{-3}	p_1/ MPa	$10^2 S$/ kmol m^{-3}	p_1/ MPa	$10^2 S$/ kmol m^{-3}
0	2.026	1.607	2.127	1.87	2.198	2.05	2.218	2.19
	4.052	3.17	4.183	3.71	4.254	4.11	4.355	4.46
	6.078	4.82	6.209	5.49	6.260	5.98	6.331	6.47
0.135	2.026	1.92	2.157	2.28	2.279	2.68	2.400	2.95
	4.052	3.88	4.244	4.60	4.355	5.09	4.457	5.54
	6.078	5.89	6.280	6.79	6.452	7.54	6.614	8.21
0.38	2.026	4.02	2.177	8.04	2.299	5.40	2.421	5.94
	4.052	8.12	4.204	9.24	4.355	10.22	4.487	10.94
	6.078	12.19	6.260	16.96	6.473	15.18	6.685	16.29
1.0	2.026	11.87	2.178	13.84	2.329	15.62	2.451	17.05
	4.052	22.36	4.254	25.44	4.396	27.68	4.477	29.42
	6.078	35.80	6.240	39.73	6.412	42.94	6.594	45.98

A Henry's solubility constant, H/kmol m^{-3} kPa^{-1}, was calculated by the authors, and data correlated within 4.7% with the following equation: (Note that this H is the inverse of the conventional Henry's constant)

$$\ln H = -11.10 - 214.4/T - 60.5x_2(1/298-1/T) + 2.972\ln(1+x_2)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas to saturation under pressure in an autoclave of 2 dm^3 capacity, maintained at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure, where the volume of the desorbed gas is measured by displacement of gas-saturated water at constant temperature (1).

Vapour pressures of solvent mixtures are given, used to calculate partial pressure of gas in autoclave.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: generated by dehydration of formic acid; purity >99.5%.

(2) Ethanoic acid: from BDH Laboratories, freshly distilled; purity >99%.

(3) Water: distilled.

ESTIMATED ERROR:

δS = ±3% (authors)

REFERENCES:

1. Radhakrishnan, K.; Ramachandran, P. A.; Brahme, P. H.; Chaudhari, R. V. *J. Chem. Eng. Data* 1983, *28*, 1.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Propanoic acid (propionic acid); $C_3H_6O_2$; [79-09-4]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Dake, S. B.; Chaudhari, R. V.

J. Chem. Eng. Data 1985, *30*, 400-403.

VARIABLES:

T/K = 298 - 448
p_1/MPA = 1.5 - 7
x_2 = 0 - 1.0

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

propanoic acid mole fraction, x_2	298 K		348 K		398 K		448 K	
	p_1/ MPa	10^2S/ kmol m^{-3}	p_1/ MPa	10^2S/ kmol m^{-3}	p_1/ MPa	10^2S/ kmol m^{-3}	p_1/ MPa	10^2S/ kmol m^{-3}
0.00	2.026	1.607	2.127	1.87	2.198	2.05	2.218	2.19
	4.052	3.17	4.183	3.71	4.254	4.11	4.355	4.46
	6.078	4.82	6.209	5.49	6.260	5.98	6.331	6.42
0.11	2.026	2.10	2.188	2.68	2.299	3.04	2.431	3.44
	4.052	4.29	4.214	5.09	4.325	5.71	4.426	6.25
	6.078	6.43	6.229	7.59	6.351	8.39	6.452	9.11
0.33	2.026	3.75	2.177	4.69	2.299	5.54	2.400	6.16
	4.052	7.95	4.214	9.60	4.335	10.98	4.447	12.05
	6.078	11.16	6.229	13.39	6.351	15.18	6.452	16.61
1.00	2.026	12.05	2.127	15.18	2.228	18.30	2.299	21.87
	4.052	24.11	4.153	29.91	4.254	35.27	4.335	41.52
	6.078	35.71	6.209	45.09	6.351	52.23	6.381	61.16

A Henry's solubility constant, H/kmol m^{-3} kPa^{-1}, was calculated by the authors, and data correlated within 1.6% with the following equation: (Note that this H is the inverse of the conventional Henry's constant)

$$\ln H = -10.99 - 229.1/T + 185.3x_2(1/298-1/T) + 2.91\ \ln(1+x_2)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas to saturation under pressure in an autoclave of 2 dm^3 capacity, maintained at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure, where the volume of the desorbed gas is measured by displacement of gas-saturated water at constant temperature (1).

Vapour pressures of solvent mixtures are given, used to calculate partial pressure of gas in autoclave.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: generated by dehydration of formic acid; purity >99.5%.

(2) Propanoic acid: from BDH Laboratories, freshly distilled; purity >99%.

(3) Water: distilled.

ESTIMATED ERROR:

δS = ±3% (authors)

REFERENCES:

1. Radhakrishnan, K.; Ramachandrar, P. A.; Brahme, P. H.; Chaudhari, R. V. *J. Chem. Eng. Data* 1983, *28*, 1.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. N-Ethylethanamine, (diethylamine); $C_4H_{11}N$; [109-89-7]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Taqui Khan, M. M.; Halligudi, S. B.

J. Chem. Eng. Data 1988, *33*, 276-278.

VARIABLES:

T/K = 343 - 373
p_1/MPa = 3.2
x_2 = 0 - 1.0

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

mol frn x_2	343 K p_1/MPa	343 K 10^6H/kmol m^{-3} kPa^{-1}	353 K p_1/MPa	353 K 10^6H/kmol m^{-3} kPa^{-1}	363 K p_1/MPa	363 K 10^6H/kmol m^{-3} kPa^{-1}	373 K p_1/MPa	373 K 10^6H/kmol m^{-3} kPa^{-1}
0	3.171	6.00	3.155	6.07	3.132	6.13	3.101	6.19
0.05	3.165	9.76	3.146	9.10	3.121	10.24	3.087	10.47
0.10	3.158	13.52	3.138	13.94	3.110	14.34	3.074	14.75
0.15	3.152	17.29	3.129	17.87	3.099	18.45	3.061	19.03
0.20	3.145	21.06	3.121	21.81	3.089	22.55	3.047	23.30
0.50	3.106	43.64	3.070	45.42	3.024	47.19	2.966	48.97
0.80	3.067	66.23	3.019	68.62	2.960	71.00	2.886	73.39
1.00	3.041	81.29	2.985	84.77	2.916	88.25	2.832	91.74

The data correlated within 4.2% with the equation

$$\ln H = -11.10 - 190.23/T - 21.33x_2(1/303-1/T) + 3.21 \ln(1+x_2)$$

Note that this H is the inverse of the conventional Henry's constant.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas under pressure in an autoclave of 300 cm^3 capacity at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure where the volume of gas is measured by displacement of gas-saturated water at constant temperature (1).

Corrections are made for vapour pressures of solvent mixtures, and for the solubility of the gas at atmospheric pressure.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from British Oxygen Co, purity >99.6% by GC analysis.

(2) Diethylamine: AR grade, distilled before use, purity >99.5% by GC analysis.

(3) Water: distilled.

ESTIMATED ERROR:

δp_1 = 3 kPa
δT = 0.1 K
δH = ±3% (authors)

REFERENCES:

1. Chaudhary, V. R.; Parande, M. G.; Brahme, P. H. *Ind. Eng. Chem. Fundam.* 1982, *21*, 472.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. N,N-Diethylethanamine, (triethylamine); $C_6H_{15}N$; [121-44-8]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Taqui Khan, M. M.; Halligudi, S. B.
J. Chem. Eng. Data 1988, *33*, 276-278.

VARIABLES:

T/K = 343 - 373
p_1/MPa = 3.2
x_2 = 0 - 0.05, 1.0

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

mol frn	343 K		353 K		363 K		373 K	
x_2	p_1/ MPa	$10^6 H$/ kmol m^{-3} kPa^{-1}	p_1/ MPa	$10^6 H$/ kmol m^{-3} kPa^{-1}	p_1/ MPa	$10^6 H$/ kmol m^{-3} kPa^{-1}	p_1/ MPa	$10^6 H$/ kmol m^{-3} kPa^{-1}
0	3.171	6.00	3.155	6.06	3.132	6.13	3.101	6.19
0.01	3.171	6.55	3.155	6.64	3.133	6.72	3.101	6.81
0.02	3.171	7.10	3.154	7.21	3.132	7.32	3.100	7.43
0.03	3.171	7.654	3.154	7.78	3.131	7.92	3.099	8.05
0.05	3.171	8.76	3.154	8.93	3.130	9.11	3.099	9.28
1.00	3.149	61.12	3.127	63.39	3.097	65.57	3.063	67.95

The data correlated within 2.9% with the equation

$$\ln H = -11.45 - 200.12/T - 28.45x_2(1/303-1/T) + 3.35\ \ln(1+x_2)$$

Note that this H is the inverse of the conventional Henry's constant.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas under pressure in an autoclave of 300 cm^3 capacity at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure where the volume of gas is measured by displacement of gas-saturated water at constant temperature (1).

Corrections are made for vapour pressures of solvent mixtures, and for the solubility of the gas at atmospheric pressure.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from British Oxygen Co, purity >99.6% by GC analysis.

(2) Triethylamine: AR grade, distilled before use, purity >99.5% by GC analysis.

(3) Water: distilled.

ESTIMATED ERROR:

δp_1 = 3 kPa
δT = 0.1 K
δH = ±3% (authors)

REFERENCES:

1. Chaudhary, V. R.; Parande, M. G.; Brahme, P. H. *Ind. Eng. Chem. Fundam.* 1982, *21*, 472.

COMPONENTS:
1. Carbon monoxide; CO; [630-08-0]

2. n-Alkanes

EVALUATOR:

Robert W. Cargill,
Department of Molecular
and Life Sciences,
Dundee Institute of Technology,
Bell Street, Dundee DD1 1HG, U.K.

May 1989

CRITICAL EVALUATION:

The Solubility of Carbon Monoxide at a Partial Pressure of 101.3 kPa in n-Alkanes

Some six laboratories (1,3-7) have contributed data on the solubility of carbon monoxide at pressures close to 1 atm in individual n-alkanes, and all but one included the temperature 298.15 K. There are in fact very few data for temperatures other than this.

From this evaluation of all the available data, it becomes clear that in almost all cases more work needs to be done to either confirm or extend what has been published on these systems. Some measurements have been made by other workers at higher partial pressures for a few of these, and for some other alkane solvents, which are evaluated in a later section of this volume. Comparisons with data in this section are not possible however, even by extrapolation, because in each case the temperatures are either much higher or much lower than those considered here.

The most comprehensive study is by Makranczy *et al.* (1), providing solubilities at 298.15 K for each of the n-alkanes of carbon number 5-16. Figure 1 shows the trend in their values and compares them with the other values which are available.

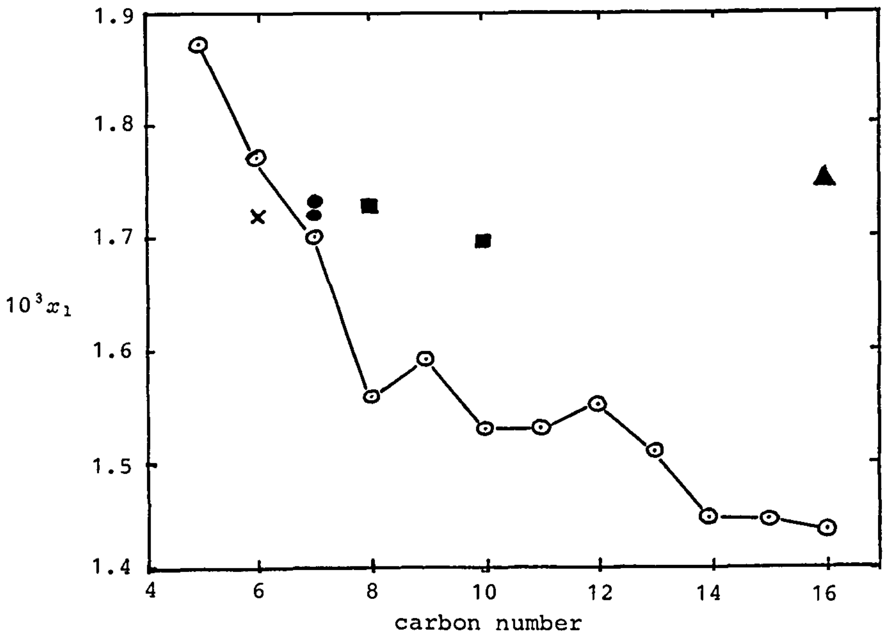


Figure 1 Mol fraction solubility of carbon monoxide in n-alkanes at 298.15 K and 101.3 kPa
⊙ Makranczy (1); × Patyi (3);
● Gjaldbeek (4); ■ Wilcock (5);
▲ Lin (6).

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. n-Alkanes	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology. Bell Street, Dundee DD1 1HG, U.K. May 1989

CRITICAL EVALUATION:

Unfortunately it appears that not too much confidence can be placed in these data of Makranczy *et al.*, not only because of their deviations from the other values but also because their data on other gases, e.g. methane (2) in n-alkanes and on carbon monoxide in other solvents, e.g. alkanols (this volume) have shown similar discrepancies. Although proof cannot be furnished, it is the belief of this evaluator that the values of Makranczy *et al* for C_8 to C_{16} alkanes could be 10-20% too low.

Comments on the individual solvents are as follows.

1. Pentane; C_5H_{12}; [109-66-0]

The mol fraction solubility of 1.87 x 10^{-3} at 298.15 K due to Makranczy *et al.* (1) is the only value for this system. It would need to be checked.

2. Hexane; C_6H_{14}; [110-54-3]

The value from Makranczy, Patyi *et al.* (1) is about 3% higher than that given by Patyi, Makranczy *et al.* (3) a little later. Perhaps the lower value is more reliable because purity of reagents seems to have been checked more thoroughly. The experimental error in each measurement is about 3% according to the authors.

3. Heptane; C_7H_{16}; [142-85-5]

Gjaldbaek's two values (4) are about 1.5% higher than that of Makranczy *et al.* (1). These values may be accepted tentatively within the percentage error quoted on the data sheets.

4. Octane; C_8H_{18}; [111-65-9]

Decane; $C_{10}H_{22}$; [124-18-5]

For both of these solvents, the values of Wilcock *et al.* (5) at 298.15 K are about 10% higher than those of Makranczy *et al.* (1), and are to be preferred. In fact the data and the smoothing equations covering 283-313 K given on the data sheets from Wilcock *et al.* can be accepted tentatively for those solvents because this group's work is normally of a high standard.

5. Nonane; C_9H_{20}; [111-84-2]

n-Alkanes C_{11}-C_{15}

For these solvents the values given by Makranczy *et al.* (1) show an irregular and unusual trend with increasing carbon number and may be in error, probably at least 10% low.

6. Hexadecane; $C_{16}H_{34}$; [544-76-3]

The value of Makranczy *et al.* (1) at 298.15 K is about 20% lower than that of Lin and Parcher (6). Although the latter value was obtained by a chromatographic method which can give rise to inaccuracies, it is much closer to the value of Tremper and Prausnitz (7) at the slightly higher temperature of 300 K. The data of Tremper and Prausnitz cover 300-475 K and may be accepted tentatively although confirmation is obviously necessary.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. n-Alkanes	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. May 1989

CRITICAL EVALUATION:

7. Mixtures containing alkanes

Data are available for the solubility of carbon monoxide in petroleum at 283.15 K and 293.15 K from the year 1887 (8), in mineral oil ("Wemco A") at 298.15 K and 353.15 K (9), in "Kerosene A1" over 233-293 K (10), and in a paraffin oil (average relative molar mass 405) at 293.15 K (11). Whilst the compositions of these solvents are uncertain, the solubility values appear to be of an appropriate magnitude, and can be accepted as a good indication of the solubility of carbon monoxide in these types of solvent.

References

1. Makranczy, J.; Begyery-Balog, K.; Rusz, L.; Patyi, L.
Hung. J. Ind. Chem. 1976, *4*, 269.

2. Clever, H.L.
METHANE, IUPAC Solubility Data Series, Pergamon Press 1988, *27/28.*

3. Patyi, L.; Furmer, I.E.; Makranczy, J.; Sadilenko, A.S.;
Stepanova, Z.G,.; Berengarten, M.G.
Zh. Prikl. Khim. 1978, *51*, 1296.

4. Gjaldbaek, J.C.
Acta Chem. Scand. 1952, *6*, 623.

5. Wilcock, R.J.; Battino, R.; Danforth, W.F.; Wilhelm, E.
J. Chem. Thermodyn. 1978, *10*, 817.

6. Lin, P.J.; Parcher, J.F.
J. Chromatog. Sci. 1982, *20*, 33.

7. Tremper, K.K.; Prausnitz, J.M.
J. Chem. Eng. Data 1976, *21*, 295.

8. Gniewosz, S.; Walfisz, A.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1887, *1*, 70.

9. Rodman, C.J.; Maude, A.H.
Trans. Am. Electrochem. Soc. 1925, *47*, 71.

10. Hannaert, H.; Haccuria, M.; Mathieu, M.P.
Ind. Chim. Belge 1967, *32*, 156.

11. Luther, H.; Hiemenz, W.
Chemie Ing. Techn. 1957, *29*, 530.

COMPONENTS:

(1) Carbon Monoxide; CO; [630-08-0]

(2) Pentane; C_5H_{12}; [109-66-0]

Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Megyery-Balog, K.; Rusz, L.; Patyi, L.

Hung. J. Ind. Chem. 1976, *4*, 269 - 280.

VARIABLES:

T/K: 298.15

p/kPa: 101.325 (1 atm)

PREPARED BY:

S. A. Johnson

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
Pentane			
298.15	1.87	0.362	0.395
Hexane			
298.15	1.77	0.301	0.329

The Bunsen coefficient and mole fraction values were calculated by the compiler assuming that the gas is ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus described by Bodor, Bor, Mohai and Sipos was used (1).

SOURCE AND PURITY OF MATERIALS:

Both the gas and the liquid were analytical grade reagents of Hungarian or foreign origin. No further information.

ESTIMATED ERROR:

$\delta L/L = \pm 0.03$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip. Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Patyi, L.; Furmer, I. E.; Makranczy, J.; Sadilenko, A. S.; Stepanova, Z. G.; Berengarten, M. G.

Zh. Prikl. Khim. 1978, *51*, 1296-1300.

VARIABLES:

T = 298.15 K
p = 101.3 kPa

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	$\alpha^{\dagger}$	Mole fraction of carbon monoxide at a partial pressure of 101.325 kPa x_{CO}
298.15	0.293	0.00172

† volume of gas (measured at 101.325 kPa and 273.15 K) dissolved by one volume of hexane.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. Pressure measured when known amounts of gas were added, in increments, to a known amount of liquid in a vessel of known dimensions. Corrections were made for the partial pressure of solvent. Details in ref. (1).

SOURCE AND PURITY OF MATERIALS:

Purity better than 99 mole per cent as determined by gas chromatography.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$; $\delta\alpha = \pm 4\%$ or less.

REFERENCES:

1. Bodor, E.; Bor, G. J.; Mohai, G.; Sipos, G. *Veszpremi. Vegyip. Egy. Kozl.* 1957, *1*, 55.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Heptane; C_7H_{16}; [142-82-5]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.

Acta Chem. Scand. 1952, *6*, 623 - 633.

VARIABLES:

$T/K = 298.03, 298.08$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^3 x_1$	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
298.03	1.73	0.263	0.287
298.08	1.72	0.262	0.286

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO + 0.5% N_2.

(2) Heptane. Phillips Petroleum Co. Pure grade. B.p. (760 mmHg)/°C = 98.3 - 98.4, refractive index, $n_D(25°C) = 1.3855$.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon Monoxide; CO; [630-08-0] (2) Heptane; C_7H_{16}; [142-82-5] Octane; C_8H_{18}; [111-65-9]	Makranczy, J.; Megyery-Balog, K.; Rusz, L.; Patyi, L. *Hung. J. Ind. Chem.* 1976, *4*, 269 - 280.

VARIABLES:	PREPARED BY:
T/K: 298.15 p/kPa: 101.325 (1 atm)	S. A. Johnson H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\mathrm{cm^3(STP)cm^{-3}atm^{-1}}$	Ostwald Coefficient $L/\mathrm{cm^3cm^{-3}}$
Heptane			
298.15	1.70	0.258	0.282
Octane			
298.15	1.56	0.214	0.234

The Bunsen coefficient and mole fraction values were calculated by the compiler assuming that the gas is ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus described by Bodor, Bor, Mohai and Sipos was used (1).

SOURCE AND PURITY OF MATERIALS:

Both the gas and the liquid were analytical grade reagents of Hungarian or foreign origin. No further information.

ESTIMATED ERROR:

$\delta L/L = \pm\ 0.03$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip. Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Octane; C_8H_{18}; [111-65-9]	Wilcock, R. J.; Battino, R.; Danforth, W. F.; Wilhelm, E. *J. Chem. Thermodyn.* 1978, *10*, 817 - 822.
VARIABLES:	**PREPARED BY:**
T/K: 283.27 - 312.94 p/kPa: 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\ \text{cm}^{-3}\ \text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\ \text{cm}^{-3}$
283.27	1.774	0.2477	0.2569
298.21	1.714	0.2353	0.2569
312.94	1.695	0.2287	0.2620

The Bunsen coefficients were calculated by the compiler.

It is assumed that the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 283.15 and 313.15 K

$$\ln x_1 = -6.8224 + 1.3727/(T/100\ \text{K})$$

The standard error about the regression line is 1.45×10^{-5}.

T/K	Mol Fraction 10^3x_1
283.15	1.769
293.15	1.740
298.15	1.727
303.15	1.713
313.15	1.689

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum mole per cent purity stated to be 99.5.

(2) Octane. Phillips Petroleum Co. 99 mole per cent, distilled, density at 298.15 K, $\rho/\text{g cm}^{-3}$ 0.6988.

ESTIMATED ERROR:

$\delta T/K = 0.02$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.01$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon Monoxide; CO; [630-08-0]

(2) Nonane; C_9H_{20}; [111-84-2]

Decane; $C_{10}H_{22}$; [124-18-5]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Megyery-Balog, K.; Rusz, L.; Patyi, L.

Hung. J. Ind. Chem. 1976, *4*, 269 - 280.

VARIABLES:

T/K: 298.15
p/kPa: 101.325 (1 atm)

PREPARED BY:

S. A. Johnson
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
Nonane			
298.15	1.59	0.199	0.217
Decane			
298.15	1.53	0.175	0.191

The Bunsen coefficient and mole fraction values were calculated by the compiler assuming that the gas is ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus described by Bodor, Bor, Mohai and Sipos was used (1).

SOURCE AND PURITY OF MATERIALS:

Both the gas and the liquid were analytical grade reagents of Hungarian or foreign origin. No further information.

ESTIMATED ERROR:

$\delta L/L = \pm 0.03$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip. Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Decane; $C_{10}H_{22}$; [124-18-5]

ORIGINAL MEASUREMENTS:

Wilcock, R. J.; Battino, R.; Danforth, W. F.; Wilhelm, E.

J. Chem. Thermodyn. 1978, *10*, 817 - 822.

VARIABLES:

T/K: 283.15 - 313.48
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3(STP) cm^{-3} atm^{-1}	Ostwald Coefficient L/cm^3 cm^{-3}
283.15	1.698	0.1975	0.2047
298.16	1.662	0.1905	0.2079
313.48	1.722	0.1941	0.2228

The Bunsen coefficients were calculated by the compiler.

It is assumed that the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 283.15 and 313.15 K

$$\ln x_1 = -6.2505 - 0.3880/(T/100K)$$

The standard error about the regression line is 3.96×10^{-5}.

T/K	Mol Fraction 10^3x_1
283.15	1.682
293.15	1.690
298.15	1.694
303.15	1.698
313.15	1.705

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum mole per cent purity stated to be 99.5.

(2) Decane. Phillips Petroleum Co. 99 mol %, distilled, density at 298.15 K, ρ/g cm^{-3} 0.7264.

ESTIMATED ERROR:

$\delta T/K = 0.02$
$\delta P/mmHg = 0.5$
$\delta x_1/x_1 = 0.01$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon Monoxide; CO; [630-08-0] (2) Undecane; $C_{11}H_{24}$; [1120-21-4] Dodecane; $C_{12}H_{26}$; [112-40-3]	Makranczy, J.; Megyery-Balog, K.; Rusz, L.; Patyi, L. *Hung. J. Ind. Chem.* 1976, *4*, 269 - 280.
VARIABLES:	**PREPARED BY:**
T/K: 298.15 p/kPa: 101.325 (1 atm)	S. A. Johnson H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\mathrm{cm^3(STP)cm^{-3}atm^{-1}}$	Ostwald Coefficient $L/\mathrm{cm^3cm^{-3}}$
Undecane			
298.15	1.53	0.162	0.177
Dodecane			
298.15	1.55	0.152	0.166

The Bunsen coefficient and mole fraction values were calculated by the compiler assuming that the gas is ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus described by Bodor, Bor, Mohai and Sipos was used (1).

SOURCE AND PURITY OF MATERIALS:

Both the gas and the liquid were analytical grade reagents of Hungarian or foreign origin. No further information.

ESTIMATED ERROR:

$\delta L/L = \pm 0.03$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip. Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h.

COMPONENTS:

(1) Carbon Monoxide; CO; [630-08-0]

(2) Tridecane; $C_{13}H_{28}$; [629-50-5]

Tetradecane; $C_{14}H_{30}$; [629-59-4]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Megyery-Balog, K.; Rusz, L.; Patyi, L.

Hung. J. Ind. Chem. 1976, *4*, 269 - 280.

VARIABLES:

T/K: 298.15

p/kPa: 101.325 (1 atm)

PREPARED BY:

S. A. Johnson
H. L. Clever

EXPERIMENTAL VALUES:

/K	Mol Fraction $10^3 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3\,(\text{STP})\,\text{cm}^{-3}\,\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\,\text{cm}^{-3}$
Tridecane			
298.15	1.51	0.138	0.151
Tetradecane			
298.15	1.45	0.125	0.136

The Bunsen coefficient and mole fraction values were calculated by the compiler assuming that the gas is ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus described by Bodor, Bor, Mohai and Sipos was used (1).

SOURCE AND PURITY OF MATERIALS:

Both the gas and the liquid were analytical grade reagents of Hungarian or foreign origin. No further information.

ESTIMATED ERROR:

$\delta L/L = \pm\ 0.03$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip. Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h.

COMPONENTS:

(1) Carbon Monoxide; CO; [630-08-0]

(2) Pentadecane; $C_{15}H_{32}$; [629-62-9]

Hexadecane; $C_{16}H_{34}$; [544-76-3]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Megyery-Balog, K.; Rusz, L.; Patyi, L.

Hung. J. Ind. Chem. 1976, *4*, 269 - 280.

VARIABLES:

T/K: 298.15
p/kPa: 101.325 (1 atm)

PREPARED BY:

S. A. Johnson
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
Pentadecane			
298.15	1.45	0.117	0.128
Hexadecane			
298.15	1.44	0.110	0.120

The Bunsen coefficient and mole fraction values were calculated by the compiler assuming that the gas is ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus described by Bodor, Bor, Mohai and Sipos was used (1).

SOURCE AND PURITY OF MATERIALS:

Both the gas and the liquid were analytical grade reagents of Hungarian or foreign origin. No further information.

ESTIMATED ERROR:

$\delta L/L = \pm 0.03$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip. Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hexadecane; $C_{16}H_{34}$; [544-76-3]

ORIGINAL MEASUREMENTS:

Tremper, K.K.; Prausnitz, J.M.

J. Chem. Engng. Data

1976, *21*, 295-299.

VARIABLES:

T/K = 300 - 475

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	Henry's Constant[a] /atm	Mole fraction[b] of carbon monoxide at 1 atm. partial pressure, x_{CO}
300	538.0	0.00186
325	527.0	0.00190
350	515.0	0.00194
375	501.0	0.00200
400	482.0	0.00207
425	461.0	0.00217
450	437.0	0.00229
475	419.0	0.00239

[a] Authors stated measurements were made at several pressures and values of solubility used were made all within the Henry's Law region.

[b] Calculated by compiler assuming linear relationship between mole fraction and pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric apparatus similar to that described by Dymond and Hildebrand (1). Pressure measured with a null detector and precision gauge. Details in ref. (2).

SOURCE AND PURITY OF MATERIALS:

ESTIMATED ERROR:

REFERENCES:

1. Dymond, J.; Hildebrand, J.H. *Ind. Eng. Chem. Fundam.* 1967, *6*, 130.
2. Cukor, P.M.; Prausnitz, J.M. *Ind. Eng. Chem. Fundam.* 1971, *10*, 638.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alkanes

ORIGINAL MEASUREMENTS:

Lin, P. J.; Parcher, J. F.

J. Chromatog. Sci.

1982, *20*, 33-38.

VARIABLES:

T/K = 298.2 - 413.2
p = 101.3 kPa

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	Henry's law constant, H /atm	Mole fraction at a partial pressure of 1 atmosphere x_{CO}
	Hexadecane; $C_{16}H_{34}$; [544-76-3]	
298.2	570	0.00175
313.2	541	0.00185
328.2	543	0.00184
	Octacosane; $C_{28}H_{58}$; [630-02-4]	
353.2	411	0.00243
373.2	372	0.00269
393.2	386	0.00259
	Hexatriacontane; $C_{36}H_{74}$; [630-06-8]	
353.2	346	0.00289
373.2	359	0.00279
393.2	344	0.00291
413.2	329	0.00304

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Henry's law constant determined from retention volume of gas on a chromatographic column. Helium was used as a carrier gas and a mass spectrometer was used as a detector. The measured Henry's law constants were independent of sample size, flow rate and composition of injected sample. The dead volume was determined by two independent methods and the values agreed within experimental error.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$; $\delta x_{CO} = \pm 5\%$

(estimated by compiler).

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Petroleum

ORIGINAL MEASUREMENTS:

Gniewosz, S.; Walfisz, A.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1887, *1*, 70-72.

VARIABLES:

T/K = 283.15, 293.15
p/kPa = 101 ("atmospheric")

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

Temperature $t/^{\circ}$C	Temperature T/K	Bunsen Coefficient $\alpha/\mathrm{cm^3(STP)\,cm^{-3}\,atm^{-1}}$	Ostwald Coefficient $L/\mathrm{cm^3\,cm^{-3}}$
10	283.15	0.135	
		0.134	
		0.132	
		0.134 Av.	0.139
20	293.15	0.123	
		0.125	
		0.122	
		0.123 Av.	0.132

The Ostwald coefficients were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consisted of an absorption flask connected to a gas buret by a flexible lead capillary. The system was thermostated in a large water bath.

The volume of gas absorbed in a known volume of degassed petroleum was measured directly using the gas buret.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. No information.

(2) Petroleum. Russian petroleum. Cleaned by boiling in a large copper flask.

ESTIMATED ERROR:

$\delta\alpha/\alpha = \pm\ 0.05$ (compiler)

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Mineral oil (Wemco A)	Rodman, C.J.; Maude, A.H. *Trans. Am. Electrochem. Soc.* 1925, *47*, 71 - 92.
VARIABLES: T/K = 298.15, 353.15 p_1/kPa = 101.3 (760 mmHg)	PREPARED BY: H.L. Clever

EXPERIMENTAL VALUES:

Temperature		Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$	Solubility g kg^{-1}
t/°C	T/K			
25	298.15	0.186	0.204	0.277
80	353.15	0.153	0.198	0.239

These values appear in the International Critical Tables, McGraw-Hill Book Co., New York and London, Vol.III, pp.261 - 270 where they are credited to an industrial report edited by A.H. Maude.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of an 180 cm^3 absorption bottle connected to a 100 cm^3 gas buret. The absorption bottle sits in a thermostat, which is attached to a shaking machine.

A weighed sample of oil is introduced into the absorption vessel. The sample is degassed by vacuum, taking care to avoid excessive foaming. The gas is brought into the system. An initial buret reading is taken, and the shaker is started and reading taken every 5 minutes until 2 or 3 constant readings are obtained.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. No information

(2) Mineral oil. A Pennsylvania base oil, 96 per cent saturated hydrocarbons, and distilling between 300 and 400°C. Density at 25°C = 0.840 and at 80°C = 0.800 g cm^{-3}. As a commercial product the oil is known as "Wemco A".

ESTIMATED ERROR:

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [4906-87-0]

(2) Kerosene A-1

ORIGINAL MEASUREMENTS:

Hannaert, H.; Haccuria, M.;
Mathieu, M. P.

Ind. Chim. Belge 1967, *32*,
156 - 164.

VARIABLES:

T/K = 233.15 - 293.15

PREPARED BY:

E. L. Boozer
H. L. Clever

EXPERIMENTAL VALUES:

Temperature Interval of Measurements T/K	Carbon Monoxide Mol % Range 10^2x_1/mol %	$K\pi\nu$/atm[1] at 293.15 K	Enthalpy of Dissolution ΔH/kcal mol^{-1}	Constant A
233.15-293.15	0.1	573	0.274	2.96

[1] $\log (K\pi\nu/\text{atm}) = A - (\Delta H/\text{cal mol}^{-1})/(2.3R(T/\text{K}))$

The author's definitions are:

$$K = y_1/x_1 = \frac{\text{mole fraction gas in gas phase}}{\text{mole fraction gas in liquid phase}},$$

π/atm = total pressure

ν = coefficient of fugacity

The function, $K\pi\nu$/atm, is equivalent to a Henry's constant in the form $H_{1,2}/\text{atm} = (f_1/\text{atm})/x_1$ where f_1 is the fugacity.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The authors describe three methods:

1.A. [Saturat. n° 1]. A measure of the static pressure of saturation in an apparatus which gave a precision of 10 - 15 %.

1.B. [Saturat. n° 2]. A measure of the static pressure of saturation in an apparatus which gave a precision of 2 - 5 %.

2. [Chromato]. A Gas liquid chromatographic method estimated to have a precision of 2 - 5 %.

3. [Anal. directe]. Direct analysis of the gaseous and liquid phases.

Method 1.B. was used for this system.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Air Liquide. Contains N_2, purity 99 per cent.

(2) Kerosene A-1.

Distillation range, °C	Density gcm^{-3},20°C	mol wt
A-1 150-280	0.7805	170

ESTIMATED ERROR:

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Paraffin oil (ca. 30% naphthalene derivatives + 70% branched paraffins)	Luther, H.; Hiemenz, W. *Chemie. Ing. Techn.* 1957, *29*, 530-535.
VARIABLES:	**PREPARED BY:**
T/K: 293.15, various pressures.	E. Wilhelm

EXPERIMENTAL VALUES:

T/K	K_H/atm	K_H/MPa*	mol fraction solubility at 1atm, $10^3 x_1$
293.15	551	55.8	1.81

* calculated by compiler

Solubility measurements were carried out between ca. 0.1 kPa and 93 kPa, yet only the Henry's Law constant derived therefrom was presented by the authors.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Degassed liquid is flowed slowly in a thin film down a glass spiral, thereby equilibrating rapidly with the gas (~ 1 hour).
Details in source.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no details given.

(2) Paraffin oil: density (293.15K) = 0.8795 g cm^{-3}, average relative molecular mass M_r = 405.

ESTIMATED ERROR:

$\delta K_H = \pm 7.5\%$

REFERENCES:

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Hydrocarbons	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. May 1989

CRITICAL EVALUATION:

The Solubility of Carbon Monoxide at High Pressures in Hydrocarbons

To complement the previous section on the solubility of carbon monoxide at a partial pressure of 1 atm in hydrocarbons, the following pages summarise, and evaluate where possible, solubilities where the partial pressure of carbon monoxide is significantly greater. For most of the studies this is in the range 0.5 - 5 MPa (5-50 atm). The solvents include saturated hydrocarbons of low and high molecular weights, some pure compounds and some mixtures, and there is also one study of an unsaturated hydrocarbon solvent.

1. Methane; CH_4; [74-82-8]

Of the four groups which have investigated the carbon monoxide - methane system, Toyama *et al.*(1) and Christiansen *et al.*(2) have provided the most comprehensive data, covering 113-186 K and 123-178 K respectively at pressures up to about 5 MPa. The agreement between these two data sets is very good, and the values given by each of these groups are recommended. The data of Cheung and Wang(3) cover the lower temperature range of 91-124 K at lower pressures of 0.026 - 0.52 Mpa, and are classed as tentative. The two values of Kerner and Knapp(4) at 140 K are in some disagreement with the recommended values, and should be regarded with less confidence.

Ostronov *et al.* (5) performed calculations on the phase equilibria of carbon monoxide and methane, and found satisfactory agreement with some published data at 0.68 MPa.

2. Propane; C_3H_8; [74-98-6]

The data of Cheung and Wang(3) cover temperatures of 86-129 K, and are classed as tentative. Work by Trust and Kurata(6) on the solubility of carbon monoxide and hydrogen together as gaseous solutes in propane at 223-323 K, may be referred to in Volume 5-6 of the Solubility Data Series, from which the solubilities of carbon monoxide in propane at these higher temperatures may be calculated.

With the increasing interest which has been shown by industrial and synthetic chemists in the interactions of carbon monoxide at high pressures with higher molecular weight hydrocarbons and their derivatives, there has been published, mostly within the past five years, several papers dealing with a variety of these systems. Some of the solvents are the single alkanes, C_8H_{18}, $C_{20}H_{42}$, $C_{28}H_{58}$ and $C_{36}H_{74}$. Others are complex mixtures containing alkanes of a range of carbon numbers, some of them commercial products, others involved in industrial processes. Those for which data sheets have been compiled are summarised in Table 1, where the solvents have been listed in order of increasing molecular weight. The general trend is that solubility decreases as molecular weight increases, although the special nature of some of the solvents can create anomalies from this principle.

It has been possible in only a few cases to make a critical evaluation because few studies have been duplicated under close enough conditions. Comments on individual systems follow after Table 1. The single alkanes are considered first, followed by the various mixtures.

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Hydrocarbons	EVALUATOR: Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology. Bell Street, Dundee DD1 1HG, UK. May 1989

CRITICAL EVALUATION:

Table 1: Alkanes for which carbon monoxide solubility data are available.

molecular weight	formula (substance)	temperature T/K	pressure p/MPa	author	(ref)
114	C_8H_{18}	463-533	0.46 - 7.1	Connolly	(7)
			0.6 - 5.2	Connolly	(8)
114	C_5-C_{11}	373-423	1 - 3.2	Deimling	(9)
201.2	C_{11}-C_{22}	373-523	1 - 4.5	Deimling	(9)
226	$C_{16}H_{34}$	300-475	0.101	Tremper	(*)
282	$C_{20}H_{42}$	373-573	1 - 5	Huang	(10)
345	(wax)	373-573	0.2 - 1	Peter	(11)
366	C_{15}-C_{36}	471-534	0.1 - 0.5	Leda kowicz	(12)
368.5	C_{19}-C_{42}	373-523	1 - 4.5	Deimling	(9)
380	(wax)	348-523	1 - 3.2	Albal	(13)
394	$C_{28}H_{58}$	488-553	0.5 - 0.8	Matsumato	(14)
		373-573	1 - 5.1	Huang	(10)
446.5	(bitumen)	296-375	3 - 9.7	Mehrotra	(15)
506	$C_{36}H_{74}$	373-573	1 - 5.1	Huang	(10)
857	(wax)	473-573	1 - 5	Huang	(10)

* data for 0.101 MPa, in previous section of this volume.

3. Octane; C_8H_{18}; [111-65-9]

The work of Connolly (7), repeated and extended by Connolly and Kandalic(8), appears to be reliable and can be accepted tentatively for this solvent. In the earlier paper, results are given as *K* values, which are the ratios of the mol fraction of carbon monoxide in the gas and liquid phases. In the later paper, these mol fractions are actually listed.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrocarbons

EVALUATOR:

Robert W. Cargill,
Department of Molecular
and Life Sciences,
Dundee Institute of Technology,
Bell Street, Dundee DD1 1HG, UK.

May 1989

CRITICAL EVALUATION:

4. Eicosane; $C_{20}H_{42}$; [112-95-8]

Octacosane; $C_{28}H_{58}$; [630-02-4]

Hexatriacontane; $C_{36}H_{74}$; [630-06-8]

Huang *et al.* (10) measured the solubility of carbon monoxide in these three heavy n-paraffins at 373-573 K and 1-5 MPa, as did Matsumato and Satterfield (14) for octacosane at 488-553 K and 0.5-0.8 MPa. Huang *et al.* (10) also measured the solubility of "synthesis gas" (mixtures of three different compositions of carbon monoxide and hydrogen), in octacosane. There is very good agreement between the two sets of data for carbon monoxide in this solvent, and the values may be accepted tentatively. The values of Huang *et al.* for the C_{20} and C_{36} paraffins are probably also reliable. At the temperatures studied, their solubilities increase with increasing molecular weight, which is however an unusual feature compared with the trend in Table 1.

5. C_6 - C_8 mixture of hydrocarbons.

Alekseeva *et al.* (16) measured the solubility of carbon monoxide (and of hydrogen also) at 5-15 MPa in "synthol" fractions in an investigation of starting materials and final products of the "oxo" process. These fractions were mixtures of hexane-hexene, heptane-heptene, and octane-octene. Hexyl alcohol was also investigated. Their results were given only on graphs, and temperature conditions were unclear, so no meaningful data sheets could be compiled.

6. Fischer-Tropsch fractions (alkane mixtures).

The work of Deimling *et al.* (9) on the solubility of carbon monoxide (and hydrogen) in C_5-C_{11}, C_{11}-C_{22}, and C_{19}-C_{42} mixtures ("light", "medium", and "heavy" Fischer-Tropsch fractions) at 373-523 K and 0.5-4.5 MPa has shown that the solubility of carbon monoxide increases with temperature and decreases with increasing carbon number of the alkanes. They also found that the solubilities followed Henry's law very closely. Later work by this group (17, 18) showed that the solubilities in the "medium" and "heavy" fractions increased significantly when the wax was saturated with water.

To compile data sheets from their papers, solubility values had to be read from small-scale graphs. This obviously affects the accuracy of the data recorded on the sheets, but within the 5% possible error quoted by the authors, the data are classed as tentative. The values are consistent with those obtained by others for paraffin solvents of comparable molecular weights.

Deimling *et al.* (9) compared their data for the "light" and "medium" fractions with values computed from a nomograph by Zanker (19). This estimates solubilities of different gases in petroleum liquids by a method which depends on the application of the Clausius - Clapeyron equation, Henry's Law, and the ideal gas laws. Those computed values were in good agreement with the experimental data. A measurement by one member of the group (20) of the solubility of carbon monoxide at 298 K in "Soltrol", an isoparaffin mixture of the C_9-C_{12} range, was also shown to be consistent with their values for the "medium" fraction at higher temperatures.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Hydrocarbons	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. May 1989

CRITICAL EVALUATION:

7. Other hydrocarbon oils and waxes.

The values of Ledakowicz and Nowicki (12) for a paraffin oil solvent (C_{15}-C_{36} mixture) at 471-534 K and 0.1-0.52 MPa appear to be consistent and compare favourably with values for other similar solvents. The same may be said for the values obtained by Peter and Weinert (11) for a paraffin wax of molecular weight 345 at 379-573 K and 0.1-0.5 MPa, and by Albal *et al* (13) for a "Gulfwax" of molecular weight 380 at 348-523 K and 1-3.2 MPa. Similarly the values of Huang *et al.* (10) for a "Mobil wax" of molecular weight 857 at 473-573 K and 1-5 MPa agree well with other available data. Additionally, their original paper develops a theoretical model which gives a good correlation with experimental values, and shows clearly how solubility decreases as molecular weight of the wax increases.

Finally, the work of Mehrotra and Svrcek (15) on a bitumen sample at 296-375 K and 3-9.7 MPa appears to be reliable, but like all other data considered in this section, would need further confirmation.

8. Isononenes; C_9H_{18}; [31387-92-5]

Tyvina *et al.* (21) have provided data for the solubility of carbon monoxide at 313-553 K and 5-30 MPa in this mixture of C_9 alkenes. The values may be used with caution, pending further investigations of this system.

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9. Deimling, A.; Karandikar, B.M.; Shah, Y.T.; Carr, N.L. *Chem. Eng. J.* 1984, *29*, 127.

COMPONENTS:	EVALUATOR:
1. Carbon Monoxide; CO; [630-08-0] 2. Hydrocarbons	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. May 1989.

CRITICAL EVALUATION:

10. Huang, S.H.; Lin. H.; Tsai, F.; Chao, K.
Ind. Eng. Chem. Res. 1988, *27*, 162.

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Z. Phys. Chem (Frankfurt) 1955, *5*, 114.

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J. Chem. Eng. Data 1987, *32*, 166.

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Chem. Eng. Science 1984, *39*, 905.

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Ind. Eng. Chem. Process Des. Dev. 1985, *24*, 1297.

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AOSTRA J. Res. 1985, 2, 83.

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Can. J. Chem. Eng. 1987, *65*, 973.

19. Zanker, A.
Hydrocarbon Processing 1977, *56*, 255-256.

20. Albal, R.S.
Ph. D. Thesis, University of Pittsburgh, 1983.

21. Tyvina, T.N.; Fokina, V.V.; Naumova, A.A.; Polyakov, A.A.
Zh. Prikl. Khim. 1984, *57*, 2101.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methane; CH_4; [74-82-8]

ORIGINAL MEASUREMENTS:

Toyama, A.; Chappelear, P. S.;
Leland, T. W.; Kobayashi, R.
Adv. Cryogenic Eng.
1961, *7*, 125-136.

VARIABLES:

T/K = 113 - 186
p/MPa = 0.69 - 5

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/psi	P/MPa^a	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor, y_{CO}
185.9	698	4.813	0.106	0.108
	670	4.619	0.0778	0.1044
	600	4.137	0.0157	0.0305
184.8	600	4.137	0.0271	0.0509
182.0	700	4.826	0.1534	0.1975
172.0	720	4.964	0.3565	0.393
	700	4.826	0.3365	0.3985
	600	4.137	0.211	0.339
	400	2.758	0.035	0.093
163.7	700	4.826	0.469	0.506
	300	2.068	0.0302	0.100
158.2	670	4.619	0.551	0.622
	600	4.137	0.456	0.630
	400	2.758	0.209	0.450
	300	2.068	0.0992	0.2805
152.6	200	1.379	0.0352	0.1405
149.8	600	4.137	0.651	0.745
148.3	570	3.930	0.7875	0.8365
	500	3.447	0.6715	0.806
	400	2.758	0.475	0.7315
	300	2.068	0.311	0.6345
	200	1.379	0.139	0.4462

(cont.)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Stainless steel equilibrium cell with glass windows. Pressure measured with Bourdon gauge. Temperature measured with thermocouple. Vapor and liquid samples analysed by gas chromatography using thermal conductivity detection. Details in source and ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. Matheson, C.P. grade, purity 99.5 mole per cent or better.
2. Tennessee Gas Transmission Co. sample, purity 99.7 mole per cent; major impurity ethane.

ESTIMATED ERROR:

δT/K = ±0.1; δP/MPa = ±0.01;
δx_{CO}, δy_{CO} = ±0.001 (estimated by compiler).

REFERENCES:

1. Price, A. R.; Kobayashi, R.
J. Chem. Engng. Data
1959, *4*, 40.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Methane; CH_4; [74-82-8]	Toyama, A.; Chappelear, P. S.; Leland, T. W.; Kobayashi, R. *Adv. Cryogenic Eng.* 1961, *7*, 125-136.

EXPERIMENTAL VALUES:

T/K	*P*/psi	*P*/MPa[a]	Mole fraction of carbon monoxide in liquid, x_{CO}	Mole fraction of carbon monoxide in vapor, y_{CO}
138.7	100	0.689	0.0171	0.1055
130.4	300	2.068	0.616	0.883
	200	1.379	0.359	0.7575
	110	0.758	0.122	0.5075
	100	0.689	0.096	0.443
122.0	200	1.379	0.591	0.9065
	100	0.689	0.210	0.685
113.7	100	0.689	0.4445	0.867

[a] Calculated by compiler.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methane; CH_4; [74-82-8]

ORIGINAL MEASUREMENTS:

Cheung, H.; Wang, D. I. J.
Ind. Eng. Chem. Fundam.
1964, *3*, 355-361.

VARIABLES:

$T/K = 91 - 124$
$p/MPa = 0.026 - 0.52$

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor, y_{CO}
91.4	0.0268	0.031	0.432
91.5	0.0420	0.059	0.605
91.8	0.0663	0.114	0.736
91.7	0.0843	0.165	0.794
91.4	0.1140	0.246	0.863
97.1	0.0465	0.031	0.385
97.3	0.0649	0.059	0.542
97.3	0.1010	0.114	0.703
97.0	0.1248	0.165	0.776
104.9	0.0874	0.030	0.353
105.4	0.1202	0.058	0.497
105.2	0.1749	0.113	0.664
105.0	0.2110	0.164	0.735
105.4	0.2672	0.245	0.789
114.6	0.1811	0.030	0.266
114.6	0.2297	0.057	0.415
114.5	0.3139	0.112	0.587
114.3	0.3746	0.164	0.667
114.4	0.4840	0.245	0.744
123.9	0.3201	0.030	0.204
123.9	0.3913	0.057	0.342
123.9	0.5205	0.111	0.509

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static equilibrium cell fitted with magnetic stirrer. Pressure measured on mercury manometer. Temperature measured by thermocouple. Details of apparatus in source ref. Known quantity of solvent added to evacuated cell. Metered quantity of solute added. Solubility determined from equilibrium pressure and mass balance.

SOURCE AND PURITY OF MATERIALS:

Not given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.2$; $\delta P/MPa = \pm 0.0015$;
δx_{CO}, δy_{CO} = ±4% (estimated by compiler).

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methane; CH_4; [74-82-8]

ORIGINAL MEASUREMENTS:

Christiansen, L.J.; Fredenslund, A.; Mollerup, J.

Cryogenics, 1973, *13*, 405-413.

VARIABLES:

$T/K = 123 - 178$
$p/MPa = 0.36 - 4.74$

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	p/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor y_{CO}
123.00	0.364	0.0500	0.3460
	0.501	0.1190	0.5420
	0.699	0.2070	0.6880
	0.988	0.3600	0.8000
	1.285	0.5380	0.8650
	1.588	0.7210	0.9160
	1.818	0.8420	0.9470
	2.024	0.9260	0.9750
	2.132	0.9660	0.9880
137.10	0.699	0.0400	0.2060
	0.870	0.0960	0.3810
	1.300	0.2210	0.5960
	1.669	0.3280	0.7000
	2.060	0.4500	0.7710
	2.454	0.5870	0.8250
	2.877	0.7300	0.8680
	3.182	0.8080	0.8970
	3.355	0.8520	0.9120
	3.547	0.8920	0.9260
164.00	2.090	0.0330	0.1040
	2.344	0.0720	0.1970
	2.642	0.1200	0.2810
	3.194	0.2120	0.3890
	3.721	0.2940	0.4600
	4.159	0.3610	0.4990

contd

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Recirculating vapor flow apparatus. Temperature measured with platinum resistance thermometer. Pressure measured with dead weight piston gauge. Co-existing samples analysed by gas chromatography. Details in ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. No details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.01$; $\delta p/MPa = \pm 0.001$;
$\delta x_{CO} = \pm 0.004$; $\delta y_{CO} = \pm 0.003$.

REFERENCES:

1. Fredenslund, A.; Mollerup, J. Christiansen, L.J.; *Cryogenics* 1973, *13*, 414

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Methane; CH_4; [74-82-8]

ORIGINAL MEASUREMENTS:

Christiansen, L.J.; Fredenslund, A.; Mollerup, J.

Cryogenics 1973, *13*, 405-413.

EXPERIMENTAL VALUES:

T/K	p/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor y_{CO}
164.00	4.558	0.4290	0.5180
	4.661	0.4520	0.5100
178.00	3.301	0.0260	0.0590
	3.607	0.0620	0.1250
	3.885	0.0960	0.1760
	4.226	0.1390	0.2230
	4.551	0.1840	0.2520
	4.739	0.2130	0.2610

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methane; CH_4; [74-82-8]

ORIGINAL MEASUREMENTS:

Kerner, H.; Knapp, H.

Fluid Phase Equilibria

1983, *11*, 289-310.

VARIABLES:

T = 140 K
p/bar = 20, 28.9

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/bar	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor, y_{CO}
140	20	0.3837	0.7100
	28.9	0.6990	0.8200

AUXILIARY INFORMATION

METHOD APPARATUS/PROCEDURE:

Vapor flow apparatus with a membrane compressor (not at cell temperature) used to recirculate vapor through external loop. Temperature measured with platinum resistance thermometer. Pressure measured using Bourdon type gauges. Chemical analysis of samples undertaken using gas chromatography. Details given in ref. (1).

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.01$; $\delta P/P = \pm 0.003$ or less; $\delta x/x < \pm 0.01$.

REFERENCES:

1. Dorau, W.; Kremer, H. W.; Knapp, H. *Fluid Phase Equilibria* 1983, *11*, 83.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Propane; C_3H_8; [74-98-6]

ORIGINAL MEASUREMENTS:

Cheung, H.; Wang, D. I. J.

Ind. Eng. Chem. Fundam.

1964, *3*, 355-361.

VARIABLES:

T/K = 86 - 129
p/MPa = 0.02 - 0.4

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}
86.3	0.0204	0.011
86.4	0.0919	0.055
86.5	0.1584	0.108
86.5	0.1728	0.209
94.8	0.0300	0.0104
94.9	0.1471	0.051
94.9	0.2589	0.102
110.2	0.0530	0.0087
110.4	0.2648	0.0442
110.5	0.4923	0.0895
117.2	0.5980	0.0848
128.3	0.0790	0.00758
128.4	0.3937	0.0389

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static equilibrium cell fitted with magnetic stirrer. Pressure measured on mercury manometer. Temperature measured by thermocouple. Details of apparatus in source ref. Known quantity solvent added to evacuated cell. Metered quantity of solute added. Solubility determined from equilibrium pressure and mass balance.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

δT/K = ±0.2; δP/MPa = ±0.0015;
δx_{CO} = ±4% (estimated by compiler).

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Octane; C_8H_{18}; [111-65-9]

ORIGINAL MEASUREMENTS:

Connolly, J.F.

Amer. Petr. Inst. Report <u>*1965*</u>*,* *45 (III)*, 62-67

VARIABLES:

T/K = 463 - 533
P/bar = 4.55 - 70

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

		K-values*	
T/K	P/bar	$K_{C_8H_{18}}$	K_{CO}
463.15	4.55	1.000	78.8
	6.89	0.704	55.1
	13.8	0.398	29.0
	20.7	0.290	19.8
	27.6	0.232	15.1
473.15	5.52	1.000	60.7
	6.89	0.834	51.0
	13.8	0.478	27.0
	20.7	0.351	18.6
	27.6	0.283	14.2
	34.5	0.244	11.5
	41.4	0.218	9.71
	55.2	0.188	7.39
	68.9	0.170	5.97
483.15	6.62	1.000	46.9
	6.89	0.972	45.6
	13.8	0.565	25.1
	20.7	0.418	17.4
	27.6	0.340	13.3
	34.5	0.294	10.8
	41.4	0.263	9.11

* see next page

contd.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Sample of known composition confined over mercury. Mixture compressed at constant temperature. Dew point and bubble point determined visually. Data smoothed.

SOURCE AND PURITY OF MATERIALS:

No details given

ESTIMATED ERROR:

δT/K = ±0.2; δP/bar = ±0.5;
$\delta K/K$ = ±1%;

(estimated by compiler).

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Octane; C_8H_{18}; [111-65-9]

ORIGINAL MEASUREMENTS:

Connolly, J.F.

Amer. Petr. Inst. Report 1965, 45 (III), 62-67.

EXPERIMENTAL VALUES:

T/K	P/bar	*K*-values*	
		$K_{C_8H_{18}}$	K_{CO}
493.15	7.93	1.000	36.2
	13.8	0.656	22.9
	20.7	0.493	16.0
	27.6	0.406	12.4
	34.5	0.352	10.1
	41.4	0.317	8.48
	55.2	0.272	6.47
503.15	9.38	1.000	27.9
	13.8	0.759	20.5
	20.7	0.575	14.5
	27.6	0.476	11.3
	34.5	0.415	9.24
	41.4	0.375	7.79
513.15	11.0	1.000	21.2
	13.8	0.868	17.9
	20.7	0.663	12.8
	27.6	0.552	10.1
	34.5	0.481	8.32
523.15	12.9	1.000	15.9
	13.8	0.959	15.1
	20.7	0.750	11.3
	27.6	0.635	8.91
	34.5	0.564	7.34
	41.4	0.517	6.22
	55.2	0.464	4.75
	68.9	0.436	3.82
533.15	15.0	1.000	11.7
	20.7	0.841	9.33
	27.6	0.725	7.50
	34.5	0.625	6.26

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* *K* values are vapor-liquid equilibrium ratios, mol fraction of component in gas phase divided by its mol fraction in liquid phase.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Octane; C_8H_{18}; [111-65-9]

ORIGINAL MEASUREMENTS:

Connolly, J. F.; Kandalic, G. A.
J. Chem. Thermodyn.
1984, *16*, 1129-1139.

VARIABLES:

$T/K = 463 - 533$
$p/MPa = 0.6 - 5.2$

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in gas, y_{CO}	T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in gas, y_{CO}
463.15	0.6687	0.00488	0.2750	503.15	1.0376	0.00274	0.0702
	0.8451	0.00891	0.4059		1.1784	0.00654	0.1528
	1.0538	0.01366	0.5092		1.4581	0.01405	0.2750
	1.4611	0.02287	0.6277		1.9059	0.02598	0.4059
	2.3568	0.04285	0.7499		2.4673	0.04080	0.5092
473.15	0.8197	0.00635	0.2750		3.6588	0.07187	0.6277
	1.0416	0.01160	0.4059	513.15	1.2270	0.00360	0.0702
	1.3081	0.01787	0.5092		1.4034	0.00862	0.1528
	1.8330	0.03011	0.6277		1.7560	0.01860	0.2750
	3.0083	0.05707	0.7499		2.3315	0.03473	0.4059
483.15	0.9970	0.00823	0.2750		3.0691	0.05518	0.5092
	1.2767	0.01509	0.4059	523.15	1.4459	0.00481	0.0702
	1.6161	0.02336	0.5092		1.6668	0.01149	0.1528
	2.2960	0.03976	0.6277		2.1167	0.02497	0.2750
	3.9152	0.07806	0.7499		2.8553	0.04685	0.4059
493.15	0.9849	0.00500	0.1528		3.8899	0.07727	0.5092
	1.2078	0.01073	0.2750		6.5689	0.15699	0.6277
	1.5614	0.01976	0.4059	533.15	1.6962	0.00651	0.0702
	1.9961	0.03076	0.5092		1.9819	0.01578	0.1528
	2.8837	0.05297	0.6277		2.5676	0.03453	0.2750
	5.1777	0.10912	0.7499		3.5981	0.06717	0.4059

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Sample of known composition confined over mercury. Mixture compressed at constant temperature. Dew point and bubble point determined visually.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.2$; $\delta P/MPa = \pm 0.01$;
$\delta x/x$, $\delta y/y = \pm 0.005$ (estimated by compiler).

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. n-Eicosane; $C_{20}H_{42}$; [112-95-8]

ORIGINAL MEASUREMENTS:

Huang, S. H.; Lin, H.; Tsai, F.; Chao, K.

Ind. Eng. Chem. Res. 1988, *27*, 162-169.

VARIABLES:

T/K = 373.3 - 573.1

p_1/MPa = 1 - 5

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/atm	solubility, x_1
373.3	10.07	0.0187
	19.77	0.0380
	30.07	0.0571
	40.28	0.0761
	49.97	0.0922
473.4	9.89	0.0230
	19.78	0.0469
	29.91	0.0708
	40.16	0.0949
	49.90	0.117
573.1	9.94	0.0289
	19.84	0.0586
	29.89	0.0891
	40.25	0.117
	49.71	0.139

T/K	Henry's constant/atm
373.1	526 ± 11*
473.1	425 ± 4*
573.1	334 ± 7*

* standard deviation

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas is passed through two stainless-steel cells in series containing the solvent, in a thermostated nitrogen bath. The first cell is a presaturator, the second the equilibrium cell. A sample is taken from the equilibrium cell, and its pressure released. The solvent is solidified and weighed, and the liberated gas collected in a burette.

No undersaturation or supersaturation effects were noticed over a range of pressures.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson, purity >99.5%.

(2) Eicosane. Aldrich, purity >99%.

ESTIMATED ERROR:

δT/K = 0.1
δp/kPa = 5
$\delta x/x$ = ±0.02 (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Octacosane; $C_{28}H_{58}$; [630-02-4]

ORIGINAL MEASUREMENTS:

Matsumato, D. K.; Satterfield, C. N.

Ind. Eng. Chem. Process Des. Dev. 1985, *24*, 1297-1300.

VARIABLES:

T/K = 488 - 553
p_1/MPa = 0.5 - 0.8

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	solubility/ mol m^{-3} MPa^{-1}	Henry's constant/ MPa	mole fraction* 10^2x_1
488.16	49.7	35.8	2.79
523.16	51.1	33.8	2.96
553.16	53.1	31.7	3.15

* calculated by compiler; inverse of Henry's constant, to give mol fraction solubility at 1 MPa partial pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solvent is weighed into a 1 dm^3 stainless steel bomb, wrapped in heating tapes. After flushing and reaching temperature equilibrium, gas is charged into the bomb at the required pressure (up to about 1 MPa).

Equilibrium is established by mechanical rocking for 2-3 hours.

Amount of gas absorbed is obtained from pressure measurements, and calculation of a mole balance.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson CP grade.

(2) Octacosane. Humphrey Co. 99% pure.

ESTIMATED ERROR:

$\delta x/x = \pm 5\%$ (authors)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. n-Octacosane; $C_{28}H_{58}$; [630-02-4]

ORIGINAL MEASUREMENTS:

Huang, S. H.; Lin, H.; Tsai, F.; Chao, K.

Ind. Eng. Chem. Res. 1988, *27*, 162-169.

VARIABLES:

T/K = 373.4 - 573.4

p_1/MPa = 1 - 5.1

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/atm	solubility, x_1
373.4	9.95	0.0227
	19.73	0.0452
	29.98	0.0696
	40.21	0.0916
	50.03	0.112
473.1	10.07	0.0275
	19.65	0.0555
	30.14	0.0830
	39.92	0.109
	49.96	0.131
573.4	9.94	0.0336
	19.74	0.0669
	30.02	0.0993
	40.18	0.131
	50.06	0.156

T/K	Henry's constant/atm
373.1	431 ± 6*
473.1	354 ± 8*
573.1	286 ± 4*

* standard deviation

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas is passed through two stainless-steel cells in series containing the solvent, in a thermostated nitrogen bath. The first cell is a presaturator, the second the equilibrium cell. A sample is taken from the equilibrium cell, and its pressure released. The solvent is solidified and weighed, and the liberated gas collected in a burette.

No undersaturation or supersaturation effects were noticed over a range of pressures.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson, purity >99%.

(2) Octacosane. Alfa, purity >99%.

ESTIMATED ERROR:

δT/K = 0.1
δP/kPa = 5
$\delta x/x$ = ±0.02 (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrogen; H_2; [1333-74-0]
3. n-Octacosane; $C_{28}H_{56}$; [630-02-4]

ORIGINAL MEASUREMENTS:

Huang, S. H.; Lin, H.; Tsai, F.; Chao, K.

Ind. Eng. Chem. Res. 1988, *27*, 162-169.

VARIABLES:

$T/K = 472.8 - 573.1$

$p_1/MPa = 2 - 5$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Equilibrium gas composition	T/K	p_1/atm	solubility, mol fraction	
			x_1	x_2
59.99 mol % CO 40.01 mol % H_2	473.2	19.74	0.0326	0.0164
		29.98	0.0495	0.0247
		40.23	0.0657	0.0330
		49.98	0.0791	0.0401
	572.9	19.94	0.0417	0.0227
		30.01	0.0618	0.0336
		40.18	0.0811	0.0442
		49.81	0.0964	0.0525
49.99 mol % CO 50.01 mol % H_2	472.8	19.70	0.0275	0.0201
		29.94	0.0407	0.0303
		39.99	0.0544	0.0415
		49.90	0.0653	0.0494
	573.1	19.79	0.0340	0.0281
		29.87	0.0506	0.0412
		40.17	0.0661	0.0552
		49.78	0.0785	0.0656
33.36 mol % CO 66.64 mol % H_2	473.2	19.94	0.0181	0.0275
		30.14	0.0276	0.0417
		40.17	0.0359	0.0543
		49.91	0.0434	0.0657
	573.0	19.93	0.0228	0.0378
		30.07	0.0340	0.0562
		40.22	0.0448	0.0743
		49.80	0.0535	0.0887

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas is passed through two stainless-steel cells in series containing the solvent, in a thermostated nitrogen bath. The first cell is a presaturator, the second the equilibrium cell. A sample is taken from the equilibrium cell, and its pressure released. The solvent is solidified and weighed, and the liberated gas collected in a burette. Composition of the gas was found by chromatography.

No undersaturation or supersaturation effects were noticed over a range of pressures.

SOURCE AND PURITY OF MATERIALS:

(1,2) Synthesis gas mixture. Matheson Gas Products (primary standards with specified compositions).

(3) Octacosane. Alfa, purity >99%.

ESTIMATED ERROR:

$\delta T/K = 0.1$

$\delta p/kPa = 5$

$\delta x/x = \pm 0.02$ (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Paraffin oil (C_{15} to C_{36} mixture)

ORIGINAL MEASUREMENTS:

Ledakowicz, S.; Nowicki, L.
J. Chem. Eng. Data 1987, *32*,
166-168.

VARIABLES:

$T/K = 471 - 534$
$p_1/MPa = 0.1 - 0.52$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/MPa	$c_1/mol\ dm^{-3}$	$H/MPa\ dm^3\ mol^{-1}$*
471	0.43	0.024	17.9
470	0.34	0.020	17.0
471	0.28	0.016	17.5
470	0.26	0.015	17.3
471	0.20	0.012	16.7
472	0.18	0.010	18.0
471	0.16	0.009	17.8
492	0.42	0.025	16.8
491	0.30	0.018	16.7
492	0.19	0.011	17.3
491	0.15	0.009	16.7
492	0.10	0.006	16.7
514	0.42	0.026	16.2
513	0.32	0.019	16.8
512	0.17	0.012	14.2
512	0.15	0.009	16.7
513	0.10	0.006	16.7
532	0.52	0.031	16.8
531	0.38	0.021	18.1
534	0.23	0.015	15.3
532	0.17	0.011	15.5
531	0.14	0.008	17.5

* Temperature dependence of Henry's constant, by least-squares analysis, correlated with the equation $H = 9.92 \exp(2152.9/RT)$ for $T = 471 - 536$ K, $p_1 = 0 - 0.5$ MPa.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A stainless steel autoclave of 1 dm^3 capacity is charged with 500-700 cm^3 of solvent. Gas is introduced while stirring, and the total change in gas pressure is measured at constant volume and uniform, constant temperature throughout the gas and liquid phases.

Details are given in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. No details given.

(2) Paraffin mineral oil. Average molecular weight 366, n-alkanes C_{15} to C_{36} with maximum of C_{21} to C_{26}; other details in source.

ESTIMATED ERROR:

$\delta T/T = \pm 0.4\%$
$\delta p/p = \pm 0.1\%$
$\delta c/c = \pm 5\%$

REFERENCES:

1. Ledakowicz, S.; Nettelhoff, H.; Deckwer, W.D. *Ind. Eng. Chem. Fundam.* 1984, *23*, 510.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. n-Hexatriacontane; $C_{36}H_{74}$; [630-06-8]

ORIGINAL MEASUREMENTS:

Huang, S. H.; Lin, H.; Tsai, F.; Chao, K.

Ind. Eng. Chem. Res. 1988, *27*, 162-169.

VARIABLES:

T/K = 373.1 - 573

p_1/MPa = 1 - 5.1

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/atm	solubility, x_1
373.1	10.02	0.0257
	20.06	0.0514
	30.01	0.0764
	40.00	0.101
	49.91	0.123
473.0	10.13	0.0307
	20.05	0.0614
	29.99	0.0917
	40.08	0.119
	50.14	0.146
572.9	10.07	0.0382
	20.11	0.0754
	30.02	0.110
	40.03	0.144
	50.04	0.173

T/K	Henry's constant/atm
373.1	383 ± 3*
473.1	321 ± 5*
573.1	256 ± 2*

* standard deviation

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas is passed through two stainless-steel cells in series containing the solvent, in a thermostated nitrogen bath. The first cell is a presaturator, the second the equilibrium cell. A sample is taken from the equilibrium cell, and its pressure released. The solvent is solidified and weighed, and the liberated gas collected in a burette.

No undersaturation or supersaturation effects were noticed over a range of pressures.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson, purity >99.5%.

(2) Hexatriacontane. Alfa, purity >99%.

ESTIMATED ERROR:

δT/K = 0.1
δp/kPa = 5
$\delta x/x$ = ±0.02 (compiler)

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Mobil wax.	Huang, S. H.; Lin, H.; Tsai, F.; Chao, K. *Ind. Eng. Chem. Res.* 1988, *27*, 162-169.
VARIABLES:	PREPARED BY:
T/K = 473.1 - 573.3 p_1/MPa = 1 - 5	R. W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/atm	solubility, s/mol kg^{-1}
473.1	10.06	0.0522
	20.06	0.108
	29.98	0.165
	39.99	0.222
	40.94	0.285
543.1	17.06	0.111
	27.31	0.179
	37.39	0.248
	47.57	0.316
573.3	10.05	0.0619
	20.11	0.130
	29.99	0.197
	39.96	0.268
	49.63	0.336

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas is passed through two stainless-steel cells in series containing the solvent, in a thermostated nitrogen bath. The first cell is a presaturator, the second the equilibrium cell. A sample is taken from the equilibrium cell, and its pressure released. The solvent is solidified and weighed, and the liberated gas collected in a burette.

No undersaturation or supersaturation effects were noticed over a range of pressures.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson, purity >99.5%.

(2) Mobil wax. Mobil Research and Development Corporation, New Jersey, USA. Average MW 857, weight average 1189.

ESTIMATED ERROR:

δT/K = 0.1
δp/kPa = 5
$\delta s/s$ = ±0.05

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO;[630-08-0] 2. Mixture of alkanes with average relative molecular mass M_r = 345	Peter, S., Weinert, M. *Z. Phys. Chem., N.F.* 1955, *5*, 114-121.

VARIABLES:	PREPARED BY:
T/K: 379-537 P_1/MPa: 0.157-0.991	E. Wilhelm

EXPERIMENTAL VALUES:

T/K	P/MPa	solubility $10^2 S$/mol kg^{-1}	Mole fraction of carbon monoxide in liquid, $10^3 x_1$ (*)
379	0.177	1.232	4.23
	0.307	2.234	7.64
	0.405	2.86	9.77
	0.598	4.34	14.75
	0.772	5.47	18.52
	0.783	5.61	18.99
	0.992	6.87	23.15
476	0.219	1.766	6.05
	0.614	4.94	16.76
	0.974	7.93	26.63
	0.991	8.16	27.38
573	0.157	1.585	5.43
	0.165	1.673	5.73
	0.368	3.82	13.01
	0.564	5.52	18.69
	0.764	7.62	25.62
	0.930	9.22	30.83

* calculated by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static cylindrical equilibrium cell. Liquid saturated with gas by shaking cell. After equilibrium is established, samples are removed and analysed by volumetric method. Details in source.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no details given.

(2) Mixture of saturated hydrocarbons as occurring in FISCHER - TROPSCH synthesis (presumably alkanes) with an average relative molecular mass M_r = 345.

ESTIMATED ERROR:

δP/MPa = $\pm$0.005, x_1 = $\pm$ 2%

REFERENCES:

COMPONENTS:

1. Carbon Monoxide; CO; [630-08-0]
2. Gulfwax (paraffin wax).

ORIGINAL MEASUREMENTS:

Albal, R.S.; Shah, Y.T.; Carr, N.L.; Bell, A.T.; *Chem. Eng. Science* 1984, *39*, 905-907.

VARIABLES:

T/K = 348 - 523

p_1/MPa = 1 - 3.2

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

temperature T/K	pressure[a] p_1/MPa	solubility[a] c/mol m^{-3}	solubility[b] $10^3c'$/mol kg^{-1} MPa^{-1}	Henry's constant[c] 10^3H/MPa m^{3}mol^{-1}
348	1.23	57	58	22
	1.25	61		
	2.95	114		
	3.20	114		
423	1.25	65	66	21
	1.45	71		
	2.75	131		
	2.78	132		
523	1.38	75	78	19
	2.25	123		
	2.40	130		

[a] read from graph in source by compiler

[b] recalculated by compiler; units in Table 1 of source are incorrect

[c] calculated by compiler from slope of straight line graph of c against P_1

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A stainless-steel autoclave, 1.101 m diameter, 0.267 m high, is heated with a temperature - controlled tubular furnace. It contains about 1 dm^3 solvent which is degassed by a vacuum pump. Gas is mixed into the liquid solvent with the aid of high-speed stirrers. Solubility is measured from the pressure change which occurs during absorption of the gas. Further details in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information

(2) Gulfwax: paraffin wax of molecular weight 380; melting point 329 K; by weight 93% normal paraffins, 0.5% isoparaffins, 6.5% non-condensed cycloparaffins.

ESTIMATED ERROR:

reproducibility ± 15% (authors)

REFERENCES:

1. Albal, R.S.; Shah, Y.T.; Schumpe, A.; Carr, N.L.

Chem. Engng. J. 1983, *27*, 61.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Bitumen from Wabasca, Alberta, Canada

ORIGINAL MEASUREMENTS:

Mehrotra, A. K.; Svrcek, W. Y.

AOSTRA J. Res. 1985, *2*, 83-93.

VARIABLES:

T/K = 296 - 375
p_1/MPa = 3.0 - 9.7

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/MPa	viscosity η/Pa s	density ρ/g cm^{-3}	Solubility* cm^3(STP)cm^{-3}	Solubility* g kg^{-1}
296.1	3.10	2.240	1.008	3.98	4.9
296.1	5.90	2.120	1.009	5.73	7.1
297.1	6.40	1.960	1.008	7.48	9.3
297.1	8.55	1.840	1.008	7.36	9.1
296.3	9.67	1.820	1.009	8.36	10.4
333.6	3.20	0.158	0.990	3.52	4.4
332.9	6.37	0.149	0.990	6.48	8.2
333.7	9.08	0.134	0.983	8.26	10.5
371.7	3.02	0.033	0.957	4.08	5.3
372.1	6.40	0.031	0.956	6.21	8.1
374.9	9.30	0.027	0.957	8.38	10.9

* Solubility given in source as volumetric ratio and weight percent. Volumetric ratio defined as volume of gas (at 0°C and 101.3 kPa) dissolved in a unit volume of gas saturated bitumen.

Solubility in g of gas per kg of solution was calculated by the compiler from the weight percent.

The viscosity and density values are for the gas-saturated bitumen at the temperature and pressure of the measurement.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Bitumen is saturated with gas under pressure by recirculating through a mixing cell until the viscosity becomes constant. Temperature is controlled in an air thermostat. Sample cells of 6 cm^3 capacity are filled in the recirculating line. The volume of gas evolved from the sample is measured at 373 K and 1 bar using a mercury-filled Ruska pump. Details are in reference (1).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. No information given.

(2) Bitumen. Gulf Canada Resources Inc. Sample diluted with toluene, filtered, vacuum distilled to remove water and toluene. Average molar mass 446.5 kg kmol^{-1}. Asphaltenes 11.8%; maltenes distillable <600°C 45.0%.

ESTIMATED ERROR:

Solubility ±5%

REFERENCES:

1. Svrcek, W. Y.; Mehrotra, A. K. *J. Can. Pet. Tech.* 1982, *21*, 31.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Soltrol-130 (C_9-C_{12} paraffins)

ORIGINAL MEASUREMENTS:

Albal, R.S.
Ph.D. Thesis, University of Pittsburgh, 1983.

VARIABLES:

T = 295 K
P_1 = 0.6-4.7 MPa

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

Temperature = 295 K; Henry's constant = 12.20 MPa m^3 $kmol^{-1}$

The following solubility values were read off a graph (Figure 6.1) in source

pressure/MPa	solubility/kmol m^{-3}
0.57	0.055
1.16	0.095
2.0	0.172
2.25	0.186
2.29	0.191
3.25	0.267
3.43	0.276
4.75	0.376

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A stainless-steel autoclave, 1.101 m diameter, 0.267 m high, is heated with a temperature - controlled tubular furnace. It contains about 1 dm^3 solvent which is degassed by a vacuum pump. Gas is mixed into the liquid solvent with the aid of high-speed stirrers. Solubility is measured from the pressure change which occurs during absorption of the gas. Further details in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) Soltrol -130: isoparaffin mixture, $C_9 - C_{12}$; density 762 kg m^{-3}; flash point 336 K.

ESTIMATED ERROR:

solubility ± 10% (compiler)

REFERENCES:

1. Albal, R.S.; Shah, Y.T.; Schumpe, A.; Carr, N.L. *Chem. Engng. J.* 1983, *27*, 61.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Alkanes mixture C_5 - C_{11}; Fischer-Tropsch light fraction:

ORIGINAL MEASUREMENTS:

Deimling, A.; Karandikar, B.M.; Shah, Y.T.; Carr, N.L.

Chem. Eng. J. 1984, *29*, 127-140

VARIABLES:

T/K = 373, 423
p_1/MPa = 1 - 3.5

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/MPa*	Solubility* c/mol m^{-3}	Henry's constant* $10^3 H$/MPa m^3 mol^{-1}
373	1.4	131	11.4
	1.5	142	
	2.4	224	
	3.3	314	
423	0.9	114	8.5
	1.1	144	
	2.7	332	

* read from graphs in source by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A stainless-steel autoclave, 1.101 m diameter, 0.267 m high, is heated with a temperature - controlled tubular furnace. It contains about 1 dm^3 solvent which is degassed by a vacuum pump. Gas is mixed into the liquid solvent with the aid of high-speed stirrers. Solubility is measured from the pressure change which occurs during absorption of the gas. Further details in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) Fischer-Tropsch liquid, light fraction: alkanes C_5-C_{11} range, average molecular weight 113.9; density/kg m^{-3} = 723.0, 713.5, 681.6 at 298 K, 373 K, and 423 K respectively. Further details in source.

ESTIMATED ERROR:

$\delta c/c$ = ± 4% (authors

REFERENCES:

1. Albal, R.S.; Shah, Y.T.; Schumpe, A.; Carr, N.L.

Chem. Engng. J. 1983, 27, 61

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alkanes mixture C_{11} - C_{22}; Fischer-Tropsch medium fraction:

ORIGINAL MEASUREMENTS:

Deimling, A.; Karandikar, B.M.; Shah, Y.T.; Carr, N.L.

Chem. Eng. J. 1984, *29*, 127-140

VARIABLES:

T/K = 373, 523
p_1/MPa = 1 - 4.5

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/MPa*	Solubility* c/mol m^{-3}	Henry's constant* $10^3 H$/MPa m^3 mol^{-1}
373	1.0	68	15.8
	2.1	145	
	3.3	221	
	4.4	291	
423	1.0	75	14.5
	2.1	150	
	3.3	232	
	4.4	312	
473	1.1	83	13.4
	2.2	156	
	3.2	242	
	4.4	324	
523	0.9	83	12.2
	2.1	173	
	3.2	265	
	4.1	320	

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* read from graphs in source by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A stainless-steel autoclave, 1.101m diameter, 0.267m high, is heated with a temperature - controlled tubular furnace. It contains about $1 dm^3$ solvent which is degassed by a vacuum pump. Gas is mixed into the liquid solvent with the aid of high-speed stirrers. Solubility is measured from the pressure change which occurs during absorption of the gas. Further details in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) Fischer-Tropsch liquid, medium fraction: alkanes C_{11}-C_{22} range, average molecular weight 113.9; density/kg m^{-3} = 723.0, 713.5, 681.6 at 298 K, 373 K, and 423 K respectively. Further details in source.

ESTIMATED ERROR:

$\delta c/c = \pm 4\%$ (authors)

REFERENCES:

1. Albal, R.S.; Shah, Y.T.; Schumpe, A.; Carr, N.L.

Chem. Engng. J. 1983, *27*, 61

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alkanes mixture C_{19} - C_{42}; Fischer-Tropsch heavy fraction:

ORIGINAL MEASUREMENTS:

Deimling, A.; Karandikar, B.M.; Shah, Y.T.; Carr, N.L.

Chem. Eng. J. 1984, *29*, 127-140

VARIABLES:

T/K = 373, 523
P_1/MPa = 1 - 4.6

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/MPa*	Solubility* c/mol m^{-3}	Henry's constant* 10^3H/MPa m^3 mol^{-1}
373	1.1	48	24.5
	2.2	92	
	3.4	137	
	4.5	175	
423	1.1	51	23.8
	2.2	100	
	3.3	145	
	4.5	185	
473	1.2	58	22.8
	2.0	104	
	2.8	136	
	3.6	170	
523	1.2	65	21.4
	2.1	107	
	3.0	150	
	3.9	182	

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* read off graphs in source by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A stainless-steel autoclave, 1.101 m diameter, 0.267 m high, is heated with a temperature-controlled tubular furnace. It contains about 1dm^3 solvent which is degassed by a vacuum pump. Gas is mixed into the liquid solvent with the aid of high-speed stirrers. Solubility is measured from the pressure change which occurs during absorption of the gas. Further details in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) Fischer-Tropsch liquid, heavy fraction: alkanes C_{19}-C_{42} range, average molecular weight 368.5; density/kg m^{-3} = 820.3, 745.0, 680.0 at 298K, 423K, and 523K respectively. Further details in source.

ESTIMATED ERROR:

$\delta c/c = \pm 4\%$ (authors)

REFERENCES:

1. Albal, R.S.; Shah, Y.T.; Schumpe, A.; Carr, N.L.

Chem. Engng. J. 1983, *27*, 61

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alkanes mixture C_{11} - C_{22}; Fischer - Tropsch medium fraction
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karandikar, B.M.; Morsi, B.I.; Shah, Y.T.; Carr, N.L.

Chem. Eng. J. 1986, *33*, 157 - 168.

VARIABLES:

T/K = 423, 498

p_1/MPa = 0.5 - 3

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	mol fraction of water in solvent, x_3	p_1/MPa*	solubility* c/mol m^{-3}	Henry's constant** $10^3 H$/MPa m^3 mol^{-1}
423	0.162	0.69	48	11.5
		0.73	56	
		0.74	67	
		1.66	135	
		1.74	157	
		2.55	216	
		2.62	219	
		2.65	243	
498	0.377	0.57	85	7.85
		0.62	108	
		0.75	98	
		1.43	205	
		1.53	183	
		1.56	188	
		2.16	300	
		2.22	271	
		2.86	388	
		2.96	344	
		2.99	362	

* read from graph in source by compiler

** calculated by compiler from slope of line on graph in source

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A mechanically agitated vessel, 0.127 m diameter and 0.305 m height, equipped with flat-blade turbine agitator, is enclosed in a temperature regulated furnace. Preheated gas is fed into this reactor containing the solvent.

The solubility of the gas is calculated from the total pressure decrease during mixing, measured by a pressure transducer with its output registered on a high-speed chart recorder.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) Fischer-Tropsch liquid, medium fraction: alkanes C_{11} - C_{22}, average molecular weight 201.5; density /kg m^{-3}=874.3 - 0.3325 (T/K). Other details in source.

(3) Water: no information.

ESTIMATED ERROR:

$\delta c/c = \pm 5\%$ (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alkanes mixture C_{19} - C_{44}; Fischer - Tropsch heavy fraction
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karandikar, B.M.; Morsi, B.I.; Shah, Y.T.; Carr, N.L.

Can. J. Chem. Eng, 1987, *65*, 973-981

VARIABLES:

$T/K = 423, 498$
$p_1/\text{MPa} = 0.5 - 3.8$

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	mol fraction of water in solvent, x_3	p_1/MPa^*	solubility* $c/\text{mol m}^{-3}$	Henry's constant $10^3H/\text{MPa m}^3\text{ mol}^{-1}$
423	0	0.6	31	27.2
		0.9	44	
		1.6	75	
		2.7	105	
		2.9	100	
498	0	0.9	44	22.0
		2.5	110	
		2.6	115	
		3.8	156	
423	0.174	0.8	69	14.8
		0.85	60	
		0.9	66	
		2.2	150	
		3.6	245	
498	0.43	0.8	69	7.2
		0.9	155	
		2.2	319	
		2.3	360	
		3.6	494	
		3.7	536	

* read off graph in source by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A mechanically agitated vessel, 0.127 m diameter and 0.305 m height, equipped with flat-blade turbine agitator, is enclosed in a temperature regulated furnace. Preheated gas is fed into this reactor containing the solvent.

The solubility of the gas is calculated from the total pressure decrease during mixing, measured by a pressure transducer with its output registered on a high-speed chart recorder. Details in reference (1).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) Fischer-Tropsch liquid, heavy fraction: alkanes C_{19} - C_{44}, average molecular weight 368.5; melting point 353 K; density/kg m^{-3} = 1028 - 0.67 (T/K). Other details in source.

(3) Water: no information

ESTIMATED ERROR:

$\delta c/c = \pm 5\%$ (compiler)

REFERENCES:

1. Karandikar, B.M.; Morsi, B.I.; Shah, Y.T.; Carr, N.L.

Chem. Eng. J. 1986, *33*, 157.

COMPONENTS:

1. Carbon monoxide; CO;
   [630-08-0]

2. Isononenes; C_9H_{18};
   [31387-92-5]

ORIGINAL MEASUREMENTS:

Tyvina, T. N.; Fokina, V. V.;
Naumova, A. A.; Polyakov, A. A.

Zh. Prikl. Khim. 1984, *57*, 2101-2104.

J. Appl. Chem. USSR 1984, *57*,
1942-1945.

VARIABLES:

T/K = 313 - 553
p/MPa = 5 - 30

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	Mole fraction of carbon monoxide in vapor, y_{CO}	Molar volume of liquid $cm^3\ mol^{-1}$
313.2	5.0	0.075	0.9993	162.5
	10.0	0.148	0.9996	154.0
	15.0	0.220	0.9997	146.0
	20.0	0.286	0.9998	138.0
	25.0	0.354	0.9998	130.0
	30.0	0.417	0.9998	123.0
353.2	5.0	0.081	0.9965	171.0
	10.0	0.158	0.9982	161.5
	15.0	0.232	0.9988	152.5
	20.0	0.300	0.9991	144.0
	25.0	0.370	0.9993	135.5
	30.0	0.431	0.9994	128.0
393.2	5.0	0.090	0.9880	182.0
	10.0	0.180	0.9950	171.5
	15.0	0.247	0.9968	161.0
	20.0	0.316	0.9980	151.0
	25.0	0.388	0.9982	142.0
	30.0	0.448	0.9985	133.0

(cont.)

AUXILIARY INFORMATION

METHOD APPARATUS/PROCEDURE:

Static method in which the temperature variation of the pressure of a mixture of known composition was measured. The pressure-temperature curve has a change in slope corresponding to a change from a one-phase system to a two-phase system.
Above data obtained by graphical interpolation.
Details of method in ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. Purity 99.7 vol per cent.

2. Purity 98.2 mass per cent
   (mixture of alkenes).

ESTIMATED ERROR:

δT/K = ±0.2; δP/mPa = ±1%;
$\delta x/x$ = ±0.03 (estimated by compiler).

REFERENCES:

1. Efremova, G. D.; Sokolova, E. S.
   Zh. Fiz. Khim.
   1963, *37*, 2612.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Isononenes; C_9H_{18}; [31387-92-5]	Tyvina, T. N.; Fokina, V. V.; Naumova, A. A.; Polyakov, A. A. *Zh. Prikl. Khim.* 1984, *57*, 2101-2104. *J. Appl. Chem. USSR* 1984, *57*, 1942-1945.

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	Mole fraction of carbon monoxide in vapor, y_{CO}	Molar volume of liquid cm^3 mol^{-1}
433.2	5.0	0.095	0.9770	192.5
	10.0	0.185	0.9850	180.5
	15.0	0.265	0.9910	169.5
	20.0	0.334	0.9925	160.0
	25.0	0.400	0.9940	150.5
	30.0	0.466	0.9950	141.0
473.2	5.0	0.101	0.9240	205.5
	10.0	0.200	0.9625	192.0
	15.0	0.287	0.9770	179.5
	20.0	0.364	0.9820	168.0
	25.0	0.436	0.9860	156.0
	30.0	0.508	0.9885	145.0
513.2	5.0	0.108	0.8560	224.0
	10.0	0.222	0.9260	210.0
	15.0	0.328	0.9530	197.0
	20.0	0.425	0.9640	185.0
	25.0	0.518	0.9730	173.0
	30.0	0.602(a)	0.9770	163.0
553.2	5.0	0.113	0.7600	267
	10.0	0.265	0.8720	246
	15.0	0.430	0.9200	234
	20.0	0.550(a)	0.9410	221
	25.0	0.650(a)	0.9520	213
	30.0	0.748(a)	0.9600	207

(a) extrapolated value

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Cyclic hydrocarbons	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. May 1989

CRITICAL EVALUATION:

The solubility of carbon monoxide in some C_6, C_7, C_8, and C_{12} cyclic hydrocarbons has only recently been measured. Three laboratories have produced these data, Battino *et al.*, Patyi *et al.*, and Tremper and Prausnitz. The partial pressure of the gas in all cases was near 101.3 kPa, and temperatures were near 298 K for all systems except the C_{12} solvent (1,1' bicyclohexyl) for which the temperature range was 300-475 K.

Only in the case of cyclohexane [110-82-7] is there more than one data set between which comparisons may be made. Here the datum of Patyi *et al.*(1) at 298.15 K is only 1.6% higher than that obtained from Wilhelm and Battino (2). The results from this latter group may be accepted tentatively, for temperatures of 283-309 K, along with the smoothing equation given on the data sheet, because the group is well respected for its thorough and accurate work.

A similar comment applies to the data for methylcyclohexane [108-87-2] (3), *cis* and *trans* 1,2 dimethylcyclohexane [2207-01-4] and [6876-23-9] (4), mixtures of *cis* and *trans* 1,3 and 1,4 dimethylcyclohexanes [2207-03-6], [638-04-0], [2207-04-7] and [624-29-3] (4), and cycloctane [292-64-8], (5). For each of these solvents the data sheets should be consulted, and cautions noted, when appropriate, about smoothing equations.

The data of Tremper and Prausnitz (6) on 1,1'bicyclohexyl [92-51-3] are probably reliable enough, but they must be accepted with caution in the absence of corroborating data.

References

1. Patyi, L.; Furmer. I.E.; Makranczy, J.; Sadilenko, A.S.; Stepanova, Z.G.; Berengarten, M.G. *Zh. Prikl. Khim* 1978, *51*, 1296.

2. Wilhelm, E.; Battino, R. *J. Chem. Thermodyn.* 1973, *5*, 117.

3. Field, R.; Wilhelm, E.; Battino, R. *J. Chem. Thermodyn.* 1974, *6*, 237.

4. Geller, E.B.; Battino, R.; Wilhelm, E. *J. Chem. Thermodyn.* 1976, *8*, 197.

5. Wilcock, R.J.; Battino, R.; Wilhelm, E. *J. Chem. Thermodyn.* 1977, *9*, 111.

6. Tremper, K.K.; Prausnitz,, J.M. *J. Chem. Eng. Data*, 1976, *21*, 295.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Cyclohexane; C_6H_{12}; [110-82-7]

ORIGINAL MEASUREMENTS:

Wilhelm, E.; Battino, R.

J. Chem. Thermodyn. 1973, *5*, 117-120.

VARIABLES:

T/K: 283.26 - 308.70
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient α	Ostwald Coefficient L
283.26	9.74	0.204	0.212
283.29	9.79	0.205	0.213
283.71	9.68	0.203	0.211
297.52	9.92	0.205	0.223
297.60	9.88	0.204	0.222
308.70	10.03	0.209	0.231

The solubility values were adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) by Henry's law. The Bunsen coefficients were calculated by the compiler.

Smoothed Data: For use between 283.26 and 308.70 K

$$\ln x_1 = -6.5771 - 1.0131/(T/100\text{K})$$

The standard error about the regression line is 4.34×10^{-6}.

T/K	Mol Fraction 10^4x_1
288.15	9.79
298.15	9.91
308.15	10.02

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass spiral tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Linde Co. The minimum volume percent purity is 99.5.

(2) Cyclohexane. Phillips Petroleum Co. Pure Grade. Distilled.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.03$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil. Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Cyclohexane; C_6H_{12}; [110-82-7]	ORIGINAL MEASUREMENTS: Patyi, L.; Furmer, I. E.; Makranczy, J.; Sadilenko, A. S.; Stepanova, Z. G.; Berengarten, M. G. *Zh. Prikl. Khim.* 1978, *51*, 1296-1300.
VARIABLES: T = 298.15 K p = 101.3 kPa	PREPARED BY: C. L. Young

EXPERIMENTAL VALUES:

T/K	$\alpha^{\dagger}$	Mole fraction of carbon monoxide at a partial pressure of 101.325 kPa x_{CO}
298.15	0.207	0.001007

† volume of gas (measured at 101.325 kPa and 273.15 K) dissolved by one volume of cyclohexane.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. Pressure measured when known amounts of gas were added, in increments, to a known amount of liquid in a vessel of known dimensions. Corrections were made for the partial pressure of solvent. Details in ref. (1).

SOURCE AND PURITY OF MATERIALS:

Purity better than 99 mole per cent as determined by gas chromatography.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$; $\delta\alpha = \pm 4\%$ or less.

REFERENCES:

1. Bodor, E.; Bor, G. J.; Mohai, B.; Sipos, G.
Veszpremi. Vegyip. Egy. Kozl. 1957, *1*, 55.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methylcyclohexane; C_7H_{14}; [108-87-2]

ORIGINAL MEASUREMENTS:

Field, L. R.; Wilhelm, E.; Battino, R.

J. Chem. Thermodyn. 1974, *6*, 237 - 243.

VARIABLES:

T/K: 284.14 - 313.26
P/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
284.14	1.235	0.220	0.2283
298.12	1.241	0.217	0.2366
313.26	1.225	0.210	0.2408

The gas solubility values were adjusted to an oxygen partial pressure of 101.325 kPa (1 atm) by Henry's law.

The Bunsen coefficients were calculated by the compiler.

Smoothed Data: For use between 283.15 and 313.26 K

$$\ln x_1 = -6.7806 + 0.2469/(T/100\ \mathrm{K})$$

The standard error about the regression line is 9.03×10^{-6}.

T/K	Mol Fraction 10^3x_1
283.15	1.239
293.15	1.235
298.15	1.234
303.15	1.232
313.15	1.229

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass spiral tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Either Matheson Co., Inc. or Air Products and Chemicals, Inc. Purest grade available, minimum purity greater than 99 mole per cent.

(2) Methylcyclohexane. Phillips Petroleum Co. Pure Grade. Distilled.

ESTIMATED ERROR:

δT/K = 0.03
δP/mmHg = 0.5
$\delta x_1/x_1$ = 0.005

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) *cis*-1,2-Dimethylcyclohexane; C_8H_{16}; [2207-01-4]

ORIGINAL MEASUREMENTS:

Geller, E. B.; Battino, R. Wilhelm, E.

J. Chem. Thermodyn. 1976, *8*, 197 - 202.

VARIABLES:

T/K: 298.02, 312.97
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3\text{(STP)cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
298.02	1.254	0.1987	0.2168
312.97	1.229	0.1918	0.2198

The Bunsen coefficients were calculated by the compiler assuming ideal gas behavior.

The solubility values were adjusted to a carbon monoxide partial pressure of 101.325 kPa by Henry's law.

Smoothed Data: The equation is based on only two pair of experimental points and should be used with caution.

For use between 298.02 and 312.97 K

$$\ln x_1 = -7.1106 + 1.2798/(T/100\text{K})$$

T/K	Mol Fraction 10^3x_1
298.15	1.254
308.15	1.237

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by differences between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Stated to be 99.5 mole percent minimum.

(2) *cis*-1,2-Dimethylcyclohexane. Chemical Samples Co. Fractionally distilled and stored in dark. Refractive index (NaD, 298.15 K) 1.4337.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.03$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) *trans*-1,2-Dimethylcyclohexane; C_8H_{16}; [6876-23-9]

ORIGINAL MEASUREMENTS:

Geller, E. B.; Battino, R. Wilhelm, E.

J. Chem. Thermodyn. 1976, *8*, 197-202.

VARIABLES:

T/K: 298.22, 312.92
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
298.22	1.344	0.2076	0.2266
312.92	1.358	0.2066	0.2367

The Bunsen coefficients were calculated by the compiler assuming ideal gas behavior.

The solubility values were adjusted to a carbon monoxide partial pressure of 101.325 kPa by Henry's law.

Smoothed Data: The equation is based on only two pair of experimental points and should be used with caution.

For use between 298.22 and 312.92 K

$$\ln x_1 = -6.3942 - 0.6495/(T/100\ \text{K})$$

T/K	Mol Fraction 10^3x_1
298.15	1.344
308.15	1.354

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm³ of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by differences between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Stated to be 99.5 mole percent minimum.

(2) *trans*-1,2-Dimethylcyclohexane. Chemical samples Co. Fractionally distilled and stored in dark. Refractive index (NaD, 298.15 K) 1.4248.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.03$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) *trans*-1,3-Dimethylcyclohexane, 41 mol %; C_8H_{16}; [2207-03-6]

(3) *cis*-1,3-Dimethylcyclohexane, 59 mol %; C_8H_{16}; [638-04-0]

ORIGINAL MEASUREMENTS:

Geller, E. B.; Battino, R. Wilhelm, E.

J. Chem. Thermodyn. 1976, *8*, 197-202.

VARIABLES:

T/K: 298.06, 313.00
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
298.06	1.330	0.2047	0.2234
313.00	1.305	0.1978	0.2266

The Bunsen coefficients were calculated by the compiler.

The solubility values were adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) by Henry's law.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by differences between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Stated to be 99.5 mole percent minimum.

(2) *trans*-1,3-Dimethylcyclohexane.

(3) *cis*-1,3-Dimethylcyclohexane. Chemical Samples Co. Binary mixture used as received. Authors analyzed mixture by refractive index.

ESTIMATED ERROR:

δT/K = 0.03
δP/mmHg = 0.5
$\delta x_1/x_1$ = 0.005

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) *trans*-1,4-Dimethylcyclohexane, 30 mol %; C_8H_{16}; [2207-04-7] (3) *cis*-1,4-Dimethylcyclohexane, 70 mol %; C_8H_{16}; [624-29-3]	Geller, E. B.; Battino, R. Wilhelm, E. *J. Chem. Thermodyn.* 1976, *8*, 197-202.
VARIABLES: T/K: 298.31, 313.08 p/kPa: 101.325 (1 atm)	PREPARED BY: H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^3 x_1$	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
298.31	1.347	0.2080	0.2272
313.08	1.356	0.2062	0.2363

The Bunsen coefficients were calculated by the compiler.

The solubility values were adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) by Henry's law.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is applied intermittently through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by differences between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Stated to be 99.5 mole percent minimum.

(2) *trans*-1,4-Dimethylcyclohexane.

(3) *cis*-1,4-Dimethylcyclohexane. Chemical Samples Co. Binary mixture used as received. Authors analyzed mixture by refractive index.

ESTIMATED ERROR:

$\delta T/\mathrm{K} = 0.03$
$\delta P/\mathrm{mmHg} = 0.5$
$\delta x_1/x_1 = 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Cyclooctane; C_8H_{16}; [292-64-8]

ORIGINAL MEASUREMENTS:

Wilcock, R. J.; Battino, R.; Wilhelm, E.

J. Chem. Thermodyn. 1977, *9*, 111 - 115.

VARIABLES:

T/K: 289.11 - 313.57
P/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient α	Ostwald Coefficient L
289.11	8.40	0.1409	0.1491
298.15	8.49	0.1411	0.1540
313.57	8.52	0.1394	0.1601

The Bunsen coefficients were calculated by the compiler.

The solubility values were adjusted to a carbon monoxide partial pressure of 101.325 kPa by Henry's law.

Smoothed Data: For 288.15 - 313.15 K

$$\ln x_1 = -6.9078 - 0.4979/(T/100K)$$

The standard error about the regression line is 3.53×10^{-6}.

T/K	Mol Fraction 10^4x_1
288.15	8.41
298.15	8.46
308.15	8.51

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass spiral tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum mole per cent purity is 99.5.

(2) Cyclooctane. Chemical Samples Co. 99 mole per cent, distilled, refractive index (NaD, 298.15 K) 1.4562.

ESTIMATED ERROR:

$\delta T/K = 0.03$
$\delta P/mmHg = 0.5$
$\delta x_1/x_1 = 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. 1,1'-Bicyclohexyl; $C_{12}H_{22}$; [92-51-3]	Tremper, K.K.; Prausnitz, J.M. *J. Chem. Engng. Data.* 1976, *21*, 295-9.
VARIABLES:	PREPARED BY:
T/K = 300 - 475	C.L. Young

EXPERIMENTAL VALUES:

T/K	Henry's Constant [a] /atm	Mole fraction [b] of carbon monoxide at 1 atm partial pressure, x_{CO}
300	975.0	0.001026
325	981.0	0.001019
350	980.0	0.001020
375	967.0	0.001034
400	937.0	0.001067
425	885.0	0.001130
450	806.0	0.001241
475	723.0	0.001383

a. Authors stated measurements were made at several pressures and values of solubility were all within the Henry's - law region.

b. Calculated by compiler assuming a linear relationship between mole fraction and pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric apparatus similar to that described by Dymond and Hildebrand (1). Pressure measured with a null detector and precision gauge. Details in ref. (2).

SOURCE AND PURITY OF MATERIALS:

Solvent degassed, no other details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$; $\delta x_{CO} = \pm 1\%$

REFERENCES:

1. Dymond, J.; Hildebrand, J.H. *Ind.Chem.Eng.Fundam.* 1967, *6*, 130.
2. Cukor, P.M.; Prausnitz, J.M. *Ind.Chem.Eng.Fundam.* 1971, *10*, 638.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Aromatic hydrocarbons	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. April 1989

CRITICAL EVALUATION:

The solubility of carbon monoxide in five aromatic hydrocarbons is considered in this evaluation. In all but three of the papers considered, pressures and temperatures were around ambient.

1. Benzene; C_6H_6; [71-43-2]

There are seven papers which report the solubility of carbon monoxide at a partial pressure of 101.3 kPa in benzene. The widest temperature range is covered by Horiuti (1), giving data over 285-334 K. These data are the ones recommended for this solvent between 285 and 315 K. They are represented by the equation

$$\ln x_1 = -6.2529 + 3.1556/(T/100\ \mathrm{K}).$$

Horiuti's work is usually found by gas solubility data evaluators to be carefully and accurately executed. The data sheet gives smoothed values of the mol fraction solubility which may be referred to. Above 315 K the equation and the data should be taken more tentatively because of the lack of confirmatory experimental measurements. From the above equation, it can be calculated that for the transfer of carbon monoxide gas from the gas phase at 101.3 kPa to the infinitely dilute solution, $\Delta H_1^o = -2.62$ kJ mol^{-1}, and $\Delta S_1^o = -52.0$ J K^{-1} mol^{-1}.

The solubility data of Just (2) at 293.15 and 298.15 K, and of Skirrow (3) at 298.2 K are low by 5-7%. The three values taken from graphs in the paper by Krauss and Gestrich (4) are about 3% low, whilst those of Patyi *et al.* (5) and of Gjaldbaek (6) at 298.15 K, and of Byrne *et al.* (7) at 310.64 K are all within 1% of the recommended values.

The only high pressure, high temperature study of the solubility of carbon monoxide in benzene carried out so far is by Connolly (8,9). Pressures of 0.7-10.5 MPa, and temperatures of 433-533 K were covered. Details are given in the data sheets. In the earlier paper, the data are reported as K values, which are the mole fractions of each component in the gas phase divided by its mole fraction in the liquid phase. In the later paper, where the pressure range was somewhat greater, actual mole fractions of carbon monoxide in the gas and liquid phases are given. The two sets of data complement each other and may be accepted tentatively.

2. Methylbenzene (toluene); C_7H_8; [108-88-3]

From the data in eight papers on the solubility of carbon monoxide at partial pressures near 101.3 kPa in methylbenzene, the recommended values are those of Field *et al* (10), given for T = 283-313 K by the equation

$$\ln x_1 = -6.6251 - 1.5015/(T/100\ \mathrm{K}).$$

The data sheet from this work contains smoothed data which may be referred to with some confidence. From the smoothing equation, it can be calculated that for the transfer of carbon monoxide from the gas phase at 101.3 kPa to the infinitely dilute solution, $\Delta H_1^o = 1.25$ kJ mol^{-1}, and $\Delta S_1^o = -55.1$ J K^{-1} mol^{-1}.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Aromatic hydrocarbons	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology. Bell Street, Dundee, DD1 1HG, U.K. April 1989

CRITICAL EVALUATION:

Compared with this data set, the values of Just (2) are 2-3% too low, and those of Skirrow (3) and of Krauss and Gestrich (4) between 293 and 306 K are about 1% too low. The values of Krauss and Gestrich are taken from graphs, and their other values at 289.3 and 316.2 K may be 2% and 4% low respectively, whilst Gjaldbaek's data (6) at 298.15 K are 1-2% high.

The values obtained by Chen *et al.*(11) between 298 and 323 K show a much steeper increase with temperature than any of the other data. Little confidence can be placed in any of the values except the one at 303.15 K which is 1% higher than the interpolated value from Field *et al.* A single value at 303 K by Sato *et al.*(12) is also classed as doubtful, being about 6% lower than the others around 303 K. A very recent measurement by Lühring and Schumpe (13) gives a value at 293.2 K which is over 35% lower than any of the others at this temperature, and it has to be rejected.

3. Dimethylbenzene (xylene); C_8H_{10}; [1330-20-7]

The solubility of carbon monoxide in xylene was measured by Just (2) in 1901 and by Krauss and Gestrich (4) in 1977. In each of these cases it was assumed by the compilers of the data sheets that the xylene was a mixture of its isomers, although this was not clear from the original papers. On this basis, the more recent data are about 3% higher than corresponding values from Just, but all values on these data sheets must be treated with caution.

4. 1,2,4-Trimethylbenzene; C_9H_{12}; [95-63-6]

Krauss and Gestrich (4) measured the solubility of carbon monoxide in 1,2,4-trimethylbenzene over 289-314 K. The measurements require confirmation by other work, and it must be borne in mind that the data recorded were read off a graph in the original paper, making exact comparisons difficult.

5. Phenanthrene; $C_{14}H_{10}$; [85-01-8]

Matsumato and Satterfield (14) measured the solubility of carbon monoxide in phenanthrene at temperatures of 433-504 K and pressures of 0.5-0.8 MPa. The data require some further confirmation although there is no reason to doubt their validity.

Solvent mixtures including benzene or toluene.

The solubility of carbon monoxide at a partial pressure of 1 atm and at 298.2 K was measured by Skirrow (3) in a variety of solvent mixtures. Data sheets appear in this section for the solubilities in mixtures of benzene with 8 different substances, and in mixtures of toluene with 6 of these substances, viz. naphthalene, phenanthrene, α-naphthol, ethanoic acid, aniline, and nitrobenzene. β-Naphthol and methanol are the two additional substances which were studied mixed with benzene but not with toluene. In view of the reasonable accuracy of Skirrow's work, the data may be taken as a good indication of the solubility in the various mixtures.

Byrne *et al.*(7) measured the solubility of carbon monoxide at 1 atm and 310.6 K in benzene to which cholesterol or cephalin or lecithin had been added. "Salting-out" parameters are quoted for each additive, and solubilities of carbon monoxide in each additive itself have been obtained by extrapolation. Whilst these values must be taken very tentatively because of the extensive extrapolation, the experimental data are probably reliable within the 1-2% estimated on the data sheets.

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Aromatic hydrocarbons	EVALUATOR: Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. April 1989

CRITICAL EVALUATION:

References

1. Horiuti, J.
Sci. Pap. Inst. Phys. Chem. Res. (Jpn.) 1931/32, *17*, 125.

2. Just, G.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

3. Skirrow, F.W.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139.

4. Krauss, W. ; Gestrich, W.
Chem. Tech. (Heidelberg) 1977, *6*, 513.

5. Patyi, L.; Furmer, I.E.; Makranczy, J.; Sadilenko, A.S.; Stepanova, Z.G.; Berengarten, M.G.
Zh. Prikl. Khim. 1978, *51*, 1296.

6. Gjaldbaek, J.C.
Acta Chem. Scand. 1952, *6*, 623.

7. Byrne, J.E.; Battino, R.; Danforth, W.F.
J. Chem. Thermodyn. 1974, *6*, 245.

8. Connolly, J.F.
Amer. Petr. Inst. Report 1965, *45* (III), 62.

9. Connolly, J.F.; Kandalic, G.A.
J. Chem. Thermodyn. 1984, *16*, 1129.

10. Field, L.R.; Wilhelm, E.; Battino, R.
J. Chem. Thermodyn. 1974, *6*, 237.

11. Chen. H.; Liu, M.; Zheng, L.; Zhu, Z.
Zhejiang Daxue Xuebao 1985, *19*, 140.

12. Sato, T.; Toyoda, I.; Yamamori, Y.; Yanemoto, T.; Kato, H.; Tadaki, T.
J. Chem. Eng. Japan 1988, *21*, 192.

13. Lühring, P.; Schumpe, A.
J. Chem. Eng. Data 1989, *34*, 250.

14. Matsumato, D.K.; Satterfield, C.N.
Ind. Eng. Chem. Process Dev. 1985, *24*, 1297.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

$T/K = 293.15, 298.15$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
293.15	6.07	0.153	0.1645
298.15	6.24	0.156	0.1707

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Benzene. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. Timofejew, W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. Steiner, P. *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Horiuti, J.

Sci. Pap. Inst. Phys. Chem. Res. (Jpn) 1931/32, *17*, 125 - 256.

VARIABLES:

T/K: 285.13 - 333.45

p_1/kPa: 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3 (STP) cm^{-3} atm^{-1}	Ostwald Coefficient L/cm^3 cm^{-3}
285.15	6.398	0.1630	0.1702
293.15	6.538	0.1650	0.1771
313.20	6.983	0.1720	0.1972
333.45	7.506	0.1803	0.2201

The mole fraction and Bunsen coefficient values were calculated by the compiler with the assumption the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 285.13 and 333.45 K.

$$\ln x_1 = -6.2529 + 3.1556/(T/100\text{K})$$

The standard error about the regression line is 4.90 x 10^{-6}.

T/K	Mol Fraction $10^4 x_1$
283.15	6.315
288.15	6.439
293.15	6.560
298.15	6.680
303.15	6.797
313.15	7.027
323.15	7.249
333.15	7.465

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a gas buret, a solvent reservoir, and an absorption pipet. The volume of the pipet is determined at various meniscus heights by weighing a quantity of water. The meniscus height is read with a cathetometer.

The dry gas is introduced into the degassed solvent. The gas and solvent are mixed with a magnetic stirrer until saturation. Care is taken to prevent solvent vapor from mixing with the solute gas in the gas buret. The volume of gas is determined from the gas buret readings, the volume of solvent is determined from the meniscus height in the absorption pipet.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by dropping formic acid onto conc. H_2SO_4. The gas was passed through several wash solutions to remove CO_2 and O_2, dried by H_2SO_4 and P_2O_5.

(2) Benzene. Merck. Extra pure and free of sulfur. Refluxed with sodium amalgam, distilled. Boiling point (760 mmHg) 80.18°C.

ESTIMATED ERROR:

δT/K = 0.05

$\delta x_1/x_1$ = 0.01

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.

Acta Chem. Scand. 1952, *6*, 623 - 633.

VARIABLES:

$T/K = 298.10$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
298.18	6.74	1.70	1.86
298.10	6.73	1.70	1.85
298.13	6.75	1.70	1.85

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO + 0.5% N_2.

(2) Benzene. Merck and Co. Analytical reagent. B.p. (760 mmHg)/°C = 80.28.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Benzene; C_6H_6; [71-43-2]	Byrne, J. E.; Battino, R.; Danforth, W. F. *J. Chem. Thermodyn.* 1974, *6*, 245-250.

VARIABLES:	PREPARED BY:
T/K: 310.64 P/kPa: 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
310.63	6.91	0.1706	0.1940
310.65	6.90	0.1704	0.1938

The mole fraction and Bunsen coefficient values were calculated by the compiler assuming ideal gas behavior.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid nitrogen trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum purity is 99.5 mole per cent.

(2) Benzene. J. T. Baker Analyzed Reagent Grade. 99.9 mole per cent, thiophene free.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.01$

$\delta P/\text{mmHg} = 0.5$

$\delta L_0/L_0 = 0.01$

$\delta L_W/L_W = 0.02$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Krauss, W.; Gestrich, W.
Chem.-Tech. (Heidelberg) 1977, *6*, 513-516.

VARIABLES:

T/K = 288 - 317

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature T/K	Solubility* S/mol dm^{-3} bar^{-1}	Bunsen coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Mol fraction 10^4x_1
288.8	0.0071	0.159	6.26
297.8	0.0073	0.164	6.52
316.9	0.0075	0.168	6.87

* read off graph in source.

The Bunsen coefficients and mole fractions (at 1 bar) were calculated by the compiler, assuming that the gas is ideal, and Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of gas was added to a known volume of liquid in a stirred equilibrium cell.

The equilibrium partial pressure was measured up to 2 bar. Diagram and details are given in source.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

δT/K = ±0.05; $\delta S/S$ = ±5%
(estimated by compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Patyi, L.; Furmer, I. E.; Makranczy, J.; Sadilenko, A. S.; Stepanova, Z. G.; Berengarten, M. G.

Zh. Prikl. Khim. 1978, *51*, 1296-1300.

VARIABLES:

T = 298.15 K
p = 101.3 kPa

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	$\alpha^{\dagger}$	Mole fraction of carbon monoxide at a partial pressure of 101.325 kPa x_{CO}
298.15	0.165	0.000658

† volume of gas (measured at 101.325 kPa and 273.15 K) dissolved by one volume of benzene.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. Pressure measured when known amounts of gas were added, in increments, to a known amount of liquid in a vessel of known dimensions. Corrections were made for the partial pressure of solvent. Details in ref. (1).

SOURCE AND PURITY OF MATERIALS:

Purity better than 99 mole per cent as determined by gas chromatography.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$; $\delta\alpha = \pm 4\%$ or less.

REFERENCES:

1. Bodor, E.; Bor, G. J.; Mohai, B.; Sipos, G. *Veszpremi. Vegyip. Egy. Kozl.* 1957, *1*, 55.

COMPONENTS:

1. Carbon monoxide; CO;; [630-08-0]
2. Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Connolly, J.F.

Amer. Petr. Inst. Report, 1965, *45, (III)*, 62-67.

VARIABLES:

$T/K = 433 - 533$
$p/\text{bar} = 7 - 70$

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P/bar	*K*-values*	
		$K_{C_6H_6}$	K_{CO}
433.15	7.10	1.000	114.3
	13.8	0.565	62.1
	20.7	0.406	42.2
	27.6	0.324	32.1
	34.5	0.274	25.8
	41.4	0.241	21.7
	55.2	0.201	16.3
	68.9	0.178	13.0
443.15	8.55	1.000	88.7
	13.8	0.671	57.9
	20.7	0.484	39.6
	27.6	0.389	30.1
	34.5	0.328	24.3
	41.4	0.287	20.4
	55.2	0.239	15.4
	68.9	0.213	12.4
453.15	10.3	1.000	69.1
	13.8	0.789	53.1
	20.7	0.573	36.7
	27.6	0.460	28.1
	34.5	0.389	22.7
	41.4	0.342	19.1
	55.2	0.284	14.4

* see next page

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Sample of known composition confined over mercury. Mixture compressed at constant temperature. Dew point and bubble point determined visually. Data smoothed.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.2$; $\delta P/\text{bar} = \pm 0.5$;
$\delta K/K = \pm 1\%$;

(estimated by compiler).

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Connolly, J.F.

Amer. Petr. Inst. Report. 1965, *45,(III)* 62-67.

EXPERIMENTAL VALUES:

		K-values*	
T/K	*P*/bar	$K_{C_6H_6}$	K_{CO}
453.15	68.9	0.250	11.6
463.15	12.2	1.000	54.1
	13.8	0.910	48.7
	20.7	0.667	34.1
	27.6	0.538	26.3
	34.5	0.455	21.3
	41.4	0.402	17.9
	55.2	0.337	13.6
	68.9	0.298	10.9
473.15	14.3	1.000	42.2
	20.7	0.768	30.7
	27.6	0.625	23.9
	34.5	0.532	19.4
	41.4	0.468	16.4
	55.2	0.395	12.5
	68.9	0.353	10.0
483.15	16.8	1.000	33.1
	20.7	0.866	27.7
	27.6	0.705	21.6
	34.5	0.605	17.7
	41.4	0.536	15.0
	55.2	0.452	11.5
	68.9	0.404	9.22
493.15	19.6	1.000	25.7
	20.7	0.970	24.5
	27.6	0.798	19.3
	34.5	0.690	15.9
	41.4	0.617	13.5
	55.2	0.520	10.4
	68.9	0.466	8.37
503.15	22.7	1.000	19.9
	27.6	0.887	17.0
	34.5	0.773	14.1
	41.5	0.694	12.0
	55.2	0.593	9.20
	68.9	0.533	7.43
513.15	26.1	1.000	15.2
	27.6	0.971	14.6
	34.5	0.852	12.2
	41.4	0.768	10.4
	55.2	0.665	8.05
	68.9	0.606	6.48
523.15	29.9	1.000	11.5
	34.5	0.926	10.3
	41.4	0.847	8.83
	55.2	0.741	6.86
533.15	34.1	1.000	8.43
	34.5	0.996	8.40
	41.4	0.915	7.27
	55.2	0.816	5.61
	68.9		4.53+

\+ obtained by extrapolation by authors.

*K_n = mol fraction of n in gas phase/mol fraction of n in liquid phase.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Connolly, J. F.; Kandalic, G. A.

J. Chem. Thermodyn.

1984, *16*, 1129-1139.

VARIABLES:

$T/K = 433 - 533$

$p/MPa = 1 - 10.5$

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	Mole fraction of carbon monoxide in gas, y_{CO}
433.15	1.005	0.00309	0.2585
	1.298	0.00615	0.4037
	1.660	0.00993	0.5202
	2.198	0.01553	0.6186
	3.814	0.03228	0.7562
	7.202	0.06714	0.8377
443.15	1.227	0.00402	0.2585
	1.590	0.00796	0.4037
	2.055	0.01301	0.5202
	2.739	0.02042	0.6186
	4.929	0.04404	0.7562
	10.456	0.10340	0.8377
453.15	1.250	0.00253	0.1475
	1.483	0.00518	0.2585
	1.937	0.01032	0.4037
	2.528	0.01700	0.5202
	3.405	0.02688	0.6186
	6.434	0.06099	0.7562
463.15	1.494	0.00324	0.1475
	1.782	0.00665	0.2585
	2.352	0.01338	0.4037
	3.105	0.02226	0.5202
	4.238	0.03563	0.6186
	8.692	0.08837	0.7562

(cont.)

AUXILIARY INFORMATION

METHOD APPARATUS/PROCEDURE:

Sample of known composition confined over mercury. Mixture compressed at constant temperature. Dew point and bubble point determined visually.

SOURCE AND PURITY OF MATERIALS:

No details given

ESTIMATED ERROR:

$\delta T/K = \pm 0.2$; $\delta P/MPa = \pm 0.01$;

$\delta x/x$, $\delta y/y = \pm 0.005$ (estimated by compiler).

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Benzene; C_6H_6; [71-43-2]	Connolly, J. F.; Kandalic, G. A. *J. Chem. Thermodyn.* 1984, *16*, 1129-1139.

EXPERIMENTAL VALUES:

T/K	*P*/MPa	Mole fraction of carbon dioxide in liquid, x_{CO}	in gas, y_{CO}
473.15	1.775	0.00418	0.1475
	2.133	0.00860	0.2585
	2.845	0.01741	0.4037
	3.782	0.02900	0.5202
	5.310	0.04792	0.6186
483.15	2.097	0.00537	0.1475
	2.536	0.01106	0.2585
	3.433	0.02270	0.4037
	4.639	0.03839	0.5202
	6.734	0.06588	0.6186
493.15	2.176	0.00298	0.0698
	2.465	0.00693	0.1475
	3.011	0.01440	0.2585
	4.144	0.02993	0.4037
	5.769	0.05239	0.5202
	8.847	0.09691	0.6186
503.15	2.529	0.00381	0.0698
	2.887	0.00900	0.1475
	3.570	0.01890	0.2585
	5.026	0.04014	0.4037
	7.324	0.07434	0.5202
513.15	2.932	0.00501	0.0698
	3.375	0.01185	0.1475
	4.238	0.02524	0.2585
	6.184	0.05592	0.4037
	9.943	0.11897	0.5202
523.15	3.391	0.00672	0.0698
	3.945	0.01594	0.1475
	5.070	0.03487	0.2585
	7.908	0.08504	0.4037
533.15	3.906	0.00913	0.0698
	4.638	0.02252	0.1475
	6.183	0.05145	0.2585

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Benzene; C_6H_6; [71-43-2]

Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2

p/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature $t/^\circ C$	T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient $L/cm^3\ cm^{-3}$
Benzene				
25.0	298.2	6.36	0.159	0.174
Methylbenzene				
25.0	298.2	7.94	0.167	0.182

The Bunsen coefficient and the mole fraction values were calculated by the compiler assuming ideal gas behavior. The values are adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) assuming Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of the liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the solvent volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Benzene.
Methylbenzene.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm\ 0.001$

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Methyl benzene or toluene; C_7H_8; [108-88-3]	Just, G. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* <u>1901</u>, *37*, 342-67.

VARIABLES:	PREPARED BY:
T/K = 293.15, 298.15 p_1/kPa = 101.325 (1 atm)	M. E. Derrick H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
293.15	7.69	0.162	0.1742
298.15	7.89	0.166	0.1808

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Methyl benzene. No information.

ESTIMATED ERROR:

$\delta L/L$ = 0.03 (compiler)

REFERENCES:

1. Timofejew, W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* <u>1890</u>, *6*, 141.
2. Steiner, P. *Ann. Phys. (Leipzig)*, <u>1894</u>, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

T/K = 298.15
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
298.15	8.20	0.172	0.188
	8.11	0.170	0.186

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent). 99.6 - 99.9% CO, the rest being atmospheric air.

(2) Methylbenzene. Riedel-de-Haën. Analytical reagent. Fractionated by distillation. B.p. (760 mmHg)/°C = 110.75 - 110.80, refractive index n_D(25.1°C) = 1.4936 - 1.4938.

ESTIMATED ERROR:

$\delta T/\text{K} = \pm\ 0.05$
$\delta x_1/x_1 = \pm\ 0.015$

REFERENCES:

1. Lannung, A.
   J. Am. Chem. Soc. 1930, *52*, 68.
2. Gjaldbaek, J. C.
   Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Field, L. R.; Wilhelm, E.; Battino, R.

J. Chem. Thermodyn. 1974, *6*, 237 - 243.

VARIABLES:

T/K: 283.66 - 313.28
P/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
283.66	7.82	0.173	0.1797
308.27	8.11	0.165	0.1857
313.28	8.25	0.171	0.1955

The gas solubility values were adjusted to carbon monoxide partial pressure 101.325 kPa (1 atm) by Henry's law.

The Bunsen coefficients were calculated by the compiler.

Smoothed Data: For use between 283.15 and 313.28 K.

$$\ln x_1 = -6.6251 - 1.5015/(T/100\text{ K})$$

The standard error about the regression line is 5.44×10^{-6}.

T/K	Mol Fraction 10^4x_1
283.15	7.81
293.15	7.95
298.15	8.02
303.15	8.08
313.15	8.21

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm³ of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is applied intermittently through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass spiral tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Either Matheson Co., Inc. or Air Products and Chemicals, Inc. Purest grade available, minimum purity greater than 99 mole per cent.

(2) Methylbenzene. Phillips Petroleum. Pure Grade. Distilled.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.03$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methylbenzene (toluene); C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Krauss, W.; Gestrich, W.

Chem.-Tech. (Heidelberg) 1977, *6*, 513-516.

VARIABLES:

T/K = 288 - 317

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature T/K	Solubility* S/mol dm^{-3} bar^{-1}	Bunsen coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Mol fraction 10^4x_1
289.3	0.0073	0.164	7.72
294.2	0.0074	0.166	7.87
305.6	0.0075	0.168	8.08
316.2	0.0073	0.164	7.95

* read off graph in source.

The Bunsen coefficients and mole fractions (at 1 bar) were calculated by the compiler, assuming that the gas is ideal, and Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of gas was added to a known volume of liquid in a stirred equilibrium cell.

The equilibrium partial pressure was measured up to 2 bar. Diagram and details are given in source.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

δT/K = ±0.05; $\delta S/S$ = ±5%

(estimated by compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methylbenzene (toluene); C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Chen, H.; Liu, M.; Zheng, L.; Zhu, Z. *Zhejiang Daxue Xuebao*, 1985, *19(1)*, 140-148 (Chinese).

VARIABLES:

Temperature = 298.15 - 323.15 K

PREPARED BY:

Shiqing Bo

EXPERIMENTAL VALUES:[a]

T/K	Henry's Constant[b] $H_{2,1}$/atm	Mole fraction[c] at 1 atm P_{CO}, $10^4 x_1$
298.15	1295.72	7.72
303.15	1224.74	8.17
313.15	1165.25	8.58
323.15	1112.18	8.99

a. Measured at atmospheric pressure.

b. The data were used to obtain (by linear regression); $H_{2,1} = 2492.3 - 4.1649T$, based on which the calculated values have a maximum relative deviation of ± 2.71%.

c. Calculated by compiler based on $P_{CO} = H_{2,1}\, x_{CO}$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. Modified Novak and Conway (1) apparatus. Solvent degassed to its vapor pressure. Pressure measured with a mercury manometer. Solvent stirred with a magnetic stirrer. Gas circulated by a gas pump. Equilibrium established when constant readings of volume reached.

SOURCE AND PURITY OF MATERIALS:

(1) Prepared by the authors, ca. 98% pure.

(2) Hongzhou Chlorophyll Plant (China), analytical grade.

ESTIMATED ERROR:

δT/K = ±0.1 (absorption vessel)
δT/K = ±1.0 (entire system)

REFERENCES:

1. Novak-Adamic, D.M.; Conway, B.F., *Chem. Instrum.*, 1973, *5*, 79.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Sato, T.; Toyoda, I.; Yamamori, Y.; Yonemoto, T.; Kato, H.; Tadaki, T.

J. Chem. Eng. Japan 1988, *21*, 192-198.

VARIABLES:

$T/K = 303$
$p_1/kPa = 5.1 - 140$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature/K	solubility $10^6 H/$ mol m^{-3} Pa^{-1}	Bunsen coefficient $\alpha/$ cm^3(STP)$cm^{-3}atm^{-1}$	mol fraction, $10^4 x_1$ at 1 atm
303	69.87	0.159	7.60

Bunsen coefficient calculated by compiler.

Mol fraction calculated by compiler assuming density of toluene at 303 K = 0.8564 g cm^{-3}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solvent was degassed by boiling. Carbon monoxide was mixed with dry nitrogen and saturated with solvent vapour, then stirred into the solvent at constant temperature. The pressure change was followed with a pressure sensor, and the solubility was calculated.

The apparatus is based on that of Loprest (1).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from cylinder, passed through silica gel and activated alumina.

(2) Toluene: dehydrated with sodium sulphate.

ESTIMATED ERROR:

$\delta H/H = \pm 5\%$ (compiler)

REFERENCES:

1. Loprest, F. J.; *J. Phys. Chem.* 1957, *61*, 1128.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Toluene; C_7H_8; [108-88-3]	Lühring, P.; Schumpe, A. *J. Chem. Eng. Data* 1989, *34*, 250-252.
VARIABLES:	**PREPARED BY:**
T = 293.2 K p_1 = 101.3kPa (1 atm)	R.W. Cargill

EXPERIMENTAL VALUES:

Temperature = 293.2 K

Henry's constant H/kPa m^3 mol^{-1}	Bunsen coefficient* α/cm^3 (STP) cm^{-3} atm^{-1}	mol fraction solubility* at 101.3 kPa, 10^4x_1
22.44	0.101	4.80

* calculated by compiler, assuming ideal gas behaviour and that Henry's law is obeyed; also that the density of toluene at 293.2 K is 0.866 g cm^{-3}

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A barometic method of measurement (reference 1). A glass vessel containing 349.6 cm^3 liquid and 589.9 cm^3 gas, divided by a perforated glass plate, was stirred magnetically. Liquid was previously degassed by evacuation. Dry gas was admitted, and the pressure decrease monitored by a micromanometer. Saturation was achieved within 3-6 minutes.

Reported value is mean of 3 determinations.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information

(2) Toluene: from Merck, "highest available purity".

ESTIMATED ERROR:

$\Delta T = \pm$ 0.1K
$\delta x/x = \pm$ 2% (authors)

REFERENCES:

1. Schumpe, A.; Quicker, G.; Deckwer, W.D. *Adv. Biochem. Eng.* 1982, *24*, 1.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Dimethylbenzene or xylene (mixture?); C_8H_{10}; [1330-20-7]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	8.87	0.163	0.1744
298.15	8.95	0.163	0.1781

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

The compiler assumed the dimethylbenzene was a mixture of 40 per cent 1,3-dimethylbenzene and 20 per cent each of 1,2-dimethylbenzene, 1,4-dimethylbenzene, and ethylbenzene. See Riddick, J. A.; Bunger, W. B. *Organic Solvents* 3rd Ed., Wiley-Interscience, New York, 1970, p. 614.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Dimethylbenzene. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Dimethylbenzene or xylene (mixture?); C_8H_{10}; [1330-20-7]

ORIGINAL MEASUREMENTS:

Krauss, W.; Gestrich, W.
Chem.-Tech. (Heidelberg) 1977, *6*, 513-516.

VARIABLES:

$T/K = 288 - 317$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature T/K	Solubility* $S/\text{mol dm}^{-3}\text{ bar}^{-1}$	Bunsen coefficient $\alpha/\text{cm}^3\text{(STP)cm}^{-3}\text{atm}^{-1}$	Mol fraction $10^4 x_1$
288.1	0.0075	0.168	9.18
301.9	0.0075	0.168	9.28
313.7	0.0075	0.168	9.38

* read off graph in source.

The Bunsen coefficients and mole fractions (at 1 bar) were calculated by the compiler, assuming that the gas is ideal, and Henry's law is obeyed.

NOTE: The compiler assumed that the xylene was a mixture of 40% 1,3 dimethylbenzene and 20% each of the 1,2 and the 1,4 isomers, but this is not certain. The original paper, and an earlier reference (1) gives no clarification.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of gas was added to a known volume of liquid in a stirred equilibrium cell.

The equilibrium partial pressure was measured up to 2 bar. Diagram and details are given in source.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$; $\delta S/S = \pm 5\%$

(estimated by compiler)

REFERENCES:

1. Krauss, W.; Gestrich, W. *Chem.-Tech. (Heidelberg)*, 1977, *6*, 35.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1,2,4-Trimethylbenzene; C_9H_{12}; [95-63-6]

ORIGINAL MEASUREMENTS:

Krauss, W.; Gestrich, W.

Chem.-Tech. (Heidelberg), 1977, *6*, 513-516.

VARIABLES:

T/K = 288 - 317

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature T/K	Solubility* S/mol dm^{-3} bar^{-1}	Bunsen coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Mol fraction 10^4x_1
288.7	0.0064	0.143	8.76
295.3	0.0063	0.141	3.63
305.2	0.0064	0.143	8.80
314.1	0.00635	0.142	8.76

* read off graph in source.

The Bunsen coefficients and mole fractions (at 1 bar) were calculated by the compiler, assuming that the gas is ideal, and Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of gas was added to a known volume of liquid in a stirred equilibrium cell.

The equilibrium partial pressure was measured up to 2 bar. Diagram and details are given in source.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

δT/K = ±0.05; $\delta S/S$ = ±5%

(estimated by compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Phenanthrene; $C_{14}H_{10}$; [85-01-8]

ORIGINAL MEASUREMENTS:

Matsumato, D. K.; Satterfield, C. N.

Ind. Eng. Chem. Process Des. Dev. 1985, *24*, 1297-1300.

VARIABLES:

$T/K = 433 - 503$
$p_1/MPa = 0.5 - 0.8$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	solubility/ mol m^{-3} MPa^{-1}	Henry's constant/ MPa	mole fraction* 10^3x_1
433.16	28.3	207	4.83
473.16	30.3	188	5.32
503.16	34.0	172	5.81

* calculated by compiler; inverse of Henry's constant, to give mol fraction solubility at 1 MPa partial pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solvent is weighed into a 1 dm^3 stainless steel bomb, wrapped in heating tapes. After flushing and reaching temperature equilibrium, gas is charged into the bomb at the required pressure (up to about 1 MPa).

Equilibrium is established by mechanical rocking for 2-3 hours.

Amount of gas absorbed is obtained from pressure measurements, and calculation of a mole balance.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson CP grade.

(2) Phenanthrene. Aldrich Chemical Co. Purity >98%.

ESTIMATED ERROR:

$\delta x/x = \pm 5\%$ (authors)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Naphthalene; $C_{10}H_8$; [91-20-3]

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.15
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Naphthalene		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm³cm⁻³
25.0	298.15	0.0	0.0	0.174
		11.52	7.35	0.164
		11.65	7.44	0.163
		23.98	16.14	0.149
		23.60	15.83	0.148
		32.35	22.56	0.142
		32.74	22.87	0.143
		33.79	23.72	0.141

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Naphthalene.
(3) Benzene.

No information.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Phenanthrene; $C_{14}H_{10}$; [85-01-8] (3) Benzene; C_6H_6; [71-43-2]	Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.
VARIABLES:	PREPARED BY:
T/K = 298.2 p_1/kPa = 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Phenanthrene		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.174
		10.48	4.88	0.144
		10.48	4.88	0.144
		19.22	9.43	0.132
		18.99	9.31	0.133
		27.04	13.96	0.128
		27.39	14.19	0.127

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Phenanthrene.
(3) Benzene.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001 (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methanol; CH_4O; [64-56-1]

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Methanol		Ostwald Coefficient
t/°C	T/K	$10^2 w_2$/wt %	$10^2 \phi_2$/vol %	L/cm³cm⁻³
25.0	298.2	0.0	0.0	0.174
		15.43	16.92	0.179
		52.34	55.08	0.181
		100	100	0.192

The author also reported refractive index and vapor pressure of the solvents.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Methanol.
(3) Benzene.

No information.

ESTIMATED ERROR:

δL/cm³ = ± 0.001 (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Naphthalenol or α-naphthol; $C_{10}H_8O$; [90-15-3]

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		1-Naphthalenol		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.174
		3.48	1.91	0.149
		6.75	3.77	0.145
		6.59	3.68	0.144
		12.10	6.94	0.139
		11.81	6.76	0.139

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) 1-Naphthalenol.
(3) Benzene.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001 (Author)

REFERENCES:

1. **Just, G.**

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Naphthalenol or β-naphthol; $C_{10}H_8O$; [135-19-3]

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2
p/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		2-Naphthalenol		Ostwald Coefficient
$t/^\circ C$	T/K	Wt %	Mol %, 10^2x_2	$L/\text{cm}^3\ \text{cm}^{-3}$
25.0	298.2	0.0	0.0	0.174
		2.06	1.13	0.158
		4.14	2.29	0.151
		4.36	2.41	0.149

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) 1-Naphthanenol.
(3) Benzene.

Sources not given. The mixtures were prepared under vacuum.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm\ 0.001$ (author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Acetic acid; $C_2H_4O_2$; [64-19-7]

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Acetic acid		Ostwald Coefficient
$t/°C$	T/K	$10^2 w_2$/wt %	$10^2 \phi_2$/vol %	$L/cm^3 cm^{-3}$
25.0	298.2	0.0	0.0	0.174
		19.47	16.51	0.190
		33.54	29.6	0.198
		67.51	63.4	0.199
		100	100	0.172

The author also reported the vapor pressure of the solvents.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Acetic acid.
(3) Benzene.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Benzenamine or aniline; C_6H_7N; [62-53-3] (3) Benzene; C_6H_6; [71-43-2]	Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.
VARIABLES:	**PREPARED BY:**
T/K = 298.2 p_1/kPa = 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Benzenamine		Ostwald Coefficient
t/°C	T/K	$10^2 w_2$/wt %	$10^2 x_2$/mol %	L/cm^3 cm^{-3}
25.0	298.2	0.0	0.0	0.174
		12.69	10.86	0.156
		12.03	10.29	0.158
		19.57	16.95	0.145
		19.43	16.83	0.144
		28.43	24.99	0.131
		28.26	24.84	0.131
		57.68	53.35	0.0945
		57.38	53.04	0.0953
		78.90	75.90	0.0689
		78.80	75.7	0.0684
		100	100	0.053

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Benzenamine.
(3) Benzene.

No information.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm\ 0.001$ (Author)

REFERENCES:

1. Just, G.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Nitrobenzene; $C_6H_5NO_2$; [98-95-3]

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Nitrobenzene		Ostwald Coefficient
$t/°$	T/K	10^2w_2/mol %	10^2x_2/mol %	L/cm^3cm^{-3}
25.0	298.2	0.0	0.0	0.174
		14.5	9.71	0.162
		14.12	9.44	0.162
		28.18	19.92	0.152
		28.14	19.89	0.152
		40.58	30.23	0.140
		40.63	30.26	0.140
		54.9	43.56	0.126
		54.9	43.6	0.127
		83.33	76.0	0.101
		83.2	75.9	0.102
		100	100	0.093

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Nitrobenzene.
(3) Benzene.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Cholest-5-en-3β-ol or Cholesterol; $C_{27}H_{46}O$; [57-88-5]

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Byrne, J. E.; Battino, R.; Danforth, W. F.

J. Chem. Thermodyn. 1974, *6*, 245-250.

VARIABLES:

T/K: 310.65
P/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mass Fraction Cholesterol W_3	Ostwald Coefficient $L/\mathrm{cm^3 cm^{-3}}$	"Salting Out" Parameter $k = (1/W_3)\log(L_o/L_w)$
310.63	0.0	0.1940	
310.65	0.0	0.1938	
310.61	0.0519	0.187	
310.62	0.0519	0.189	0.26 ± 0.17
310.60	0.1050	0.182	
310.61	0.1050	0.181	0.27 ± 0.09
310.65	1.0	0.104*	

*Extrapolated carbon monoxide solubility in hypothetical liquid cholesterol.

L_o and L_w are the carbon monoxide Ostwald coefficients in benzene and in the benzene + cholesterol solution, respectively.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm³ of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid nitrogen trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum purity 99.5 mole per cent.

(2) Cholesterol. Source not given. Recrystalized from benzene.

(3) Benzene. J. T. Baker Analyzed Reagent Grade. 99.9 mole per cent, thiophene free.

ESTIMATED ERROR:

δT/K = 0.01
δP/mmHg = 0.5
$\delta L_o/L_o$ = 0.01
$\delta L_w/L_w$ = 0.02

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Cephalin

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Byrne, J. E.; Battino, R.; Danforth, W. F.

J. Chem. Thermodyn. 1974, *6*, 245-250.

VARIABLES:

T/K: 310.65

Total P/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mass Fraction Cephalin W_2	Ostwald Coefficient $L/\mathrm{cm^3\,cm^{-3}}$	"Salting Out" Parameter $k = (1/W_2)\log(L_o/L_w)$
310.63	0.0	0.1940	
310.65	0.0	0.1938	
310.69	0.2003	0.168	
310.70	0.2003	0.168	0.31 ± 0.05
310.65	1.0	0.095*	

* Extrapolated carbon monoxide solubility in hypothetical liquid cephalin.

L_o and L_w are the carbon monoxide Ostwald coefficients in benzene and in the benzene + cephalin solution, respectively.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans and Danforth (2). The degassing apparatus is that described by Battion, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm³ of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred and vacuum is intermittently applied through a liquid nitrogen trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum purity 99.5 mole per cent.

(2) Cephalin. Nutritional Biochemicals Corp. Homostatic phosphatide obtained from bovine brain tissue, used as received.

(3) Benzene. J. T. Baker Analyzed Reagent Grade. 99.9 mole per cent, thiophene free.

ESTIMATED ERROR:

δT/K = 0.01

δP/mmHg = 0.5

$\delta L_o/L_o$ = 0.01

$\delta L_w/L_w$ = 0.02

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino,R.;Evans,F.D.;Danforth,W.F. *J.Am.Oil Chem.Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Lecithin

(3) Benzene; C_6H_6; [71-43-2]

ORIGINAL MEASUREMENTS:

Byrne, J. E.; Battino, R.; Danforth, W. F.

J. Chem. Thermodyn. 1974, *6*, 245-250.

VARIABLES:

T/K: 310.65
Total p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mass Fraction Lecithin W_2	Ostwald Coefficient $L/\mathrm{cm^3\,cm^{-3}}$	"Salting Out" Parameter $k = (1/W_2)\log(L_o/L_w)$
310.63	0.0	0.1940	
310.65	0.0	0.1938	
310.59	0.1997	0.171	
310.60	0.1997	0.171	0.28 ± 0.05
310.65	1.0	0.102*	

*Extrapolated carbon monoxide solubility in hypothetical liquid lecithin.

L_o and L_w are the carbon monoxide Ostwald coefficients in benzene and in the benzene + lecithin solution, respectively.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 $\mathrm{cm^3}$ of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid nitrogen trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum purity 99.5 mole per cent.

(2) Lecithin. Nutritional Biochemicals Corp. Vegetable source, about 95 per cent, used as received.

(3) Benzene. J. T. Baker Analyzed Reagent Grade. 99.9 mol per cent, thiophene free.

ESTIMATED ERROR: $\delta T/\mathrm{K} = 0.01$
$\delta P/\mathrm{mmHg} = 0.5$
$\delta L_o/L_o = 0.01$
$\delta L_w/L_w = 0.02$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Naphthalene; $C_{10}H_8$; [91-20-3]

(3) Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Naphthalene		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.182
		7.13	5.23	0.169
		7.10	5.20	0.171
		15.10	11.34	0.161
		15.13	11.36	0.161
		22.75	17.48	0.153
		22.58	17.33	0.154

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Naphthalene.
(3) Methylbenzene.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001 (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Phenanthrene; $C_{14}H_{10}$; [85-01-8] (3) Methylbenzene or toluene; C_7H_8; [108-88-3]	Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.
VARIABLES: T/K = 298.2 p_1/kPa = 101.325 (1 atm)	PREPARED BY: H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Phenanthrene		Ostwald Coefficient
t/°C	T/K	$10^2 w_2$/wt %	$10^2 x_2$/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.182
		5.59	2.97	0.170
		5.58	2.96	0.171
		11.16	6.10	0.161
		11.20	6.12	0.161
		21.62	12.49	0.147
		21.93	12.68	0.147

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Phenanthrene.
(3) Methylbenzene.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001 (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Naphthalenol or α-naphthol; $C_{10}H_8O$; [90-15-3]

(3) Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		1-Naphthalenol		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.182
		4.46	2.89	0.171
		4.44	2.88	0.171
		8.75	5.77	0.162
		8.89	5.86	0.163

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) 1-Naphthalenol.
(3) Methylbenzene.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001 (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Acetic acid; $C_2H_4O_2$; [64-19-7]

(3) Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Acetic acid		Ostwald Coefficient
t/°C	T/K	$10^2 w_2$/wt %	$10^2 \phi_2$/vol %	$L/\text{cm}^3\text{cm}^{-3}$
25.0	298.2	0.0	0.0	0.182
		20.48	17.77	0.190
		56.89	52.56	0.195
		74.71	71.05	0.191
		100	100	0.172

The author also reported the vapor pressure of the solvents.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Acetic acid.
(3) Methylbenzene.

No information.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm\ 0.001$ (Author)

REFERENCES:

1. **Just, G.**

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Benzenamine or aniline; C_6H_7N; [62-53-3] (3) Methylbenzene or toluene; C_7H_8; [108-88-3]	Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.
VARIABLES:	**PREPARED BY:**
$T/K = 298.2$ $p_1/kPa = 101.325$ (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Benzenamine		Ostwald Coefficient
$t/°C$	T/K	$10^2 w_2$/wt %	$10^2 x_2$/mol %	$L/cm^3 cm^{-3}$
25.0	298.2	0.0	0.0	0.182
		6.61	6.54	0.169
		6.61	6.54	0.168
		13.56	13.43	0.157
		13.55	13.42	0.156
		19.91	19.74	0.148
		19.96	19.79	0.148
		44.64	44.36	0.115
		44.31	44.03	0.116
		74.63	74.44	0.0768
		75.03	74.85	0.0753
		100	100	0.053

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Benzenamine.
(3) Methylbenzene.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Nitrobenzene; $C_6H_5NO_2$; [98-95-3]

(3) Methylbenzene or toluene; C_7H_8; [108-88-3]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Nitrobenzene		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	$L/\text{cm}^3\text{cm}^{-3}$
25.0	298.2	0.0	0.0	0.182
		8.86	6.77	0.168
		8.87	6.78	0.168
		18.27	14.33	0.160
		18.19	14.27	0.161
		26.82	21.52	0.151
		26.76	21.46	0.151
		49.14	41.95	0.131
		49.02	41.83	0.131
		76.31	70.67	0.108
		76.31	70.67	0.108
		100	100	0.093

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Nitrobenzene.
(3) Methylbenzene.

No information.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm\ 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO;[630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. March 1989

CRITICAL EVALUATION:

The Solubility of Carbon Monoxide in Alkanols at a Partial Pressure of 101.3 kPa.

Eight papers provide data on the solubility of carbon monoxide at 101.3 kPa in alcohols of carbon number C_1 to C_{12}. All of the straight-chain primary alkanols in the C_1 to C_{12} range are covered, along with a few secondary and branched-chain alcohols. One paper gives a result for cyclohexanol as solvent, and another includes a qualitative reference to glycerol.

In making comparisons it is noteworthy that all the measurements were made by volumetric methods, and the temperatures studied all included 298.15 K. Some data cover temperatures of 274-328 K.

Straight-chain Primary Alcohols.

To assist in the evaluation, the mole fraction solubilities at 298 K and 101.3 kPa partial pressure of carbon monoxide have been plotted on Figure 1 against carbon number of the alcohol. The smoothly increasing solubility with increasing carbon number is a feature which has been noticed for other gases in normal alcohols, according to an equation of the type due to Hayduk (1,2)

$$\ln x = b_1 + b_2 \ln C_n$$

From Figure 1 it is clear that over the range C_1 to C_{10}, there are two self-consistent but divergent lines which correlate two sets of data points. The lower set includes most of those by Makranczy *et al.*, Skirrow's value, and Just's two values. The data of Makranczy *et al.* for C_{11} and C_{12} alcohols are about 15% too low to be included on this line. The upper set includes the data of Gjaldbaek and of Wilcock *et al.* and it is the evaluator's belief that this line is more reliable because these workers are very thorough in their experimental work, and measured solubilities over a wider range of temperatures obtaining more data points, which permits checking by interpolation, whereas Makranczy *et al.* and Skirrow measured the solubility at 298 K only, and Just at 293 and 298 K only.

Also, the work of Makranczy *et al.* on other gases dissolving in these alcohols has been found by other evaluators to show some significant deviations from other published data, e.g. hydrogen (3), oxygen (4), methane (2). Although conclusive proof is absent, several factors suggest that the solubilities of carbon monoxide measured by Makranczy *et al.* are about 10% too small over the C_1 to C_{10} range of alcohols.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	R. W. Cargill Dept of Molecular & Life Sciences Dundee Institute of Technology Bell St Dundee DD1 1HG, UK March 1989

CRITICAL EVALUATION:

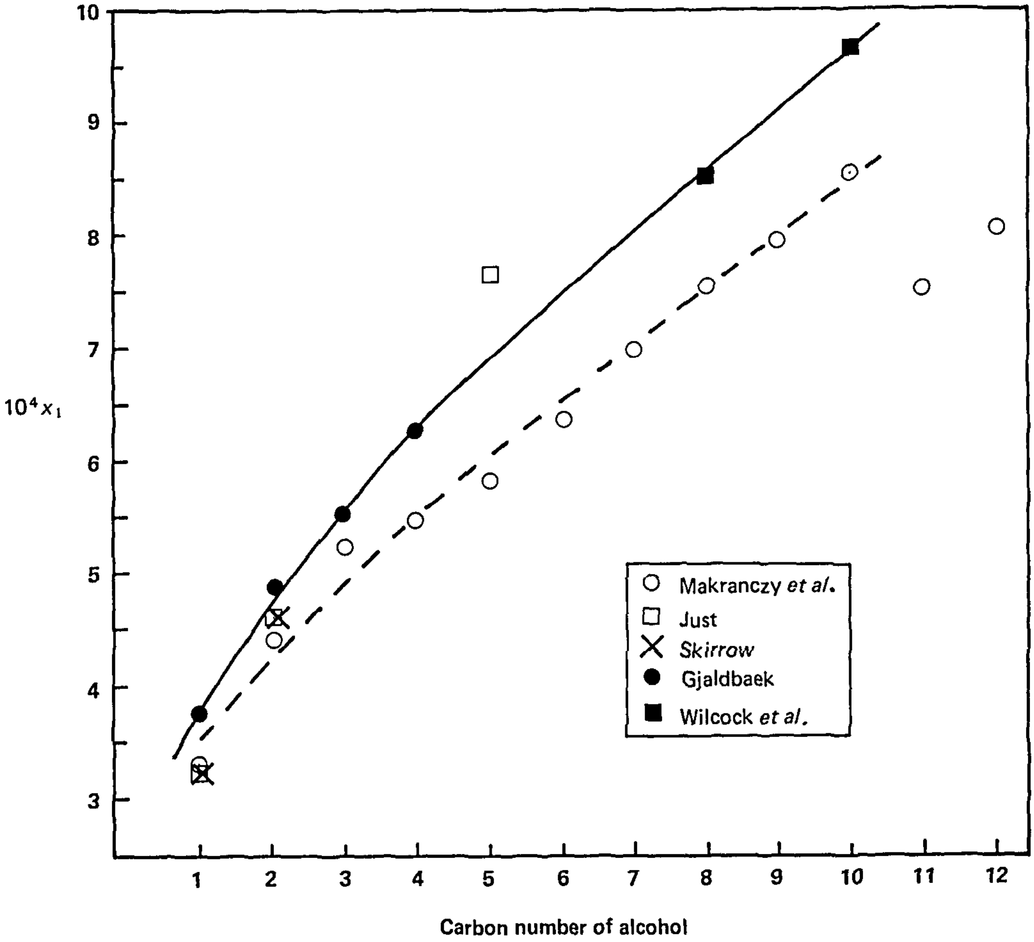

Figure 1. Mole fraction solubility of carbon monoxide in n-alcohols at 298.15 K and 101.3 kPa.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alcohols

EVALUATOR:

Robert W. Cargill,
Department of Molecular
and Life Sciences,
Dundee Institute of Technology.
Bell Street, Dundee DD1 1HG, UK.

March 1989

CRITICAL EVALUATION:

Individual alcohols as solvents for carbon monoxide are now considered in turn.

1. Methanol; CH_4O; [67-56-1]

Just in 1901 (5) and Skirrow in 1902 (6) reported values for the solubility of carbon monoxide at 298.15 K, which are 1-2% lower than these of Makranczy *et al.* in 1979 (7). All of these values are about 12% lower than those obtained by Gjaldbaek in 1948. His data cover temperatures of 293-323 K, where the equation applies

$$\ln x_1 = -7.5979 - 0.8566/(T/100\ \text{K})$$

giving in Table 1 smoothed solubility values which can be tentatively accepted for this system. From the constants in the equation, it can be calculated that $\Delta H^o_1 = 710$ J mol^{-1} and $\Delta S^o_1 = -63.2$ J K^{-1} mol^{-1}, for the transfer of one mole of carbon monoxide at a partial pressure of 101.3 kPa in the gas phase to the infinitely dilute solution.

Table 1: The Solubility of Carbon Monoxide in Methanol:

tentative values of the mole fraction solubility and partial molar Gibbs energy of solution at a partial pressure of 101.3 kPa.

T/K	$10^4 x_1$	ΔG_1^o/kJ mol^{-1}
293.15	3.74	19.23
298.15	3.76	19.55
303.15	3.78	19.86
308.15	3.80	20.18
313.15	3.82	20.49
318.15	3.83	20.81
323.15	3.85	21.13

Brunner *et al.* (8) extrapolated data from their high pressure measurements on this system to give values of $10^4 x_1$ of 3.56 and 3.77 at 298.15 and 323.15 K respectively. These values are 5% and 2% lower than the corresponding values in Table 1. A very recent measurement by Luhring and Schumpe (16) at 293.2 K has given a solubility value which is also lower than Gjaldbaek's at 293.2 K, by about 10%. The evaluator believes, however, that confidence may be placed in Gjaldbaek's values over 293-323 K, although they appear to be high by comparison.

In a paper on gas-cleaning systems, Kruis and Scholz (9) gave a graphical representation of the solubility of carbon monoxide in methanol over 193 to 293 K. A line was drawn to include literature values along with some experimental results. However it was not clear what these were, and no reliable low temperature solubility data could be extracted. It can only be stated with caution that from this work it appears that the solubility increases almost linearly by about 54% as the temperature decreases from 293 to 193 K.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. March 1989

CRITICAL EVALUATION:

2. Ethanol; C_2H_6O; [64-17-5]

The data of Gjaldbaek (10) over the temperature range 293-323 K are the most comprehensive and consistent for this solvent. The data of Just (5) at 293 and 298 K, and of Skirrow (6) at 298 K are about 6% lower, and those of Makranczy *et al.* (7) are about 12% lower. Gjaldbaek's data can be tentatively accepted, given between 293 and 333 K by the equation

$$\ln x_1 = - 7.5543 - 0.2053/(T/100\ \mathrm{K})$$

Smoothed values are given in Table 2. From the constants in the equation, $\Delta H_1^{\circ} = 171\ \mathrm{J\ mol^{-1}}$ and $\Delta S_1^{\circ} = - 62.8\ \mathrm{J\ K^{-1}\ mol^{-1}}$ for the transfer of one mole of the gas at a partial pressure of 101.3 kPa to the infinitely dilute solution.

Table 2: The Solubility of Carbon Monoxide in Ethanol:

tentative values of the mole fraction solubility and the partial molar Gibbs energy of solution at a partial pressure of 101.3 kPa.

T/K	$10^4 x_1$	ΔG_1°/kJ mol^{-1}
293.15	4.88	18.58
298.15	4.89	18.90
303.15	4.89	19.21
308.15	4.90	19.52
313.15	4.90	19.84
318.15	4.91	20.15
323.15	4.91	20.47

3. 1-Propanol; C_3H_8O; [71-23-8]

The 298 K value of Makranczy *et al.* (7) is about 5% lower than the value interpolated from Gjaldbaek's data (10) at 293, 308, and 323 K. The tentative mole faction solubilities, from Gjaldbaek, are given between 293 and 323 K by the equation

$$\ln x_1 = - 7.4802 - 0.0771/(T/100\ \mathrm{K}),$$

from which smoothed values have been calculated in Table 3. From the constants in this equation, $\Delta H_1^{\circ} = 64\ \mathrm{J\ mol^{-1}}$ and $\Delta S_1^{\circ} = -62.2\ \mathrm{J\ K^{-1}\ mol^{-1}}$ for the transfer of one mole of the gas at a partial pressure of 101.3 kPa to the infinitely dilute solution.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. March 1989

CRITICAL EVALUATION:

Table 3: The Solubility of Carbon Monoxide in 1-Propanol:

tentative values of the mole fraction solubility and the partial molar Gibbs energy of solution at a partial pressure of 101.3 kPa.

T/K	10^4x_1	ΔG^o_1/kJ mol^{-1}
293.15	5.495	18.30
298.15	5.495	18.61
303.15	5.50	18.92
308.15	5.50	19.23
313.15	5.505	19.54
318.15	5.505	19.85
323.15	5.51	20.16

4. 2-Propanol; C_3H_8O; [67-63-0]

Gjaldbaek's measurements (10) at 293.1, 308.2, and 324.3 K are the only ones available for this system. They may be accepted tentatively. A smoothing equation and some calculated values are given on the data sheet. From that equation, it can be shown that ΔH_1^o = 396 J mol^{-1} and ΔS_1^o = 60.3 J K^{-1} mol^{-1} for the transfer of one mole of the gas at 101.3 kPa partial pressure to the infinitely dilute solution.

5. 1-Butanol; $C_4H_{10}O$; [71-36-3]

The value of Makranczy *et al.* (7) at 298 K is about 12% lower than value of Gjaldbaek (10) interpolated from a spread of ten measurements between 292.9 and 323 K. Once again Gjaldbaek's data may be accepted tentatively. From 292.9 to 323 K they fit the equation

$$\ln x_1 = -7.5867 + 0.6180/(T/100\ \mathrm{K})$$

and Table 4 gives some smoothed values. From the constants in this equation, ΔH_1^o = -514 J mol^{-1} and ΔS_1^o = - 6.31 J K^{-1} mol^{-1} for the transfer of one mole of the gas at 101.3 kPa partial pressure to the infinitely dilute solution.

Table 4: The Solubility of Carbon Monoxide in 1-Butanol:
tentative values of the mole fraction solubility and the partial molar Gibbs energy of solution at a partial pressure of 101.3 kPa.

T/K	10^4x_1	ΔG_1^o/kJ mol^{-1}
293.15	6.26	17.98
298.15	6.24	18.29
303.15	6.22	18.61
308.15	6.20	18.92
313.15	6.18	19.24
318.15	6.16	19.55
323.15	6.14	19.87

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. March 1989

CRITICAL EVALUATION:

6. 2-Butanol; $C_4H_{10}O$; [78-92-2]

Gjaldbaek's six values (10) between 293.2 and 323.4 K are the only ones available for this system. They may be accepted tentatively on the strength of the reliability of this worker's results on related solutions. A smoothing equation and some calculated values are given on the data sheet. From that equation it is found that $\Delta H_1^{\circ} = 32$ J mol^{-1} and $\Delta S_1^{\circ} = -61.1$ J K^{-1} mol^{-1} for the transfer of one mole of gas at 101.3 kPa partial pressure to the infinitely dilute solution.

7. 2-Methyl-1-propanol; $C_4H_{10}O$; [78-83-1]

Two quite detailed studies of this system have been made, that of Gjaldbaek (10) in 1948 over 293-323 K (5 values) and that of Battino *et al.* (11) in 1971 over 274-328 K (9 values).

Each set of data is self consistent and smoothing equations for each are given in the two data sheets, but there is an increasing discrepancy between the two sets of data as the temperature goes from 300 to 330 K. Over this range the values of Battino *et al.* are from 2 to 7% lower, but show a temperature coefficient which is consistent from 274 to 330 K. On the evidence available it is not possible to entirely recommend any one of the data sets, and both may be used with caution. Smoothed values are given in Table 5, along with 2 values which have been extrapolated from values given by Tonner *et al.* (12) at 1000 kPa, assuming that Henry's law holds between 101 and 1000 kPa. If this assumption is correct, it indicates a preference for the data of Battino *et al.* Although many of the measurements by Tonner *et al.* are of doubtful accuracy (see the evaluation for carbon monoxide at high pressure in alcohols), the temperature coefficient of all the data for this system agrees with that of Battino *et al.* The wider temperature range, the reliability of the apparatus and its accessories, and the better accuracy of Battino *et al.* would confirm the choice of their data. From their smoothing equation, $\Delta H_1^{\circ} = -1.39$ kJ mol^{-1} and $\Delta S_1^{\circ} = -65.7$ J K^{-1} for the transfer of one mole of gas at 101.3 kPa partial pressure to the infinitely dilute solution.

Table 5: The Solubility of Carbon Monoxide in 2-Methyl-1-propanol:

comparative values of mole fraction solubility, 10^4x_1, from different workers, at 101.3 kPa partial pressure.

T/K	Gjaldbaek	Battino *et al.*	Tonner *et al.**
278.15		6.79	
288.15		6.65	
293.15	6.66	6.60	
298.15	6.66	6.53	6.4
308.15	6.66	6.41	
318.15	6.65	6.30	
323.15	6.65	6.25	6.1
328.15		6.20	

* extrapolated from high pressure values.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. March 1989

CRITICAL EVALUATION:

8. 2-Methyl-2-propanol; $C_4H_{10}O$; [75-65-0]

Gjaldbaek's data for this solvent may be accepted tentatively for the temperature interval 300-323 K, since they are in line with data on other similar systems. However they should be used with caution in the absence of any confirmatory evidence. A smoothing equation and some calculated values appear on the data sheet. From the equation, ΔH_1° is 3.46 kJ mol^{-1} and ΔS_1° is - 48.2 J K^{-1} mol^{-1} for the transfer of one mole of carbon monoxide at a partial pressure of 101.3 kPa to the infinitely dilute solution.

9. 1-Pentanol; $C_5H_{12}O$; [71-41-0]

Just's two measurements (5) of the solubility at 293.15 and 298.15 K, and Makranczy's (7) at 298.15 K are the only ones available for this system. Each should be used with great caution because it is likely that Just's values are several percent high, and Makranczy's about ten percent low (see figure 1).

10. 1-Hexanol; $C_6H_{14}O$; [111-27-3]

1-Heptanol; $C_7H_{16}O$; [111-70-6]

1-Nonanol; $C_9H_{20}O$; [143-08-8]

The values of Makranczy *et al.* (7) at 298.15 K for these solvents are probably about 10% too low, and should be used with caution.

11. 1-Octanol; $C_8H_{18}O$; [111-87-5]

1-Decanol; $C_{10}H_{22}O$; [12-30-1]

The values of Wilcock *et al.* (13) are to be preferred to the lower values of Makranczy *et al.* (7) at 298 K. Some confirmatory data are required for these solvents before the values can be recommended.

12. 1-Undecanol; $C_{11}H_{24}O$; [112-42-5]

1-Dodecanol; $C_{12}H_{26}O$; [112-53-5]

The values of Makranczy *et al.* should be treated with great caution. Compared to the trends observed through the homologoeus series of *n*-alcohols, these values may be up to 20% too low (see Figure 1).

13. Cyclohexanol; $C_6H_{12}O$; [108-93-0]

The single measurement by Cauquil (14) at 299 K would need to be confirmed, but it appears to be of the appropriate magnitude.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, UK. March 1989

CRITICAL EVALUATION:

Solvent mixtures containing alcohols.

The solubility of carbon monoxide at 1 bar in a 1:1 molar mixture of 1-decanol and 1-dodecanol was measured at 293 K by Luther and Hiemenz (15). Other related solvent mixtures for which data are included in this section are methanol with glycerol, and methanol with chloroform, both due to Skirrow (6), at 1 bar and 298.2 K. All of these data appear to be of the correct magnitude, but would need further confirmation.

References

1. Hayduk, W. *ETHANE, IUPAC Solubility Data Series* 1982, *9*, 166-167; *PROPANE, BUTANE, 2-METHYLPROPANE, IUPAC Solubility Data Series* 1985, *24*, 331-334.

2. Clever, H.L. *METHANE, IUPAC Solubility Data Series* 1988, *27/28*, 582-595.

3. Clever, H.L. *HYDROGEN, IUPAC Solubility Data Series* 1981, *5/6*, 186-190.

4. Clever, H.L. *OXYGEN, IUPAC Solubility Data Series* 1981, *7*, 261-267.

5. Just, G. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1901, *37*, 342.

6. Skirrow, F.W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139.

7. Makranczy, J.; Rusz, L.; Balog-Megyery, K. *Hung. J. Ind. Chem.* 1979, *7*, 41.

8. Brunner, E.; Hultenschmidt, W.; Schlichtharle, G. *J. Chem. Thermodyn.* 1987, *19*, 273.

9. Kruis, A.; Scholz, W. *Linde Ber. Tech. Wiss.* 1964, *17*, 15.

10. Gjaldbaek, J. Chr. *Kgl. Danske Videnskab. Selskab., Mat-fys. Medd.* 1948, *24*, No.13.

11. Battino, R.; Evans, F.D.; Danforth, W.F.; Wilhelm, E. *J. Chem. Thermodyn.* 1971, *3*, 743.

12. Tonner, S.D.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W. *J. Chem. Eng. Data,* 1983 *28*, 59.

13. Wilcock, R.J.; Battino, R.; Danforth, W.F.; Wilhelm, E. *J. Chem. Thermodyn.* 1978, *10*, 817.

14. Cauquil, G. J. *J. Chim. Phys.* 1927, *24*, 53.

15. Luther, I.H.; Hiemenz, W. *Chem. Ing. Tech.* 1957, *29*, 530.

16. Lühring, P.; Schumpe, A. *J. Chem. Eng. Data* 1989, *34*, 250.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methanol; CH_3OH; [67-56-1]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	3.08	0.171	0.1830
298.15	3.25	0.179	0.1955

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Methanol. No information.

ESTIMATED ERROR:

$\delta L/L$ = 0.03 (compiler)

REFERENCES:

1. Timofejew, W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. Steiner, P. *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methanol; CH_4O; [67-56-1]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. Chr.

Kgl. Danske Videnskab. Selskab., Mat.-fys. Medd. 1948, *24*, No. 13, 16 pp.

VARIABLES:

$T/K = 293.0 - 322.9$
$p_1/\text{kPa} = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
293.0	3.80	0.210	0.225
293.1	3.74	0.207	0.222
293.2	3.77	0.209	0.224
302.1	3.71	0.203	0.224
307.3	3.85	0.210	0.236
308.3	3.71	0.202	0.228
312.6	3.76	0.203	0.232
321.9	3.82	0.204	0.240
322.9	3.95	0.211	0.249

Smoothed Data: For use between 293.0 and 322.9 K.

$$\ln x_1 = -7.5979 - 0.8566/(T/100\text{ K})$$

T/K	Mol Fraction $10^4 x_1$
298.15	3.76
308.15	3.80
318.15	3.83

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The degassed solvent and the gas are placed in a calibrated all-glass combined manometer and bulb enclosed in an air thermostat. The apparatus and contents are shaken until equilibrium. Mercury is used for calibration and as the confining liquid. The solvent is degassed in the apparatus.

The absorbed volume of gas is calculated from the initial and final amounts of gas,both saturated with solvent vapor.The amount of solvent is determined by the weight of displaced mercury. Details in ref. 1,2.

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5 % CO and 0.5 % nitrogen (no CO_2 or O_2).

(2) Methanol. Dehydrated with magnesium. B.p./°C = 64.7, $\rho/\text{g cm}^{-3}(20\ ^\circ\text{C}) = 0.7916$.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.
2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Methanol; CH_4O; [67-56-1]	ORIGINAL MEASUREMENTS: Makranczy, J.; Rusz, L.; Balog-Megyery, K. *Hung. J. Ind. Chem.* 1979, *7*, 41-6
VARIABLES: T = 298.15 K p = 101.3 kPa	PREPARED BY: C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO}
298.15	101.3	0.199	0.000331

* calculated by compiler

\+ partial pressure of carbon monoxide.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given

ESTIMATED ERROR:

$\delta x_{CO} = \pm 3\%$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos. G. *Veszpremi Vegyip. Egy. Kozl* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Methanol; CH_4O; [67-56-1]	ORIGINAL MEASUREMENTS: Lühring, P.; Schumpe, A. *J. Chem. Eng. Data* 1989, *34*, 250-252.
VARIABLES: T = 293.2 K p_1 = 101.3 kPa (1 atm)	PREPARED BY: R.W. Cargill

EXPERIMENTAL VALUES:

Temperature = 293.2K

Henry's constant H/kPa m^3 mol^{-1}	Bunsen coefficient* α/cm^3 (STP) cm^{-3} atm^{-1}	mol fraction solubility* at 101.3 kPa, $10^4 x_1$
12.10	0.188	3.38

* calculated by compiler, assuming ideal gas behaviour and that Henry's law is obeyed; also that the density of methanol at 293.2 K is 0.7917 g cm^{-3}

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A barometric method of measurement (reference 1). A glass vessel containing 349.6 cm^3 liquid and 589.9 cm^3 gas, divided by a perforated glass plate, was stirred magnetically. Liquid was previously degassed by evacuation. Dry gas was admitted, and the pressure decrease monitored by a micromanometer. Saturation was achieved within 3-6 minutes.

Reported value is mean of 3 determinations.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) Methanol: from Merck, "highest available purity".

ESTIMATED ERROR:

$\Delta T = \pm 0.1$K

$\delta x/x = \pm 2\%$ (authors)

REFERENCES:

1. Schumpe, A.; Quicker, G.; Deckwer, W.D. *Adv. Biochem. Eng.* 1982, *24*, 1.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methanol; CH_4O; [67-56-1]

Ethanol; C_2H_6O; [64-17-5]

1,2,3-Propanetriol; $C_3H_8O_3$; [56-81-5]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
Methanol			
298.15	3.26	0.180	0.196
Ethanol			
298.15	4.60	0.176	0.192
1,2,3-Propanetriol or glycerol			
298.15	----	----	very small

The Bunsen coefficient and the mole fraction values were calculated by the compiler assuming ideal gas behavior. The values are adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) assuming Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of the liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the solvent volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Methanol.
Ethanol.
1,2,3-Propanetriol.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS: (1) Carbon monoxide; CO; [630-08-0] (2) Ethanol; C_2H_5OH; [64-17-5]	ORIGINAL MEASUREMENTS: **Just, G.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1901, *37*, 342-67.
VARIABLES: T/K = 293.15, 298.15 p_1/kPa = 101.325 (1 atm)	PREPARED BY: M. E. Derrick H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	4.61	0.177	0.1901
298.15	4.61	0.176	0.1921

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Ethanol. Source not given. Stated to be 99.8 per cent.

ESTIMATED ERROR:

$\delta L/L$ = 0.03 (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Ethanol; C_2H_6O; [64-17-5]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. Chr.

Kgl. Danske Videnskab. Selskab., Mat.-fys. Medd. 1948, *24*, No. 13, 16 pp.

VARIABLES:

T/K = 293.1 - 323.3
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/\text{cm}^3\,(\text{STP})\,\text{cm}^{-3}\,\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\,\text{cm}^{-3}$
293.1	4.88	0.187	0.201
293.4	4.93	0.189	0.203
293.8	4.87	0.187	0.201
302.0	4.85	0.184	0.203
302.9	4.89	0.186	0.206
306.8	4.90	0.185	0.208
311.0	4.92	0.185	0.211
311.9	4.91	0.185	0.211
321.0	4.89	0.182	0.214
323.3	4.94	0.183	0.217

Smoothed Data: For use between 293.1 and 323.3 K.

$$\ln x_1 = -7.5543 - 0.2053/(T/100\ \text{K})$$

T/K	Mol Fraction 10^4x_1
298.15	4.89
308.15	4.90
318.15	4.91

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The degassed solvent and the gas are placed in a calibrated all-glass combined manometer and bulb enclosed in an air thermostat. The apparatus and contents are shaken until equilibrium. Mercury is used for calibration and as the confining liquid. The solvent is degassed in the apparatus.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Details in ref. 1,2.

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO and 0.5% nitrogen (no CO_2 or O_2).

(2) Ethanol. Dehydrated with magnesium. B.p./°C = 78.3, ρ/g cm^{-3} (20°C) = 0.7892.

ESTIMATED ERROR:

δT/K = ± 0.05
$\delta x_1/x_1$ = ± 0.015

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Ethanol; C_2H_6O; [64-17-5]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Rusz, L.; Balog-Megyery, K.

Hung. J. Ind. Chem. 1979, *7*, 41-6

VARIABLES:

T = 298.15 K
p = 101.3 kPa

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO}
298.15	101.3	0.183	0.000439

* calculated by compiler

\+ partial pressure of carbon monoxide

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai, and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given

ESTIMATED ERROR:

$\delta x_{CO} = \pm 3\%$

REFERENCES:

1. Bodor, E.; Bor, Gy,; Mohai, B.; Sipos, G.
Veszpremi Vegyip. Egy. Kozl. 1957, *1*, 55.
Chem. Abstr. 1961, *55*, 3175h

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Propanol; C_3H_8O; [71-23-8]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. Chr.

Kgl. Danske Videnskab. Selskab., Mat.-fys. Medd. 1948, *24*, No. 13, 16 pp.

VARIABLES:

$T/K = 293.1 - 323.1$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
293.1	5.51	0.165	0.177
293.1	5.51	0.165	0.177
307.9	5.47	0.161	0.181
308.1	5.47	0.161	0.182
323.1	5.57	0.162	0.192
323.1	5.48	0.159	0.188

Smoothed Data: For use between 293.1 and 323.1 K.

$$\ln x_1 = -7.4802 - 0.0771/(T/100\ K)$$

T/K	Mol Fraction $10^4 x_1$
298.15	5.495
308.15	5.50
318.15	5.505

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The degassed solvent and the gas are placed in a calibrated all-glass combined manometer and bulb enclosed in an air thermostat. The apparatus and contents are shaken until equilibrium. Mercury is used for calibration and as the confining liquid. The solvent is degassed in the apparatus.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Details in ref. 1,2.

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO and 0.5% nitrogen (no CO_2 or O_2).

(2) 1-Propanol. Dehydrated with magnesium. B.p./°C = 97.2, ρ/g cm^{-3}(20°C) = 0.8038.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$

$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1-Propanol; C_3H_8O; [71-23-8]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Rusz, L.; Balog-Megyery, K.

Hung. J. Ind. Chem. 1979, *7*, 41-6.

VARIABLES:

T = 298.15 K
p = 101.3 kPa

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO}
298.15	101.3	0.170	0.000522

* calculated by compiler

\+ partial pressure of carbon monoxide

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai, and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta x_{CO} = \pm 3\%$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B. Sipos, G.
Veszpremi Vegyip. Egy. Kozl. 1957, *1*, 55.
Chem. Abstr. 1961, *55*, 3175h

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Propanol; C_3H_8O; [67-63-0]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. Chr.

Kgl. Danske Videnskab. Selskab., Mat.-fys. Medd. 1948, *24*, No. 13, 16 pp.

VARIABLES:

T/K = 293.1 - 324.3
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.1	6.05	0.177	0.190
293.1	6.05	0.177	0.190
308.2	6.03	0.174	0.196
324.3	6.16	0.174	0.207

Smoothed Data: For use between 293.1 and 342.3 K.

$$\ln x_1 = -7.2500 - 0.4762/(T/100\ \mathrm{K})$$

T/K	Mol Fraction $10^4 x_1$
298.15	6.05
308.15	6.08
318.15	6.11

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The degassed solvent and the gas are placed in a calibrated all-glass combined manometer and bulb enclosed in an air thermostat. The apparatus and contents are shaken until equilibrium. Mercury is used for calibration and as the confining liquid. The solvent is degassed in the apparatus.

The absorbed volume of gas is calculated from the initial and final smounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Details in ref. 1,2.

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO and 0.5% nitrogen (no CO_2 or O_2).

(2) 2-Propanol. Distilled in a 50 plate wire-gauze column. B.p./°C = 82.4, ρ(20°C)/g cm^{-3} = 0.7859.

ESTIMATED ERROR:

δT/K = ± 0.05
$\delta x_1/x_1$ = ± 0.015

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Butanol; $C_4H_{10}O$; [71-36-3]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. Chr.

Kgl. Danske Videnskab. Selskab., Mat.-fys. Medd. 1948, *24*, No. 13, 16 pp.

VARIABLES:

T/K = 292.9 - 323.0
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
292.9	6.29	0.154	0.165
293.0	6.25	0.153	0.164
293.0	6.25	0.153	0.164
293.1	6.24	0.153	0.164
293.1	6.28	0.154	0.165
308.2	6.17	0.149	0.168
308.8	6.23	0.150	0.170
308.8	6.19	0.149	0.168
322.9	6.14	0.146	0.173
323.0	6.14	0.146	0.173

Smoothed Data: For use between 292.9 and 323.0 K.

$$\ln x_1 = -7.5867 + 0.6180/(T/100\ \text{K})$$

T/K	Mol Fraction $10^4 x_1$
298.15	6.24
308.15	6.20
318.15	6.16

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The degassed solvent and the gas are placed in a calibrated all-glass combined manometer and bulb enclosed in an air thermostat. The apparatus and contents are shaken until equilibrium. Mercury is used for calibration and as the confining liquid. The solvent is degassed in the apparatus.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Details in ref. 1,2.

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO and 0.5% nitrogen (no CO_2 or O_2).

(2) 1-Butanol. Distilled in a 50 plate column. B.p./°C = 117.8.

ESTIMATED ERROR:

δT/K = ± 0.05
$\delta x_1/x_1$ = ± 0.015

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. 1-Butanol; $C_4H_{10}O$; [71-36-3]	ORIGINAL MEASUREMENTS: Makranczy, J.; Rusz, L.; Balog-Megyery, K. *Hung. J. Ind. Chem.* <u>1979</u>, *7*, 41-6.
VARIABLES: T = 298.15 K p = 101.3 kPa	PREPARED BY: C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO}
298.15	101.3	0.145	0.000545

* calculated by compiler

\+ partial pressure of carbon monoxide.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai, and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta x_{CO} = \pm 3\%$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G.
Veszpremi Vegyip. Egy. Kozl. <u>1957</u>, *1*, 55.
Chem. Abstr. <u>1961</u>, *55*, 3175h

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Butanol or *sec*-butyl alcohol; $C_4H_{10}O$; [78-92-2]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.

Acta Chem. Scand. 1948, *2*, 683 - 692.

VARIABLES:

$T/K = 293.20 - 323.40$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
293.20	6.42	0.156	0.168
293.25	6.26	0.153	0.164
308.55	6.37	0.153	0.173
308.65	6.26	0.150	0.170
323.13	6.42	0.152	0.180
323.40	6.28	0.149	0.176

The mole fraction and Ostwald coefficient values were calculated by the compiler.

Smoothed Data: For use between 293.20 and 323.40 K.

$$\ln x_1 = -7.3518 - 0.0386/(T/100\ K)$$

T/K	Mol Fraction $10^4 x_1$
298.15	6.33
308.15	6.33
318.15	6.34

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99% CO, the rest being atmospheric air.

(2) 2-Butanol. Distilled in a 50 plate wire-gauze column. B.p. (760 mmHg)/°C = 99.5.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$

$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.
2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Methyl-1-propanol or isobutyl alcohol; $C_4H_{10}O$; [78-83-1]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. Chr.

Kgl. Danske Videnskab. Selskab., Mat.-fys. Medd. 1948, *24*, No. 13, 16 pp.

VARIABLES:

T/K = 293.1 - 323.1

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
293.1	6.69	0.162	0.174
293.1	6.65	0.161	0.173
308.1	6.62	0.158	0.178
308.1	6.65	0.159	0.179
322.9	6.65	0.157	0.186
323.1	6.68	0.157	0.186

Smoothed Data: For use between 293.1 and 323.1 K.

$$\ln x_1 = -7.3240 + 0.0286/(T/100\ \text{K})$$

T/K	Mol Fraction 10^4x_1
298.15	6.66
308.15	6.66
318.15	6.65

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The degassed solvent and the gas are placed in a calibrated all-glass combined manometer and bulb enclosed in an air thermostat. The apparatus and contents are shaken until equilibrium. Mercury is used for calibration and as the confining liquid. The solvent is degassed in the apparatus.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Details in ref. 1,2.

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO and 0.5% nitrogen (no CO_2 or O_2).

(2) 2-Methyl-1-propanol. Distilled in a 50 plate column. B.p./°C = 107.9.

ESTIMATED ERROR:

δT/K = ± 0.05

$\delta x_1/x_1$ = ± 0.015

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.
2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Methyl-1-propanol or isobutyl alcohol; C_4H_9OH; [78-83-1]

ORIGINAL MEASUREMENTS:

Battino, R.; Evans, F. D.; Danforth, W. F.; Wilhelm, E.

J. Chem. Thermodyn. 1971, *3*, 743 - 751.

VARIABLES:

T/K: 274.05 - 327.96
P/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α^1	Ostwald Coefficient $L/cm^3\ cm^{-3}$
274.05	6.83	0.168	0.169
282.86	6.74	0.165	0.171
282.92	6.69	0.164	0.170
295.83	6.48	0.157	0.170
297.63	6.60	0.159	0.174
308.36	6.50	0.155	0.175
312.75	6.39	0.152	0.174
314.13	6.38	0.151	0.174
327.96	6.09	0.143	0.172

[1] $\alpha/cm^3(STP)\ cm^{-3}\ atm^{-1}$. The Bunsen coefficients were calculated by the compiler.

Smoothed Data: For 273.15 to 328.15 K.

$$\ln x_1 = -7.8969 + 1.6763/(T/100K)$$

The standard error about the regression line is 7.18×10^{-6}.

T/K	Mol Fraction $10^4 x_1$
278.15	6.79
288.15	6.65
298.15	6.525
308.15	6.41
318.15	6.30
328.15	6.20

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. The Matheson Co., Inc. Commercial grade stated to be better than 99 mol per cent.

(2) 2-Methyl-1-propanol. Fisher Co. Certified grade (99 mol per cent).

ESTIMATED ERROR:

$\delta T/K = \pm 0.03$
$\delta P/mmHg = \pm 0.5$
$\delta X_1/X_1 = \pm 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Methyl-2-propanol or *t*-butyl alcohol; $C_4H_{10}O$; [75-65-0]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.

Acta Chem. Scand. 1948, *2*, 683 - 692.

VARIABLES:

$T/K = 300.71 - 323.43$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
300.71	7.50	0.176	0.194
300.90	7.53	0.177	0.195
308.72	7.84	0.182	0.206
308.75	7.92	0.184	0.208
323.13	8.40	0.191	0.226
323.43	8.44	0.192	0.227

The mole fraction and Ostwald coefficient values were calculated by the compiler.

Smoothed Data: For use between 300.71 and 323.43 K.

$$\ln x_1 = -5.7924 - 4.1670/(T/100\ K)$$

T/K	Mol Fraction 10^4x_1
303.15	7.72
313.15	8.06
323.15	8.40

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99 % CO, the rest being atmospheric air.

(2) 2-Methyl-2-propanol. Distilled in a 50 plate wire-gauze column. B.p. (760 mmHg)/°C = 82.4, m.p./°C = 25.6

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$

$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [124-38-9]

(2) 1-Pentanol; $C_5H_{12}O$; [71-41-0]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3\text{(STP)cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
293.15	7.71	0.159	0.1706
298.15	7.61	0.157	0.1714

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) 1-Pentanol. No information.

ESTIMATED ERROR:

$\delta L/L$ = 0.03 (compiler)

REFERENCES:

1. Timofejew, W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. Steiner, P. *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1-Pentanol; $C_5H_{12}O$; [71-41-0]
   or
   1-Hexanol; $C_6H_{14}O$; [111-27-3]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Rusz, L.; Balog-Megyery, K.

Hung. J. Ind. Chem. 1979, *7*, 41-6

VARIABLES:

T = 298.15 K
p = 101.3 kPa

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO}
		1-Pentanol	
298.15	101.3	0.131	0.000581
		1-Hexanol	
298.15	101.3	0.124	0.000634

* calculated by compiler

\+ partial pressure of carbon monoxide

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai, and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given

ESTIMATED ERROR:

δx_{CO} = ±3%

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G.
Veszpremi Vegyip. Egy. Kozl. 1957, *1*, 55.
Chem. Abstr. 1961, *55*, 3175h

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1-Heptanol; $C_7H_{16}O$; [111-70-6]

or

1-Octanol; $C_8H_{18}O$; [111-87-5]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Rusz, L.; Balog-Megyery, K.

Hung. J. Ind. Chem. 1979, *7*, 41-6.

VARIABLES:

T = 298.15 K
p = 101.3 kPa

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO}
		1-Heptanol	
298.15	101.3	0.120	0.000695
		1-Octanol	
298.15	101.3	0.116	0.000751

* calculated by compiler

\+ partial pressure of carbon monoxide.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai, and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta x_{CO_2} = \pm 3\%$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Octanol; $C_8H_{17}OH$; [111-87-5]

ORIGINAL MEASUREMENTS:

Wilcock, R. J.; Battino, R.; Danforth, W. F.; Wilhelm, E.

J. Chem. Thermodyn. 1978, *10*, 817 - 822.

VARIABLES:

T/K: 282.94, 298.05
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3\text{(STP) cm}^{-3}\text{ atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{ cm}^{-3}$
282.94	8.456	0.1213	0.1256
298.05	8.490	0.1202	0.1312

The Bunsen coefficients were calculated by the compiler.

It is assumed that the gas is ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum mole per cent purity stated to be 99.5.

(2) 1-Octanol. Eastman Organic Chemicals. Distilled, density at 298.15 K, $\rho/\text{g cm}^{-3}$ 0.8247.

ESTIMATED ERROR:

$\delta T/K = 0.02$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.01$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1-Nonanol; $C_9H_{20}O$; [143-08-8]
   or
   1-Decanol; $C_{10}H_{22}O$; [112-30-1]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Rusz, L.;
Balog-Megyery, K.

Hung. J. Ind. Chem. 1979, *7*, 41-6.

VARIABLES:

T = 298.15 K
P = 101.3 kPa

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO}
		1-Nonanol	
298.15	101.3	0.111	0.000793
		1-Decanol	
298.15	101.3	0.109	0.000852

* calculated by compiler

\+ partial pressure of carbon monoxide

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai, and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given

ESTIMATED ERROR:

$\delta x_{CO_2} = \pm 3\%$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G.
   Veszpremi Vegyip. Egy. Kozl. 1957, *1*, 55.
   Chem. Abstr. 1961, *55*, 3175h

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Decanol; $C_{10}H_{21}OH$; [112-30-1]

ORIGINAL MEASUREMENTS:

Wilcock, R. J.; Battino, R.; Danforth, W. F.; Wilhelm, E.

J. Chem. Thermodyn. 1978, *10*, 817 - 822.

VARIABLES:

T/K: 298.16, 313.56
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm³ (STP) cm⁻³ atm⁻¹	Ostwald Coefficient L/cm³ cm⁻³
298.16	9.640	0.1129	0.1232
313.56	9.827	0.1136	0.1304

The Bunsen coefficients were calculated by the compiler.

It is assumed that the gas ideal and that Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm³ of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Minimum mole per cent purity stated to be 99.5.

(2) 1-Decanol. Eastman Organic Chemicals. Distilled, density at 298.15 K, ρ/g cm⁻³ 0.8206.

ESTIMATED ERROR:

$\delta T/K = 0.02$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.01$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1-Undecanol; $C_{11}H_{24}O$; [112-42-5]

or

1-Dodecanol; $C_{12}H_{26}O$; [112-53-5]

ORIGINAL MEASUREMENTS:

Makranczy, J.; Rusz, L.; Balog-Megyery, K.

Hung. J. Ind. Chem. 1979, *7*, 41-6.

VARIABLES:

T = 298.15 K
p = 101.3 kPa

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P^+/kPa	Ostwald coefficient	Mole fraction of carbon monoxide*, x_{CO_2}
		1-Undecanol	
298.15	101.3	0.105	0.000750
		1-Dodecanol	
298.15	101.3	0.103	0.000805

* calculated by compiler

\+ partial pressure of carbon monoxide.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric method. The apparatus of Bodor, Bor, Mohai, and Sipos (1) was used.

SOURCE AND PURITY OF MATERIALS:

No details given

ESTIMATED ERROR:

$\delta x_{CO_2} = \pm 3\%$

REFERENCES:

1. Bodor, E.; Bor, Gy.; Mohai, B.; Sipos, G. *Veszpremi Vegyip Egy. Kozl.* 1957, *1*, 55. *Chem. Abstr.* 1961, *55*, 3175h

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Cyclohexanol; $C_6H_{12}O$; [108-93-0]	Cauquil, G. *J. Chim. Phys.* 1927, *24*, 53-55.
VARIABLES: T/K = 299 p_1/kPa = 102	PREPARED BY: H. L. Clever

EXPERIMENTAL VALUES:

The author states that one liter of cyclohexanol absorbs 894 cm^3 carbon monoxide at 26 ^0C and 766 mmHg.

The compiler calculates an Ostwald coefficient of $L/cm^3\ cm^{-3}$ = 0.894 and a mole fraction solubility of $x_1 = 3.77 \times 10^{-3}$ at 299 K and a gas partial pressure of 101.325 kPa (1 atm).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
The apparatus appears to be of the Bunsen type. The initial and final volumes of gas in contact with the liquid were measured. The vapor pressure of the liquid was ignored.	(1) Carbon monoxide. No information. (2) Cyclohexanol. Distilled, boiling point 160.9 ^0C at 766 mmHg. Degassed and tested to be air free.
	ESTIMATED ERROR: $\delta L/L = \pm\ 0.05$ (compiler)
	REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1-Decanol; $C_{10}H_{22}O$; [112-30-1]
3. 1-Dodecanol; $C_{12}H_{26}O$; [112-53-5]

ORIGINAL MEASUREMENTS:

Luther, H.; Hiemenz, W.

Chemie. Ing. Techn. 1957, *29*, 530-535.

VARIABLES:

T/K: 293.15; various pressures;

PREPARED BY:

E. Wilhelm

EXPERIMENTAL VALUES:

For carbon monoxide dissolved in an equimolar mixture of 1-decanol with 1-dodecanol ($x_2 = x_3 = 0.5$, solute-free). Solubility measurements were performed between 0.1kPa and 93kPa, yet only the Henry's Law Constant derived therefrom was presented by the authors.

T/K	K_H/atm	K_H/MPa*	mol fraction solubility at 1atm, $10^3 x_1$
293.15	904	91.6	1.11

* calculated by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Degassed liquid is flowed slowly in a thin film down a glass spiral, thereby equilibrating rapidly with the gas (~1hour). Details in source.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no details given.

(2) n-Decanol: no details given.

(3) n-Dodecanol: no details given.

ESTIMATED ERROR:

$\delta K_H = \pm 7.5\%$

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) 1,2,3-Propanetriol or glycerine; $C_3H_8O_3$; [56-81-5] (3) Methanol; CH_4O; [67-56-1]	Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.
VARIABLES:	PREPARED BY:
T/K = 298.2 p_1/kPa = 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

Temperature		1,2,3-Propanetriol		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.196
		39.6	30.1	0.0964
		60.5	50.1	0.0515
		77.1	68.9	0.0246
		100	100	very small

The author also reported the vapor pressure of the solvents.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) 1,2,3-Propanetriol.
(3) Methanol.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001 (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methanol; CH_4O; [67-56-1]

(3) Trichloromethane or chloroform; $CHCl_3$; [67-66-3]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Methanol	Ostwald Coefficient
$t/°C$	T/K	$10^2\phi_2/\text{vol}$ %	L/cm^3cm^{-3}
25.0	298.2	0.0	0.207
		13	0.202
		100	0.196

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Methanol.
(3) Trichloromethane.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alcohols

EVALUATOR:

Robert W. Cargill,
Department of Molecular
and Life Sciences,
Dundee Institute of Technology,
Bell Street, Dundee DD1 1HG, U.K.

April 1989

CRITICAL EVALUATION:

The Solubility of Carbon Monoxide at High Pressures in Alcohols

Methanol; CH_4O; [67-56-1]

Five different papers contain data on the solubility of carbon monoxide in methanol at elevated pressures, and there is fairly good agreement among most of the values. The recommended data are those by Brunner *et al.*(1), which also cover the widest ranges of temperature and pressure. A comparison of the various conditions, and standardised values of the mol fraction solubility x_1 for a pressure of 1 MPa at 298 K from each paper, are given in Table 1. To obtain these standardised values of x_1, each author's datum for the pressure p_1 nearest to 1 MPa was selected and the value divided by p_1. This assumes that Henry's law is valid over this pressure range, an assumption borne out by an analysis of the pressure dependence of most of these data.

Table 1. Solubility of carbon monoxide in methanol

authors		*T*/K	*p*/MPa	$10^3 x_1$ at 1 MPa and 298 K
Krichevskii	(2)	298-413	6-30	3.16
Granzhan	(3)	298-348	5.06	3.28
Tonner	(6)	298,323	1-4	3.2
Dake	(4)	298-448	2-7	3.58
Brunner	(1)	298-498	2-100.7	3.56
Gjaldbaek	(5)	293-323	0.101	3.76

The data of Krichevskii *et al.*(2) and of Granzhan (3) are low by about 11% and 8% respectively compared to these of Brunner *et al.*, which agree with the values of Dake and Chaudhari (4) over their pressure range of 2-7 MPa. Extrapolation of reliable measurements made by Gjaldbaek (5) at 101.3 kPa gives a somewhat higher value. Note that the data from Dake and Chaudhari appear in the water + organic solvent section earlier in this volume. The data of Tonner *et al.*(6) at 298 K and 323 K are classed as doubtful. The pressure dependence of their values appears to be too great. They obtained the solubilities by a chromatographic method, which is usually found to be unsuitable for accurate solubility measurements. The Henry's Law coefficients given on the data sheets from their work are based on data of low accuracy, and may be in error by up to 20%. It should also be noted that in the original paper a wrong multiplying constant was given, which has been corrected on the data sheet.

Krichevskii *et al.*(2) have provided data which may be accepted tentatively for three mixtures of carbon monoxide and hydrogen gases dissolving into methanol over 303-413 K, and at total pressures in the range 5-30.3 MPa.

Ethanol; C_2H_6O; [64-17-5]

There is some disagreement between the values from Tonner *et al.*(6) and those from Dake and Chaudhari (4) for this solvent. The former set of solubility values are higher but may be in error for reasons explained above (for methanol solvent). There is also an inconsistency on the data sheet derived from Tonner *et al.*, where as T increases both K and x_1 at a given pressure decrease. Clearly this cannot be the case if, as they assume, $p = Kx_1$.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology. Bell Street, Dundee DD1 1HG, U.K. April 1989

CRITICAL EVALUATION:

The data of Dake and Chaudhari may be accepted tentatively for this solvent, although there is a possibility that their values could be a little low due to contamination of their samples of ethanol with water. These values appear on a data sheet in the earlier water + organic solvent section of this volume, since they are part of a wider study of the three-component system, carbon monoxide-ethanol-water.

1-Propanol; C_3H_8O; [71-23-8] 2-Propanol; C_3H_8O; [67-63-0]

1-Butanol; $C_4H_{10}O$; [71-36-3] 2-Butanol; $C_4H_{10}O$; [78-92-2]

2-Methyl-1-propanol; $C_4H_{10}O$; [78-83-1]

2-Methyl-2-propanol; $C_4H_{10}O$; [75-65-0]

The only data on carbon monoxide in these solvents at pressures above 1 atm are those of Tonner *et al.*(6). In the light of previous comments, and also because extrapolation of reliable values at 101.3 kPa to 1-4 MPa give significantly lower values in each case, it is believed that these data of Tonner *et al* are doubtful, probably about 20% too high.

2-Propen-1-ol (allyl alcohol); C_3H_6O; [107-18-6]

Taqui Khan and Halligudi (7) measured the solubility of carbon monoxide in mixtures of this unsaturated alcohol with water at about 3 MPa over 373-403 K. Data for solubility in allyl alcohol itself were obtained, and may be read in the water + organic solvent section of this volume. Like in other alcohols, the solubility of carbon monoxide increases with temperature under these conditions. The data should be used with great caution, however, because the values for carbon monoxide in water from this series of experiments differed somewhat from other published data.

Isodecanol; $C_{10}H_{22}O$; [25339-17-7]

C_{12}-C_{15} alcohols mixture

Tyvina *et al.*(8) and Naumova *et al.*(9) studied the solubility of carbon monoxide in these solvents at 313-553 K and 5-30 MPa, in work related to investigations of the "oxo" process. Their results are in the form of mol fractions of the components in the liquid and vapor phases, and the values may be accepted tentatively although further confirmation is necessary for their unequivocal acceptance. Loktev *et al.* (10) also measured the solubility of carbon monoxide along with hydrogen and ethyne in the C_{12}-C_{15} alcohols mixture over similar temperatures and pressures by a different technique. Their data are given in Volume 5-6 of this series (11), and for carbon monoxide, the solubility values are similar to those of Naumova *et al.*, and help to confirm them.

If the English translation of the paper by Naumova *et al.*(9) is consulted, it should be noted that the pressure unit given is "gPa" which is a transliteration of a Russian symbol meaning hectopascal, i.e. 10^2Pa. It was wrongly transcribed into GPa (to indicate gigapascal) in *Chemical Abstracts 95*, 176660.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Alcohols	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. April 1989

CRITICAL EVALUATION:

1. Brunner, E.; Hultenschmidt, W.; Schlichtharle, G.
   J. Chem. Thermodyn. 1987, *19*, 273.

2. Krichevskii, I.R.; Zhavoronkov, N.M.; Tskilis, D.S.
   Zh. Fis. Chim. (U.S.S.R.) 1937, *9*, 317.

3. Granzhan, V.A.;
   Tr. Gos. Nauchno-Issled Proektn. Inst. Prom-sti Org. Synt. 1974, *27*, 5.

4. Dake, S.B.; Chaudhari, R.V.
   J. Chem. Eng. Data, 1985, *30*, 400.

5. Gjaldbaek, J. Chr.
   Kgl. Danske Videnskab Selskab, Mat.-fys. Medd, 1948, 24, No.13.

6. Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.
   J. Chem. Eng. Data, 1983, *28*, 59.

7. Taqui Khan, M.M.; Halligudi, S.B.
   J. Chem. Eng. Data 1988, *33*, 276.

8. Tyvina, T.N.; Fokina, V.V.; Naumova, A.A.; Polyakov, A.A.
   Zh. Prikl. Khim. 1984, *57*, 2101.
   J. Appl. Chem. USSR, 1984, *57*, 1942.

9. Naumova, A.A.; Polyakov, A.A.; Tyvina, T.N.; Fokina, V.V.
   Zh. Prikl. Khim. 1981, *54*, 2014.
   (*J. Appl. Chem. USSR* 1981, *54*, 1761)

10. Loktev, S.M.; Androsov, D.I.; Zuev, A.A.
    Zh. Prikl. Khim. 1978 *51*, 2023.
    (*J. Appl. Chem. USSR* 1978, 51, 2023)

11. Solubility Data Series, Volume 5-6, HYDROGEN and DEUTERIUM, *Pergamon Press* 1981, 471-474.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Methanol; CH_4O; [67-56-1]

ORIGINAL MEASUREMENTS:

Krichevskii, I.R.;
Zhavoronkov, N.M.; Tsiklis, D.S.

Zh. Fis. Chim (USSR) (J. Phys. Chem. USSR) 1937, *9*, 317-328

VARIABLES:

T/K = *298 - 413*
p_1/MPa = 5-31

PREPARED BY:

Yu. P. Yampol'skii
R.W. Cargill

EXPERIMENTAL VALUES:

T/K	p_1/atm	p_1/MPa*	Solubility	
			cm^3(STP) g^{-1}	$10^2 x_1$*
298.2	60	6.08	13.6	1.90
	67	6.79	15.5	2.17
	110	11.1	26.0	3.58
	180	18.2	41.2	5.56
	186	18.8	41.4	5.58
	241	24.4	57.3	7.56
	243	24.6	58.4	7.70
363.2	50	5.07	15.0	2.10
	100	10.1	28.5	3.91
	150	15.2	38.9	5.26
	200	20.2	48.2	6.44
	250	25.3	55.8	7.38
	300	30.3	62.1	8.15
413.2	86	8.71	27.8	3.82
	90	9.12	29.4	4.03
	145	14.7	45.8	6.14
	291	29.5	70.0	9.09

* calculated by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: purity 99.9%

(2) Methanol: purity 99.3% (main impurity water); density 0.794 g cm^{-3} at 20°C.

ESTIMATED ERROR:

p_1 = ± 2atm; *T* = ± 0.1 (at 25°C), ± 0.5 (at 90°C), ± 1° (at 140°C). $\delta x_1/x_1$ < 1% (300 atm), < 3% (60-70 atm)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Methanol; CH_4O; [67-56-1]

ORIGINAL MEASUREMENTS:

Granzhan, V.A.

Tr. Gos. Nauchno-Issled. Proektn. Inst. Prom-sti Org. Synt. 1974, *27*, 5-9.

VARIABLES:

$T/K = 298-348$
$P_1/MPa = 5.06$

PREPARED BY:

Yu.P.Yampol'skii

EXPERIMENTAL VALUES:

	Solubility at P_1 = 5.06 MPa	
T/K	$cm^3(STP)\ g^{-1}$	10^2x_1
298	11.8	1.66
323	12.7	1.78
348	14.6	2.04

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Measurements were made in the apparatus originally described in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon Monoxide. Purity ⩾99.9%

(2) Methanol. "Pure for analysis".

ESTIMATED ERROR:

Solubility: ± 5%
Pressure ± 1 atm (± 2%)

REFERENCES:

1. Krichevskii, I.R.; Zhavoronkov, N.M.; Tskilis, D.S.

Zh. fis. chim (USSR), 1937, *9*, 317.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Methanol; CH_4O; [67-56-1]

ORIGINAL MEASUREMENTS:

Tonner, S. P.; Wainwright, M. S.; Trimm, D. L.; Cant, N. W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323

p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever
C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction $10^2 x_1$	Henry's Constant $10^{-5} K$/kPa
298	1000	0.32	
	2000	0.84	
	3000	1.32	
	4000	1.78	
			2.06
323	1000	0.33	
	2000	0.83	
	3000	1.28	
	4000	1.73	
			2.15

Henry's constant, K/kPa = $(p_1/\text{kPa})/x_1$.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 μL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 cm^3 m^{-1}) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) Methanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1
δp/kPa = ± 10
$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Methanol; CH_4O; [67-56-1]

ORIGINAL MEASUREMENTS:

Brunner, E.; Hultenschmidt, W.; Schlichtharle, G.; *J. Chem. Thermodyn.*, 1987, *19*, 273-291.

VARIABLES:

T/K 298.15 - 498.75
P/MPa 2.1 - 101

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of CO in liquid	Density /kg m^{-3}	P/MPa	Mole fraction of CO in gas
298.15	2.282	0.00822	787	2.40	0.99109
	4.543	0.01640	789	3.60	0.99336
	6.879	0.02463	788	5.00	0.99476
	9.341	0.03273	791	5.50	0.99499
	14.49	0.04842	797	10.0	0.99643
	24.43	0.07684	802	20.0	0.99640
	33.10	0.09879	800	40.0	0.99640
	46.90	0.1298	806	60.0	0.99453
	84.90	0.2030	815	80.0	0.98912
	100.7	0.2323	813	100.0	0.98618
323.15	4.357	0.01561	764	5.0	0.98422
	6.528	0.02335	765	10.0	0.98954
	8.713	0.03102	767	20.0	0.99086
	11.24	0.03944	767	40.0	0.98827
	23.78	0.07790	769	60.0	0.98413
	37.30	0.1155	772	80.0	0.97921
	57.70	0.1667	777	100.0	0.97416
	81.70	0.2158	792		
	99.00	0.2539	794		
373.15	2.135	0.00714	711	10.0	0.93949
	4.006	0.01466	712	20.0	0.95385
	5.785	0.02163	713	30.0	0.95440

contd

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Two experimental methods were used. At medium to high pressures the dew and bubble points of a mixture of known composition were determined. Details of this method are given in source and ref. (1). At low mole fractions of methanol the composition of the mixture was determined by GC. In this technique several different methods were employed to obtain a representative sample. Details are given in the source.

SOURCE AND PURITY OF MATERIALS:

1. Messer-Griesheim sample, purity 99.97 mole per cent.
2. Merck sample, purity 99.95 mole per cent; mass of water equal or less than 0.015 mass per cent.

ESTIMATED ERROR:

REFERENCES:

1. Brunner, E.; Maier, S.; Windhaber, K.; *J. Phys. E.: Sci. Instrum.*, 1984, *17*, 44.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Methanol; CH_4O; [67-56-1]	Brunner, E.; Hultenschmidt, W.; Schlichtharle, G.; *J. Chem. Thermodyn.*, 1987, *19*, 273-291.

EXPERIMENTAL VALUES: (contd)

T/K	P/MPa	Mole fraction of CO in liquid	Density /kg m^{-3}	P/MPa	Mole fraction of CO in gas	Density /kg m^{-3}
373.15	7.668	0.02873	714	40.0	0.95039	
	9.38	0.03563	718	60.0	0.93708	
	11.31	0.03563	718	80.0	0.91909	
	15.01	0.05676	717	100.0	0.8944	
	18.64	0.07374	721			
	28.65	0.1064	724			
	37.90	0.1400	723			
	53.05	0.1900	727			
	73.80	0.2599	727			
	89.30	0.3132	724			
398.15	7.20	0.02915	680	7.28	0.8517	63.0
	16.18	0.06720	682	10.99	0.8846	95.0
	27.65	0.1174	680	19.55	0.90188	162
	44.40	0.1807	676	31.11	0.90761	241
	58.2	0.2402	674	40.38	0.90228	295
	70.7	0.3028	672	47.70	0.8980	
	86.2	0.3961	660	60.1	0.8705	397
	90.4	0.4338	660	66.7	0.8570	426
	93.1	0.4636	650	71.8	0.8459	446
	95.4	0.4851	635	76.2	0.8359	463
	96.0	0.5036				
423.15	7.15	0.02798	645	4.86	0.6320	43.5
	15.80	0.07021	638	8.62	0.7519	75.0
	23.60	0.1123	635	11.66	0.7964	99.7
	31.10	0.1518	630	12.15	0.8043	104
	40.30	0.1992	624	22.00	0.8043	179
	45.70	0.2370	616	27.33	0.8435	215
	51.00	0.3246	593	33.10	0.8361	253
	60.72	0.3886	577	45.00	0.8160	325
	63.2	0.4238	566	54.9	0.7723	391
	66.1	0.4875	551	65.3	0.6512	466
	66.4	0.5398	522	65.8	0.6306	483
	66.4a	0.540	518	66.3	0.5650	512
				66.4	0.5538	516
448.15	11.30	0.0518	595	5.97	0.4924	56.0
	18.47	0.09868	586	9.31	0.6176	85.0
	27.10	0.1571	575	13.22	0.6750	119
	36.24	0.2451	550	18.52	0.7093	161
	42.10	0.3368	510	24.50	0.7150	207
	43.33	0.3768	490	30.21	0.7020	252
	43.91	0.4240	462	35.20	0.6805	293
	43.91	0.4240	462	40.23	0.6264	342
	44.20a	0.460	442	43.48	0.5541	393
				44.00	0.5025	417
473.15	16.0	0.09194	514	7.83	0.3408	79.0
	21.9	0.1604	477	12.10	0.4718	121
	26.3	0.2469	429	16.72	0.5143	165
	27.5	0.2684	403	20.85	0.5179	206
	27.6a	0.3400	364	22.2	0.5179	218
				24.3	0.4906	247
498.75	9.85	0.03549	432	8.66	0.1167	129
	11.45	0.05422	419	9.80	0.1523	147
	12.9	0.07502	401	11.05	0.1784	166
	14.0	0.1023	365	12.30	0.1970	187
	14.52	0.1415	313	13.67	0.2013	219
	14.52a	0.150	305			

a = critical pressure

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrogen; H_2; [1333-74-0]
3. Methanol; CH_4O; [67-56-1]

ORIGINAL MEASUREMENTS:

Krichevskii, I.R.; Zhavoronkov, N.M.; Tskilis, D.S.

Zh. Fis. Chim (USSR) (J. Phys. Chem. USSR) 1937, 9, 317-328.

VARIABLES:

T/K = 303 - 413
Total pressure; 5 - 30.3 MPa

PREPARED BY:

Yu. P. Yampol'skii

EXPERIMENTAL VALUES:

Solute gas	Total pressure		Solubility of CO/cm^3 (STP) g^{-1}		
composition	p/atm	p/MPa	303.2 K	363.2 K	413.2 K
73% CO; 27% H_2	50	5.07	9.85		
	100	10.1	19.4		
	150	15.2	28.3		
	200	20.2	37.0		
	250	25.3	45.7		
	300	30.3	54.6		
68.7% CO; 31.3% H_2	50	5.07		9.47	9.22
	100	10.1		18.9	20.7
	150	15.2		28.1	32.0
	200	20.2		36.2	42.4
	250	25.3		43.4	51.7
	300	30.3		50.3	58.6
36.2% CO; 63.8%H_2	50	5.07	5.62	5.43	5.62
	100	10.1	10.2	11.1	12.0
	150	15.2	13.6	16.4	17.3
	200	20.2	16.5	20.1	21.6
	250	25.3	19.2	23.0	25.4
	300	30.3	21.8	31.6	28.7

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. purity 99.9%

(2) Methanol. purity 99.3% (main impurity water); density 0.794 g cm^{-3} at 20°C.

ESTIMATED ERROR:

p_1 = ± 2 atm; T = ± 0.1 (at 25°C), ± 0.5 (at 90°C), ± 1 (at 140°C). $\delta x_1/x_1$ <1% (300 atm), <3% (60-70 atm)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Ethanol; C_2H_6O; [64-17-5]

ORIGINAL MEASUREMENTS:

Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323
p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever
C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction 10^2x_1	Henry's Constant $10^{-5}K$/kPa
298	1000	0.53	
	2000	1.11	
	3000	1.65	
	4000	2.21	
			1.80
323	1000	0.50	
	2000	1.05	
	3000	1.64	
	4000	2.17	
			1.78

Henry's constant, K/kPa = $(p_1/\text{kPa})/x_1$.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting, and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 μL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 cm^3 m^{-1}) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) Ethanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1
δp/kPa = ± 10
$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Propanol; C_3H_8O; [71-23-8]

ORIGINAL MEASUREMENTS:

Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323
p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever
C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction 10^2x_1	Henry's Constant $10^{-5}K$/kPa
298	1000	0.67	
	2000	1.50	
	3000	2.41	
	4000	3.23	
			1.16
323	1000	0.60	
	2000	1.43	
	3000	2.33	
	4000	3.12	
			1.18

Henry's constant, K/kPa = $(p_1/\text{kPa})/x_1$.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting, and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 µL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 cm^3 m^{-1}) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) 1-Propanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1
δp/kPa = ± 10
$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Propanol; C_3H_8O; [67-63-0]

ORIGINAL MEASUREMENTS:

Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323
p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever
C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction 10^2x_1	Henry's Constant $10^{-5}K$/kPa
298	1000	0.71	
	2000	1.50	
	3000	2.26	
	4000	3.16	
			1.23
323	1000	0.69	
	2000	1.42	
	3000	2.23	
	4000	3.23	
			1.18

Henry's constant, K/kPa = $(p_1/\text{kPa})/x_1$.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting, and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 μL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 cm^3 m^{-1}) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) 2-Propanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1
δp/kPa = ± 10
$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1-Butanol; $C_4H_{10}O$; [71-36-3]

ORIGINAL MEASUREMENTS:

Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323

p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever

C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction 10^2x_1	Henry's Constant $10^{-5}K$/kPa
298	1000	0.64	
	2000	1.54	
	3000	2.45	
	4000	3.27	
			1.13
323	1000	0.60	
	2000	1.56	
	3000	2.39	
	4000	3.22	
			1.15

Henry's constant, K/kPa = $(p_1/\text{kPa})/x_1$.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting, and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 μL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 cm^3 m^{-1}) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) 1-Butanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1

δp/kPa = ± 10

$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Butanol; $C_4H_{10}O$; [78-92-2]

ORIGINAL MEASUREMENTS:

Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323
p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever
C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction 10^2x_1	Henry's Constant $10^{-5}K$/kPa
298	1000	0.60	
	2000	1.41	
	3000	2.18	
	4000	2.90	
			1.30
323	1000	0.60	
	2000	1.39	
	3000	2.13	
	4000	2.86	
			1.33

Henry's constant, K/kPa = (p_1/kPa)/x_1.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting, and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 μL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 cm^3 m^{-1}) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) 2-Butanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1
δp/kPa = ± 10
$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Methyl-1-propanol; $C_4H_{10}O$; [78-83-1]

ORIGINAL MEASUREMENTS:

Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323
p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever
C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction 10^2x_1	Henry's Constant $10^{-5}K$/kPa
298	1000	0.64	
	2000	1.41	
	3000	2.36	
	4000	3.09	
			1.20
323	1000	0.61	
	2000	1.39	
	3000	2.28	
	4000	3.02	
			1.23

Henry's constant, K/kPa = $(p_1/\text{kPa})/x_1$.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting, and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 μL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 cm^3 m^{-1}) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) 2-Methyl-1-propanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1
δp/kPa = ± 10
$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Methyl-2-propanol; $C_4H_{10}O$; [75-65-0]

ORIGINAL MEASUREMENTS:

Tonner, S.P.; Wainwright, M.S.; Trimm, D.L.; Cant, N.W.

J. Chem. Eng. Data 1983, *28*, 59-61.

VARIABLES:

T/K = 298, 323
p_1/kPa = 1000-4000

PREPARED BY:

H. L. Clever
C. L. Young

EXPERIMENTAL VALUES:

T/K	p_1/kPa	Mol Fraction 10^2x_1	Henry's Constant $10^{-5}K$/kPa
298	1000	0.85	
	2000	1.93	
	3000	3.02	
	4000	3.87	
			0.98
323	1000	0.77	
	2000	1.85	
	3000	2.89	
	4000	3.80	
			1.00

Henry's constant, K/kPa = $(p_1/\text{kPa})/x_1$.

The multiplying constant before Henry's constant appears to be in error. The compiler changed it from 10^{-3} to 10^{-5}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility measurements were conducted by charging 200 cm^3 of alcohol into a 300 cm^3 capacity stainless steel autoclave which was then pressurized to the desired level from a cylinder of carbon monoxide. The autoclave was fitted with ancillary lines and valves to allow gas charging, sampling of the liquid phase, venting, and draining.

Tests showed that about 2 minutes stirring brought the system to equilibrium. The liquid phase was sampled through a HPLC valve of 1 μL internal volume. The sample was switched to a stream of hydrogen carrier gas (30 $\text{cm}^3\ \text{m}^{-1}$) where it vaporized and was carried into a Gow Mac gas chromatograph with a 6 ft column of Porapak Q and fitted with a thermal conductivity cell.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. c.p. grade.

(2) 2-Methyl-2-propanol. Ajax Chemicals. 99.8 per cent purity.

ESTIMATED ERROR:

δT/K = ± 1
δp/kPa = ± 10
$\delta K/K$ = ± 0.10 (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Isodecanol; $C_{10}H_{22}O$; [25339-17-7]

ORIGINAL MEASUREMENTS:

Tyvina, T. N.; Fokina, V. V.; Naumova, A. A.; Polyakov, A. A.

Zh. Prikl. Khim. 1984, *57*, 2101-2104.

J. Appl. Chem. USSR 1984, *57*, 1942-1945.

VARIABLES:

$T/K = 313 - 553$
$p/MPa = 5 - 30$

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor, y_{CO}	Molar volume of liquid $cm^3 \, mol^{-1}$
313.2	5.0	0.045	1.0	183.0
	10.0	0.084	1.0	177.0
	15.0	0.122	1.0	170.5
	20.0	0.156	1.0	165.0
	25.0	0.188	1.0	160.0
	30.0	0.218	1.0	155.5
353.2	5.0	0.052	1.0	189.0
	10.0	0.100	1.0	181.0
	15.0	0.141	1.0	174.5
	20.0	0.178	1.0	168.5
	25.0	0.213	1.0	163.0
	30.0	0.246	1.0	157.5
393.2	5.0	0.057	1.0	196.0
	10.0	0.109	1.0	187.5
	15.0	0.159	1.0	179.0
	20.0	0.202	1.0	172.0
	25.0	0.241	1.0	165.5
	30.0	0.276	1.0	159.5

(cont.)

AUXILIARY INFORMATION

METHOD APPARATUS/PROCEDURE:

Static method in which the temperature variation of the pressure of a mixture of known composition was measured. The pressure-temperature curve has a change in slope corresponding to a change from a one-phase system to a two-phase system.
Above data obtained by graphical interpolation.
Details of method in ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. Purity 99.7 vol per cent.

2. Purity 99.5 mass per cent.

ESTIMATED ERROR:

$\delta T/K = \pm 0.2$; $\delta P/MPa = \pm 1\%$;
$\delta x/x = \pm 0.03$ (estimated by compiler)

REFERENCES:

1. Efremova, G. D.; Sokolova, E. S. *Zh. Fiz. Khim.* 1963, *37*, 2612.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Isodecanol; $C_{10}H_{22}O$; [25339-17-7]	Tyvina, T. N.; Fokina, V. V.; Naumova, A. A.; Polyakov, A. A. *Zh. Prikl. Khim.* 1984, *57*, 2101-2104. *J. Appl. Chem. USSR* 1984, *57*, 1942-1945.

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	Mole fraction of carbon monoxide in vapor, y_{CO}	Molar volume of liquid cm^3 mol^{-1}
433.2	5.0	0.065	0.9986	205.0
	10.0	0.121	0.9994	195.0
	15.0	0.174	0.9995	186.0
	20.0	0.222	0.9996	178.0
	25.0	0.268	0.9997	170.0
	30.0	0.310	0.9997	162.5
473.2	5.0	0.073	0.9920	214.5
	10.0	0.138	0.9960	203.0
	15.0	0.197	0.9974	192.5
	20.0	0.251	0.9980	183.0
	25.0	0.300	0.9982	174.0
	30.0	0.346	0.9984	165.5
513.2	5.0	0.082	0.9800	225.0
	10.0	0.154	0.9884	212.0
	15.0	0.224	0.9925	200.0
	20.0	0.286	0.9944	189.0
	25.0	0.341	0.9950	179.0
	30.0	0.396	0.9954	169.5
553.2	5.0	0.089	0.9560	238.5
	10.0	0.172	0.9780	223.0
	15.0	0.249	0.9850	210.5
	20.0	0.320	0.9886	198.0
	25.0	0.386	0.9905	186.5
	30.0	0.449	0.9910	176.0

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alcohols C_{12} - C_{15}

ORIGINAL MEASUREMENTS:

Naumova, A.A.; Polyakov, A.A.; Tyvina, T.N.; Fokina, V.V.

Zh. Prikl. Khim. 1981, *54*, 2014-2017.
J. Appl. Chem. (USSR), 1981, *54*, 1761-1764.

VARIABLES:

T/K = 313-553
p/MPa = 5.1 - 30.4

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	P/MPa*	mol fraction of CO** in vapour, x_1	in liquid, y_1	molar volume of liquid/ $cm^3\ mol^{-1}$	Henry's constant /atm $(mol\ fraction)^{-1}$
313.2	30.4	1.0	0.268	198.0	784
	25.3	1.0	0.240	204.5	
	20.3	1.0	0.206	211.5	
	15.2	1.0	0.167	219.5	
	10.1	1.0	0.120	228.0	
	5.06	1.0	0.062	237.0	
	2.02	1.0	0.028	242.0	
	1.01	0.9999	0.015	244.0	
	0.51	0.9998	0.008	244.5	
353.2	30.4	1.0	0.290	199.0	736
	25.3	1.0	0.259	206.0	
	20.3	1.0	0.222	214.0	
	15.2	1.0	0.178	223.0	
	10.1	0.99985	0.127	233.0	
	5.06	0.99983	0.067	244.0	
	2.02	0.9998	0.030	250.5	
	1.01	0.9996	0.016	253.0	
	0.51	0.9987	0.008	254.5	

(cont.)

*
** see following page

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static method which determines breaks on the pressure - temperature curves for mixtures of known composition.

Details of method in ref.1
Details of apparatus in ref.2

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: purity 99.7%

(2) Alcohols: C_{12} - C_{15} fraction, molecular weight 204.

ESTIMATED ERROR:

$\delta x/x = \pm 2\%$

REFERENCES:

1. Efremova, G.D.; Sokolova, E.S. *Zh. Fiz. Khim* 1963, *37*, 2616.

2. Tsiklis, D.S. *Techniques of Physicochemical Investigations at High Pressures* (in Russian) 1965, Izd. Khimiya, Moscow.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Alcohols C_{12} - C_{15}

ORIGINAL MEASUREMENTS:

Naumova, A.A.; Polyakov, A.A., Tyvina, T.N.; Fokina, V.V.

Zh. Prikl. Khim. 1981, *54*, 2014-2017.
J. Appl. Chem. (USSR) 1981, 54, 1761-1764.

EXPERIMENTAL VALUES: (contd)

T/K	*P*/MPa*	mol fraction of CO** in vapor, x_1	in liquid, y_1	molar volume of liquid/ $cm^3\ mol^{-1}$	Henry's constant/atm (mol fraction)$^{-1}$
393.2	30.4	0.9998	0.314	200.0	680
	25.3	0.99975	0.279	207.5	
	20.3	0.99972	0.238	217.0	
	15.2	0.99968	0.191	227.0	
	10.1	0.99965	0.135	239.0	
	5.06	0.9996	0.075	252.0	
	2.02	0.99945	0.032	260.5	
	1.01	0.9985	0.017	263.5	
	0.51	0.9955	0.009	265.5	
433.2	30.4	0.99962	0.358	202.0	614
	25.3	0.99957	0.300	211.0	
	20.3	0.9995	0.255	222.0	
	15.2	0.99945	0.205	233.0	
	10.1	0.99938	0.147	246.5	
	5.06	0.99925	0.079	260.0	
	2.02	0.9987	0.036	270.0	
	1.01	0.9960	0.018	274.0	
	0.51	0.9917	0.010	275.8	
473.2	30.4	0.9993	0.366	205.0	544
	25.3	0.9992	0.322	216.0	
	20.3	0.99907	0.274	227.3	
	15.2	0.99895	0.223	241.0	
	10.1	0.99875	0.162	254.5	
	5.06	0.99825	0.090	271.0	
	2.02	0.9964	0.040	282.5	
	1.01	0.9928	0.020	287.0	
	0.51	0.9883	0.011	289.0[a]	
513.2	30.4	0.9980	0.403	207.5	472
	25.3	0.99785	0.354	220.0	
	20.3	0.99765	0.301	233.0	
	15.2	0.9974	0.245	246.5	
	10.1	0.9970	0.180	262.5	
	5.06	0.9960	0.102	281.5	
	2.02	0.9925	0.046	295.5	
	1.01	0.9875	0.024	300.5	
	0.51	0.9760	0.012	303.5	
553.2	30.4	0.9922	0.462	204.0	400
	25.3	0.9920	0.404	219.0	
	20.3	0.9916	0.340	236.0	
	15.2	0.9911	0.276	256.0	
	10.1	0.9906	0.200	273.0	
	5.06	0.9889	0.116	295.0	
	2.02	0.9832	0.052	311.5	
	0.51	-	0.013	322.0	

[a] 239.0 in source; compiler believes it to be misprint for 289.0

* calculated by compiler. Pressure units in source are "10^3gPa" in English translation. This is not 10^3GPa as given in *Chem. Abs. 95*, 176660 for this paper, but gPa is translation from Russian symbol which means hectopascal, i.e. 10^2Pa.

** Calculated by compiler from mol fraction of alcohols in each phase, given in source, assuming $x_1 + x_2 = 1$ and $y_1 + y_2 = 1$.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Ketones, acids, esters, ethers	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

Acetone (2-propanone) [67-64-1]

The most extensive measurements of the solubility in acetone of carbon monoxide at a partial pressure of 1 atm were made by Horiuti (1), at temperatures between 193 K and 313 K. The solubility appears to pass through a minimum around 245 K. Just (2) provided data for 293.15 K and 298.15 K, and Skirrow (3) for 298.15 K. Compared with Horiuti's values at 298.15 K these are low by 14% and 8% respectively. In view of the thoroughness which characterises Horiuti's work, his values over 193-313 K can be accepted tentatively.

Skirrow's work (3) involved a rather extensive study of the solubility of carbon monoxide in solvent mixtures. In this section, data are given for solvents which were mixtures of acetone with naphthalene, phenanthrene, β-naphthol, chloroform, carbon disulfide, aniline, and nitrobenzene. The solubility values on the data sheets were stated by the author to have a possible error of 1%, but this is clearly overoptimistic in the light of comparisons with more recent data on the individual solvent components. The purity of these solvents as used in 1902 is also a matter of some doubt.

The trends in the solubilities are probably correct, but individual values need to be taken with caution.

Cyclohexanone [108-94-1]

Tyvina *et al.* (10) measured the solubility of carbon monoxide in this ketone over 313-513 K and at elevated pressures of 5-30 MPa. Their results are in the form of mol fractions of carbon monoxide in the liquid and vapour phases. There is no other work on this system with which to make comparisons, and the evaluator recommends that meantime the values be accepted tentatively. Further confirmatory evidence is obviously necessary.

Acetic acid (ethanoic acid) [64-19-7]

For a partial pressure of carbon monoxide of about 1 atm, solubilities in acetic acid were measured by Just (2) at 293.15 K and 298.15 K, and by Skirrow (3) at 298.15 K (2 values). The lower of Skirrow's values is very close to Just's at 298.15 K, which may be accepted tentatively.

For a partial pressure of carbon monoxide of 5.06 MPa Granzhan (4) measured the solubility in acetic acid at 298 K and 348 K, but the values appear to be too low and should be rejected. Dake and Chaudhari (5) measured the solubility over 298-448 K at partial pressures of 2-6 MPa, and their values appear to be of the correct magnitude. Choosing the same temperatures and pressures for comparison, their values are more than twice as large as Granzhan's and about 14% lower than those from Just and Skirrow by extrapolation. It may be that their solvent sample was not totally free from water which would lower the solubility. The data are part of a study of the solubility of carbon monoxide in mixtures of water and acetic acid, and appear in the water + organic solvent section of this volume.

Skirrow (3) measured the solubility of carbon monoxide also in solvents consisting of acetic acid mixed with chloroform aniline or nitrobenzene. Data are collected in this section, and comments made above concerning Skirrow's work on solvent mixtures containing acetone also apply here.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Ketones, acids, esters, ethers.	Robert W. Cargill. Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

Granzhan (4) also measured the solubility at 298 K and 348 K of carbon monoxide at 5.06 MPa in solvents which were binary mixtures of acetic acid, methanol, and methyl acetate. The values are classed as doubtful.

Propionic (propanoic) acid [79-09-4]

Dake and Chaudhari (5) studied the solubility of carbon monoxide at 2-6 MPa also in mixtures of propionic acid and water at 298-448 K, and values for carbon monoxide in propionic acid itself are given in the water + organic solvent section of this volume. They may be accepted tentatively, but require confirmation by further measurements.

Methyl acetate [79-20-9]

Horiuti's values (1) at a partial pressure of 1 atm and 194-313 K can again be accepted tentatively. Granzhan's values (4) at a partial pressure of 5.06 MPa and 298-348 K must be taken with great caution. Extrapolation of a value at 298 K from 5.06 MPa to 0.1 MPa for comparison with Horiuti's shows a 17% difference (low). However, part of this may be due to deviations from Henry's law.

Ethyl acetate [141-78-6]; propyl acetate [109-60-4];
isobutyl acetate [110-19-0]; amyl acetate [628-63-7]

The values of Just (2) at 293.15 K and 298.15 K, and of Gjaldbaek and Andersen (6) at 298.15 K (for propyl acetate only) may be accepted tentatively, but require confirmation. The solubilities show a steady increase as the molecular weights of the esters increase.

Diethyl ether (1-1'oxybisethane) [60-29-7]

Christoff's value (7) at 273.15 K is about 5% lower than that obtained from Horiuti (1) covering 194-293 K. Their values at 283.15 K are within 0.5% of each other. The latter set of data by linear regression gave the smoothing equation and smoothed data which appear on the data sheet, and may be accepted tentatively. However, the experimental value at 293.15K appears to be anomalously low and it was omitted from the linear regression analysis.

1,4 Dioxane [123-91-1]

For this solvent, a paper by Krauss and Gestrich (8) gave the solubility of carbon monoxide at a partial pressure of 1 atm between 288 K and 316 K, in the form of a graph from which numerical data were compiled. Veleckis and Hacker (9) measured the solubility at partial pressures between 5.7 atm and 68 atm over 352-446 K. There are no inconsistencies between them. Each may be accepted tentatively.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Ketones, acids, esters, ethers	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee, DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

References

1. Horiuti, J.
   Sci. Pap. Inst. Phys. Chem. Res. (Jpn) 1931/32 *17*, 125.

2. Just, G.
   Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

3. Skirrow, F.W.
   Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139.

4. Granzhan, V.A.
   Tr. Gos. Nauchno-Issled. Proektn. Inst. Prom.sti Org. Synt. 1974, *27*, 5.

5. Dake, S.B.; Choudhari, R.V.
   J. Chem. Eng. Data 1985, *30*, 400.

6. Gjaldbaek, J.C.; Andersen, E.K.
   Acta Chem. Scand. 1954, *8*, 1398.

7. Christoff, A.
   Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1912, *79*, 456.

8. Krauss, W.; Gestrich, W.
   Chem.-Tech. (Heidelberg) 1977, *6*, 513.

9. Veleckis, E.; Hacker, D.S.
   J. Chem. Eng. Data 1984, *29*, 36.

10. Tyvina, T.N.; Fokina, V.V.; Polyakov, A.A.
    Zh. Prikl. Khim. 1985, *58*, 442.
    (*J. Appl. Chem. USSR* 1985, *58*, 393.)

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Propanone or acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
293.15	6.49	0.198	0.2128
298.15	6.72	0.204	0.2225

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) 2-Propanone. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. Timofejew, W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. Steiner, P. *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Propanone or acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Horiuti, J.

Sci. Pap. Inst. Phys. Chem. Res. (Jpn) 1931/32, *17*, 125 - 256.

VARIABLES:

T/K: 193.35 - 313.15

p_1/kPa: 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3 (STP) cm^{-3} atm^{-1}	Ostwald Coefficient L/cm^3 cm^{-3}
193.35	7.795	0.2708	0.1917
213.45	7.402	0.2509	0.1961
232.85	7.269	0.2408	0.2053
253.10	7.293	0.2351	0.2178
273.15	7.440	0.2336	0.2336
293.15	7.738	0.2365	0.2538
313.15	8.017	0.2383	0.2732

The mole fraction and Bunsen coefficient values were calculated by the compiler with the assumption the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 193.35 and 313.15 K.

$$\ln x_1 = -12.8129 + 7.1272/(T/100\text{K}) + 2.9875 \ln (T/100\text{K})$$

The standard error about the regression line is 2.02 x 10^{-6}.

T/K	Mol Fraction $10^4 x_1$	T/K	Mol Fraction $10^4 x_1$
198.15	7.67	273.15	7.45
213.15	7.41	288.15	7.63
228.15	7.28	298.15	7.78
243.15	7.26	308.15	7.94
258.15	7.33		

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a gas buret, a solvent reservoir, and an absorption pipet. The volume of the pipet is determined at various meniscus heights by weighing a quantity of water. The meniscus height is read with a cathetometer.

The dry gas is introduced into the degassed solvent. The gas and solvent are mixed with a magnetic stirrer until saturation. Care is taken to prevent solvent vapor from mixing with the solute gas in the gas buret. The volume of gas is determined from the gas buret readings, the volume of solvent is determined from the meniscus height in the absorption pipet.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by dropping formic acid onto conc. H_2SO_4. The gas was passed through several wash solutions to remove CO_2 and O_2, dried by H_2SO_4 and P_2O_5.

(2) Acetone. Nippon Pure Chemical Co. or Merck. Extra pure grade. Recrystallized with sodium sulfite and stored over calcium chloride. Fractionated, boiling point (760 mmHg) 56.09°C.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.05$

$\delta x_1/x_1 = 0.01$

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Propanone; C_3H_6O; [67-64-1]

Acetic acid; $C_2H_4O_2$; [64-19-7]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.15$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
2-Propanone or acetone			
298.15	7.18	0.218	0.238
Acetic acid			
298.15	4.04	0.158	0.172[1]
	4.07	0.158	0.173[2]

[1] See tables 24, 25, and 26 in paper.

[2] See tables 17 and 18 in paper.

The Bunsen coefficient and the mole fraction values were calculated by the compiler assuming ideal gas behavior. The values are adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) assuming Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of the liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the solvent volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) 2-Propanone.
Acetic acid.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Naphthalene; $C_{10}H_8$; [91-20-3] (3) 2-Propanone or acetone; C_3H_6O; [67-64-1]	Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.

VARIABLES:	PREPARED BY:
T/K = 298.2 p_1/kPa = 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Naphthalene		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.238
		13.31	6.5	0.199
		27.40	14.6	0.187

The author also reported the solutions vapor pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Naphthalene.
(3) 2-Propanone.

No information.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm\ 0.001$ (Author)

REFERENCES:

1. Just, G.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS: (1) Carbon monoxide; CO; [630-08-0] (2) Phenathrene; $C_{14}H_{10}$; [85-01-8] (3) 2-Propanone or acetone; C_3H_6O; [67-64-1]	*ORIGINAL MEASUREMENTS:* Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.
VARIABLES: T/K = 298.2 p_1/kPa = 101.325 (1 atm)	PREPARED BY: H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Phenanthrene		Ostwald Coefficient
t/°C	T/K	$10^2 w_2$/wt %	$10^2 x_2$/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.238
		12.77	4.55	0.205
		25.04	9.82	0.183

The author also reported the solvent vapor pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Phenathrene.
(3) 2-Propanone.

No information.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 2-Naphthalenol or β-naphthol; $C_{10}H_8O$; [135-19-3]

(3) 2-Propanone or acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		2-Naphthalenol		Ostwald Coefficient
$t/°C$	T/K	10^2w_2/wt %	10^2x_2/mol %	L/cm^3cm^{-3}
25.0	298.2	0.0	0.0	0.238
		13.95	6.13	0.190
		26.88	12.9	0.169

The author also reported the solvents vapor pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) 2-Naphthalenol.
(3) 2-Propanone.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Trichloromethane or chloroform; $CHCl_3$; [67-66-3]

(3) 2-Propanone or acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Trichloromethane		Ostwald Coefficient
$t/°C$	T/K	10^2w_2/wt %	$10^2\phi_2$/vol %	L/cm^3cm^{-3}
25.0	298.2	0.0	0.0	0.238
		33.38	21.10	0.226
		53.2	37.78	0.219
		65.03	49.80	0.220
		73.46	59.64	0.212
		79.83	67.89	0.204
		87.3	78.61	0.207
		94.4	91.68	0.205
		100	100	0.207

The author also reported refractive index and vapor pressure of the solvents.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2

(2) Trichloromethane.
(3) 2-Propanone.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Carbon disulfide; CS_2; [75-15-0]

(3) 2-Propanone or acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Carbon disulfide		Ostwald Coefficient
$t/°C$	T/K	10^2w_2/wt %	$10^2\phi_2$/vol %	L/cm^3cm^{-3}
25.0	298.2	0.0	0.0	0.238
		8.18	5.33	0.236
		18.02	12.2	0.236
		49.46	38.2	0.227
		62.6	51.39	0.210
		74.05	64.33	0.187
		85.51	78.83	0.144
		96.42	94.36	0.114
		100	100	0.0959

The author also reported refractive index and vapor pressure of the solvents.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Carbon disulfide.

(3) 2-Propanone.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Benzenamine or aniline; C_6H_7N; [62-53-3] (3) 2-Propanone or acetone; C_3H_6O; [67-64-1]	Skirrow, F. W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* <u>1902</u>, *41*, 139-60.
VARIABLES:	**PREPARED BY:**
T/K = 298.2 p_1/kPa = 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Benzenamine		Ostwald Coefficient
t/°C	T/K	10^2w_2/wt %	10^2x_2/mol %	$L/\mathrm{cm^3 cm^{-3}}$
25.0	298.2	0.0	0.0	0.238
		20.83	14.1	0.179
		55.10	43.3	0.110
		100	100	0.053

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Benzenamine.
(3) 2-Propanone.

No information.

ESTIMATED ERROR:

$\delta L/\mathrm{cm^3} = \pm 0.001$ (Author)

REFERENCES:

1. **Just, G.**
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. <u>1901</u>, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Nitrobenzene; $C_6H_5NO_2$; [98-95-3]

(3) 2-Propanone or acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.2

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Nitrobenzene		Ostwald Coefficient
t/°C	T/K	$10^2 w_2$/wt %	$10^2 x_2$/mol %	L/cm^{3}cm^{-3}
25.0	298.2	0.0	0.0	0.238
		21.59	11.49	0.207
		53.20	30.49	0.157
		100	100	0.093

The author also reported the vapor pressure of the solvents.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Nitrobenzene.
(3) 2-Propanone.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001 (Author)

REFERENCES:

1. **Just, G.**

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Cyclohexanone; $C_6H_{10}O$; [108-94-1]

ORIGINAL MEASUREMENTS:

Tyvina, T. N.; Fokina, V. V.; Polyakov, A. A.

Zh. Prikl. Khim. 1985, *58*, 442-5.

J. Appl. Chem. USSR 1985, *58*, 393-396.

VARIABLES:

T/K = 313 - 553
p/MPa = 5 - 30

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor, y_{CO}	Molar volume of liquid $cm^3\ mol^{-1}$
313.2	5.0	0.031	-	103.8
	10.0	0.063	-	102.2
	15.0	0.097	-	100.8
	20.0	0.118	-	99.3
	25.0	0.142	0.9999	98.2
	30.0	0.163	0.9997	97.3
353.2	5.0	0.033	0.9975	107.5
	10.0	0.066	0.9988	105.7
	15.0	0.096	0.9992	104.0
	20.0	0.124	0.9994	102.5
	25.0	0.151	0.9996	101.0
	30.0	0.174	0.9998	99.8
393.2	5.0	0.036	0.9927	112.2
	10.0	0.071	0.9965	110.0
	15.0	0.103	0.9978	108.0
	20.0	0.134	0.9985	106.3
	25.0	0.163	0.9990	104.5
	30.0	0.187	0.9994	103.2

(cont.)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static method in which the temperature variation of the pressure of a mixture of known composition was measured. The pressure-temperature curve has a change in slope corresponding to a change from a one-phase to a two-phase system. Above data obtained by graphical interpolation. Details of method in ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. Purity 99.7 mole per cent.
2. Pure grade, distilled.

ESTIMATED ERROR:

δT/K = ±0.2 (up to 300 °C). ±0.5 (above 300 °C); δP/MPa = ±0.2.

REFERENCES:

1. Efremova, G. D.; Sokolova, E. S. *Zh. Fiz. Khim.* 1963, *37*, 2612.

COMPONENTS:

1. Carbon monoxide; CO;
   [630-08-0]

2. Cyclohexanone; $C_6H_{10}O$;
   [108-94-1]

ORIGINAL MEASUREMENTS:

Tyvina, T. N.; Fokina, V. V.;
Polyakov, A. A.

Zh. Prikl. Khim. 1985, *58*, 442-5.

J. Appl. Chem. USSR 1985, *58*, 393-396.

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide		Molar volume of liquid $cm^3\ mol^{-1}$
		in liquid, x_{CO}	in vapor, y_{CO}	
433.2	5.0	0.039	0.9830	117.5
	10.0	0.077	0.9922	115.0
	15.0	0.114	0.9948	112.5
	20.0	0.149	0.9964	110.5
	25.0	0.180	0.9974	108.6
	30.0	0.211	0.9982	107.0
473.2	5.0	0.040	0.9630	123.4
	10.0	0.083	0.9858	120.0
	15.0	0.124	0.9906	117.3
	20.0	0.164	0.9929	115.0
	25.0	0.200	0.9942	113.2
	30.0	0.232	0.9951	111.2
513.2	5.0	0.041	0.930	130.0
	10.0	0.090	0.9744	126.3
	15.0	0.136	0.9833	123.0
	20.0	0.180	0.9871	120.5
	25.0	0.223	0.9890	118.2
	30.0	0.262	0.9902	116.5
553.2	5.0	0.042	0.867	139.5
	10.0	0.096	0.9500	134.7
	15.0	0.150	0.9706	130.8
	20.0	0.202	0.9770	127.6
	25.0	0.256	0.9806	124.7
	30.0	0.304	0.9830	122.3

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Acetic acid; $C_2H_4O_2$; [64-19-7]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	4.02	0.157	0.1689
298.15	4.03	0.157	0.1714

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Acetic acid. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Acetic acid, $C_2H_4O_2$; [64-19-7] or 2. Acetic acid, methyl ester (methyl acetate); $C_3H_6O_2$; [79-20-9]	Granzhan, V.A. *Tr. Gos. Nauchno-Issled. Proektn. Inst. Prom-sti Org. Synt.* 1974, *27*, 5-9.
VARIABLES:	**PREPARED BY:**
T/K = 298-348 P_1/MPa = 5.06	Yu.P.Yampol'skii

EXPERIMENTAL VALUES:

	T/K	Solubility at p_1 = 5.06 MPa	
		cm^3(STP) g^{-1}	$10^2\ x_1$
(2) = Acetic acid			
	298	3.2	0.85
	323	4.5	1.20
	348	5.7	1.51
(2) = Methyl acetate			
	298	11.2	3.57
	323	12.4	3.94
	348	13.8	4.37

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Measurements were made in the apparatus originally described in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon Monoxide. Purity ⩾99.9%

(2) Solvents. "Pure for analysis".

ESTIMATED ERROR:

Solubility: ± 5%
Pressure ± 1 atm (± 2%)

REFERENCES:

1. Krichevskii, I.R.; Zhavoronkov, N.M.; Tskilis, D.S. *Zh. fis. chim* (USSR), 1937, *9*, 317.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2,3. Methanol; CH_4O; [67-56-1]
Acetic acid; $C_2H_4O_2$; [64-19-7]
Acetic acid; methyl ester
(methyl acetate); $C_3H_6O_2$;
[79-20-9]

ORIGINAL MEASUREMENTS:

Granzhan, V.A.
Tr. Gos. Nauchno-Issled. Proektn. Inst. Prom-sti Org.Synt. 1974, *27*, 5-9.

VARIABLES:

T/K = 298-348
P_1/MPa = 5.06

PREPARED BY:

Yu. P. Yampol'skii

EXPERIMENTAL VALUES:

Mol fraction of component (2)	Solubility at P_1 = 5.06 MPa			
	298K		384K	
x_2	$cm^3(STP)\ g^{-1}$	10^3x_1	$cm^3(STP)\ g^{-1}$	10^3x_1
(2) Methanol, (3) acetic acid				
0.2	3.8	9.2		
0.4	4.9	10.5		
0.6	5.8	11.1		
0.8	8.2	13.6		
(2) Methanol, (3) methyl acetate				
0.2	8.8	25.1	12.5	35.3
0.4	8.4	21.0	12.0	29.8
0.6	8.4	17.9	12.2	25.9
0.8	9.5	16.8	13.5	23.7
(2) acetic acid, (3) methyl acetate				
0.2	9.5	29.3	12.0	36.8
0.4	8.4	25.0	11.0	32.5
0.6	6.4	18.4	8.6	24.6
0.8	5.0	13.8	7.4	20.3

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Measurements were made in the apparatus originally described in reference 1.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Purity ⩾99.9%
(2,3) Solvents. "Pure for analysis".

ESTIMATED ERROR:

Solubility: ± 5%
Pressure ± 1 atm (± 2%)

REFERENCES:

1. Krichevskii, I.R.; Zhavoronkov, N.M.; Tsiklis, D.S.
Zh. fis. chim (USSR), 1937, *9*, 317.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Acetic acid; $C_2H_4O_2$; [64-19-7]

(3) Trichloromethane or chloroform; $CHCl_3$; [67-66-3]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Acetic acid		Ostwald Coefficient
$t/°C$	T/K	$10^2 w_2$/wt %	$10^2 \phi_2$/vol %	$L/cm^3 cm^{-3}$
25.0	298.2	0.0	0.0	0.206
		26.67	33.8	0.207
		56.46	64.5	0.196
		100	100	0.172

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Acetic acid.

(3) Trichloromethane.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Benzenamine or aniline; C_6H_7N; [62-53-3]

(3) Acetic acid; $C_2H_4O_2$; [64-19-7]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Benzeneamine		Ostwald Coefficient
$t/°C$	T/K	$10^2 w_2$/wt %	$10^2 x_2$/mol %	$L/cm^3 cm^{-3}$
25.0	298.2	0.0	0.0	0.173
		13.5	9.15	0.110
		41.64	31.52	0.0699
		60.77	50.00	0.0618
		82.21	74.93	0.0580
		100	100	0.053

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Benzenamine.
(3) Acetic acid.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Nitrobenzene; $C_6H_5NO_2$; [98-95-3]

(3) Acetic acid; $C_2H_4O_2$; [64-19-7]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Nitrobenzene		Ostwald Coefficient
$t/°C$	T/K	$10^2 w_2$/wt %	$10^2 x_2$/mol %	$L/cm^3 cm^{-3}$
25.0	298.2	0.0	0.0	0.173
		21.65	15.13	0.156
		51.03	33.74	0.130
		100	100	0.093

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Nitrobenzene.
(3) Acetic acid.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Acetic acid, methyl ester or methyl acetate; $C_3H_6O_2$; [79-20-9]	Horiuti, J. *Sci. Pap. Inst. Phys. Chem. Res. (Jpn)* <u>1931/32</u>, *17*, 125 - 256.
VARIABLES:	PREPARED BY:
T/K: 194.35 - 313.25 p_1/kPa: 101.325 (1 atm)	M. E. Derrick H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\mathrm{cm^3(STP)cm^{-3}atm^{-1}}$	Ostwald Coefficient $L/\mathrm{cm^3cm^{-3}}$
194.35	7.952	0.2547	0.1812
212.75	7.774	0.2436	0.1897
232.25	7.776	0.2379	0.2023
252.85	7.906	0.2357	0.2182
273.15	8.150	0.2363	0.2363
293.15	8.397	0.2375	0.2549
313.25	8.751	0.2408	0.2761

The mole fraction and Bunsen coefficient values were calculated by the compiler with the assumption the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 194.35 and 313.25 K.

$$\ln x_1 = -11.2973 + 5.1165 \ln/(T/100\ \mathrm{K}) + 2.2974 \ln (T/100\ \mathrm{K})$$

The standard error about the regression line is 1.70×10^{-6}.

T/K	Mol Fraction $10^4 x_1$	T/K	Mol Fraction $10^4 x_1$
198.15	7.895	273.15	8.123
213.15	7.785	288.15	8.331
228.15	7.773	298.15	8.490
243.15	7.835	308.15	8.662
258.15	7.955		

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
The apparatus consists of a gas buret, a solvent reservoir, and an absorption pipet. The volume of the pipet is determined at various meniscus heights by weighing a quantity of water. The meniscus height is read with a cathetometer. The dry gas is introduced into the degassed solvent. The gas and solvent are mixed with a magnetic stirrer until saturation. Care is taken to prevent solvent vapor from mixing with the solute gas in the gas buret. The volume of gas is determined from the gas buret readings, the volume of solvent is determined from the meniscus height in the absorption pipet.	(1) Carbon monoxide. Prepared by dropping formic acid onto conc. H_2SO_4. The gas was passed through several wash solutions to remove CO_2 and O_2, dried by H_2SO_4 & P_2O_5 (2) Methyl acetate. Merck. Extra pure grade. Dried with P_2O_5. Distilled several times. Boiling point (760 mmHg) 57.12°C. ESTIMATED ERROR: $\delta T/\mathrm{K} = 0.05$ $\delta x_1/x_1 = 0.01$ REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Acetic acid, ethyl ester or ethyl acetate; $C_4H_8O_2$; [141-78-6]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	9.83	0.225	0.2419
298.15	10.12	0.2305	0.2516

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Acetic acid, ethyl ester. No information.

ESTIMATED ERROR:

$\delta L/L$ = 0.03 (compiler)

REFERENCES:

1. Timofejew, W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. Steiner, P. *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Acetic acid, propyl ester or propyl acetate; $C_5H_{10}O_2$; [109-60-4]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

$T/K = 298.15$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
298.15	11.7	0.226	0.247
	11.8	0.228	0.249

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent), 99.6 - 99.9% CO, the rest being atmospheric air.

(2) Acetic acid, propyl ester. Judex Chemicals. Fractionated by distillation. B.p. (760 mmHg)/°C = 101.66 - 101.70, refractive index $n_D(20°C) = 1.3846$.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.

2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS: (1) Carbon monoxide; CO; [630-08-0] (2) Acetic acid, 2-methylpropyl ester or isobutyl acetate; $C_6H_{12}O_2$; [110-19-0]	ORIGINAL MEASUREMENTS: **Just, G.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1901, *37*, 342-67.
VARIABLES: T/K = 293.15, 298.15 p_1/kPa = 101.325 (1 atm)	PREPARED BY: M. E. Derrick H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	1.28	0.216	0.2314
298.15	1.29	0.217	0.2365

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Acetic acid, 2-methylpropyl ester. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Acetic acid, pentyl ester or amylacetate; $C_7H_{14}O_2$; [628-63-7]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	1.30	0.196	0.2108
298.15	1.31	0.196	0.2140

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Acetic acid, pentyl ester. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1,1'-Oxybisethane or diethyl ether; $C_4H_{10}O$; [60-29-7]

ORIGINAL MEASUREMENTS:

Christoff, A.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1912, *79*, 456-60.

VARIABLES:

T/K = 273.15, 283.15
p_1/kPa = atmospheric

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature t/°C	Temperature T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
0	273.15	1.62	0.3618	0.3618
10	283.15	1.69	0.3706	0.3842

The mole fraction and Bunsen coefficient values were calculated by the compiler assuming ideal gas behavior.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus is an Ostwald type as described by Just (ref 1), and modified by Skirrow (ref 2). The apparatus consists of a thermostated gas buret and an absorption flask.

The modification involves the use of vapor free gas in the gas buret. A correction is made for the vapor pressure of the solvent. A steel capillary tube with a stopcock, which prevents the gas and the solvent vapor from mixing in the buret, is used to connect the absorption flask and the buret.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the author by the action of sulfuric acid on sodium formate.

(2) Diethyl ether. Merck. Stated to be pure and anhydrous.

ESTIMATED ERROR:

$\delta L/L = \pm 0.03$

REFERENCES:

1. Just, G.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.
2. Skirrow, F. W.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

COMPONENTS:

(1) Carbon monoxide; CO;
[630-08-0]

(2) 1,1'-Oxybisethane or diethyl
ether; $C_4H_{10}O$; [60-29-7]

ORIGINAL MEASUREMENTS:

Horiuti, J.

Sci. Pap. Inst. Phys. Chem. Res. (Jpn) 1931/32, *17*, 125 - 256.

VARIABLES:

T/K: 194.35 - 293.15
p_1/kPa: 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient α/cm^3 (STP) cm^{-3} atm^{-1}	Ostwald Coefficient L/cm^3 cm^{-3}
194.35	2.158	0.5369	0.3820
213.65	1.930	0.4679	0.3660
233.05	1.801	0.4251	0.3627
253.05	1.717	0.3941	0.3651
273.15	1.700	0.3790	0.3790
293.15	1.229	0.3640	0.3907

The mole fraction and Bunsen coefficient values were calculated by the compiler with the assumption the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 194.35 and 293.15 K.

The 293.15 K value was omitted from the linear regression.

$$\ln x_1 = -12.7880 + 8.8533/(T/100\text{K}) + 3.1524 \ln (T/100\text{K})$$

The standard error about the regression line is 6.97×10^{-6}.

T/K	Mol Fraction 10^3x_1
198.15	2.103
213.15	1.933
228.15	1.823
243.15	1.754
258.15	1.714
273.15	1.697
288.15	1.696
293.15	1.699

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a gas buret, a solvent reservoir, and an absorption pipet. The volume of the pipet is determined at various meniscus heights by weighing a quantity of water. The meniscus height is read with a cathetometer.

The dry gas is introduced into the degassed solvent. The gas and solvent are mixed with a magnetic stirrer until saturation. Care is taken to prevent solvent vapor from mixing with the solute gas in the gas buret. The volume of gas is determined from the gas buret readings, the volume of solvent is determined from the meniscus height in the absorption pipet.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by dropping formic acid onto conc. H_2SO_4. The gas was passed through several wash solutions to remove CO_2 and O_2, dried by H_2SO_4 & P_2O_5.

(2) Diethyl ether. Merck. "For analysis grade". Stored over sodium amalgam until evolution of gas ceased. Distilled, boiling point constant within 0.01°C.

ESTIMATED ERROR:

δT/K = 0.05
$\delta x_1/x_1$ = 0.01

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-03-0]
2. 1,4-Dioxane; $C_4H_8O_2$; [123-91-1]

ORIGINAL MEASUREMENTS:

Krauss, W.; Gestrich, W.
Chem.-Tech. (Heidelberg) 1977, *6*, 513-516.

VARIABLES:

T/K = 288 - 317

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

Temperature T/K	Solubility* S/mol dm^{-3} bar^{-1}	Bunsen coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Mol fraction 10^4x_1
290.1	0.0055	0.123	4.68
296.4	0.0057	0.128	4.86
306.7	0.0059	0.132	5.03
315.8	0.0061	0.137	5.20

* read off graph in source.

The Bunsen coefficients and mole fractions (at 1 bar) were calculated by the compiler, assuming that the gas is ideal, and Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of gas was added to a known volume of liquid in a stirred equilibrium cell.

The equilibrium partial pressure was measured up to 2 bar. Diagram and details are given in source.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

$\delta T/\mathrm{K} = \pm 0.05$; $\delta S/S = \pm 5\%$

(estimated by compiler)

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1,4-Dioxane; $C_4H_8O_2$; [123-91-1]

ORIGINAL MEASUREMENTS:

Veleckis, E.; Hacker, D. S.

J. Chem. Eng. Data 1984, *29*, 36-39.

VARIABLES:

T/K = 352.8 - 446.6

p_t/kPa = 660 - 7113

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:- given on next page

The data were fitted by the method of least squares to the equation

$$x_1 = \alpha(T/\mathrm{K})(p_1/\mathrm{atm}) + \beta(T/\mathrm{K})(p_1/\mathrm{atm})^2$$

$$x_1 = \{2.025 \times 10^{-3} - 0.4974/(T/\mathrm{K})\}(p_1/\mathrm{atm}) + \{-2.574 \times 10^{-6} + 7.351 \times 10^{-4}/(T/\mathrm{K})\}(p_1/\mathrm{atm})^2$$

and Henry's constant, H/atm = $(p_1/\mathrm{atm})/x_1$, by the equation

$$\ln(H/\mathrm{atm}) = 5.688 + 594.6/(T/\mathrm{K})$$

The fugacity coefficient was calculated from the equation $RT\ln(f_1^0/p_1) = Bp_1 + ((C - B^2)/2RT)(p_1)^2$. The CO partial pressure was obtained by subtracting the solvent vapor pressure from the total pressure, $p_1 = p_t - p_2^0$. The 1,4-dioxane vapor pressure was taken from Vinsor, C. G.; Martin, J.J. *J. Chem. Eng. Data* 1963, *8*, 74. The virial coefficients were taken from Michels, A.; Lupton, J. M.; Wassenaar, T.; De Graaf, W. *Physica* 1952, *18*, 121 as

$$B/\mathrm{cm^3\ mol^{-1}} = -118.7 + 0.5266(T/\mathrm{K}) - 5.261 \times 10^{-}\ (T/\mathrm{K})^2$$

$$C/\mathrm{cm^6\ mol^{-2}} = 4225 - 12.18(T/\mathrm{K}) + 1.208 \times 10^{-}\ (T/\mathrm{K})^2$$

Parameters of the Krichevsky-Ilinskaya equation (*Zh. Fiz. Khim.* 1945, *19*, 621) are given in the paper. The partial molar thermodynamic properties at infinite dilution are $\Delta\bar{H}_1^\infty$ /cal mol^{-1}= 1181, and $\Delta\bar{S}_1^\infty$/cal K^{-1} mol^{-1} = -11.30.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solvent was degassed by the method of Battino, *et al.* (ref 1).

The solubility was measured in a 2 liter stainless steel autoclave equiped with a magnetically driven stirrer, pressure transducer, thermocouple system, leads to gas and liquid, and a 0.125 in diameter liquid sampling tube.

One liter of degassed liquid is placed into the autoclave. The system is pressurized with CO and brought to the measurement temperature. The system is stirred at 250 rpm until the total pressure remains constant for one hour. Stirring time ranges from 1 h at 173 °C to 8 h at 80 °C.

The liquid sampling line is purged by removing and discarding the first 6 cm^3, then an 8 to 12 cm^3 sample is collected in a previously evacuated buret system. The gas flashes out of solution and is measured at one atm pressure. The buret system is similar to the one described by Wiebe *et al.* (ref 2).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., Inc. Stated to be better than 99.99 percent.

(2) 1,4-Dioxane. Aldrich Chemical Co. Spectrophotometric grade, stated to be better than 99 percent.

ESTIMATED ERROR:

δT/K = ± 0.5

$\delta x_1/x_1$ = ± 0.03 (compiler)

REFERENCES:

1. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.
2. Wiebe, R.; Gaddy, V. L.; Heins, C. *Ind. Eng. Chem.* 1932, *29*, 823. *J. Am. Chem. Soc.* 1933, *55*, 947.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0]	Veleckis, E.; Hacker, D. S.
(2) 1,4-Dioxane; $C_4H_8O_2$; [123-91-1]	*J. Chem. Eng. Data* 1984, *29*, 36-39.

EXPERIMENTAL VALUES:

Temperature		1,4-Dioxane Vapor Pressure[a]	Total Pressure	Carbon Monoxide Fugacity	Mol Fraction
$t/^\circ C$	T/K	p_2^0/atm	p_t/atm	f_1^0/atm	x_1
79.6	352.8	0.49	7.20	6.71	0.00418
			14.04	13.56	0.00843
			23.61	23.16	0.01428
			25.33	24.89	0.01555
			30.57	30.15	0.01836
			32.48	32.08	0.01971
			39.76	39.41	0.02387
			46.62	46.33	0.02761
			54.11	53.91	0.03216
			60.97	60.87	0.03549
			68.82	68.86	0.04102
96.5	369.7	0.86	6.51	5.64	0.00378
			13.03	12.18	0.00809
			17.26	16.43	0.01096
			23.35	22.57	0.01519
			30.78	30.06	0.01952
			38.70	38.08	0.02458
			46.42	45.91	0.02924
			52.80	52.41	0.03345
			60.60	60.38	0.03778
			67.30	67.26	0.04239
113.7	386.9	1.44	8.56	7.12	0.00510
			10.65	9.22	0.00653
			13.99	12.58	0.00904
			21.39	20.04	0.01437
			28.77	27.49	0.01907
			35.36	34.17	0.02378
			43.12	42.07	0.02929
			48.82	47.90	0.03377
			55.70	54.95	0.03809
			62.31	61.76	0.04172
			63.64	63.13	0.04250
138.2	411.4	2.75	11.24	8.49	0.00672
			13.72	10.99	0.00865
			21.72	19.07	0.01470
			27.62	25.04	0.01923
			34.78	32.31	0.02502
			41.94	39.64	0.03029
			49.33	47.22	0.03612
			56.35	54.46	0.04101
			63.02	61.36	0.04597
			70.20	68.84	0.05105
173.4	446.6	6.05	13.69	7.65	0.00699
			20.65	14.67	0.01318
			27.71	21.81	0.01918
			34.93	29.14	0.02559
			41.94	36.31	0.03191
			48.66	43.22	0.03843
			55.64	50.42	0.04367
			63.30	58.38	0.05039

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[a] 1,4-Dioxane vapor pressures from literature equation in Vinsor, C. G.; Martin, J. J. *J. Chem. Eng. Data* 1963, *8*, 74.

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Organic compounds containing halogen	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

Some fluoro-, chloro-, and bromo - compounds are included in this section as solvents for carbon monoxide at partial pressures around 1 atm. There is also one set of data for the solubility of carbon monoxide at 0.5-0.8 MPa partial pressure, in a fluorinated polyether.

1. Freons:	Trifluoromethane;	CHF_3;	[75-46-7]
	Tetrafluoromethane;	CF_4;	[75-73-0]
	Chlorotrifluoromethane;	$CClF_3$;	[75-72-9]
	Chlorodifluoromethane;	$CHClF_2$;	[75-45-6]
	Dichlorodifluoromethane;	CCl_2F_2;	[75-71-8]

The solubility of carbon monoxide in these five freons has been measured by Leites *et al.* (1, 2) at low temperatures, down to 93 K in some cases. The solubilities are high, and the values recorded on the data sheets were abstracted from graphs in the original papers. This, and the unspecified error in the measurements themselves, means that these, the only data for these solvents, should be used only with some caution until some confirmatory evidence becomes available.

2. Tetrachloromethane; CCl_4; [56-23-5]

The measurements of Horiuti (3) are within about 1% of the more recent ones by Tominaga *et al.* (4) over the common temperature range 280 - 313 K. In this range, the values given on the data sheets are recommended. The values at the lower and higher temperatures, given by Horiuti may be taken as tentative, and the smoothing equation given on data sheet used with some confidence over 253 - 333 K.

3. Trichloromethane; $CHCl_3$; [67-66-3]

Skirrow's two values (5) are about 5% higher than Just's (6) at 298.15 K. All these data for this system can only be used with caution, and confirmation is obviously necessary sometime in the future.

4. 1, 2 - Dichloroethane; $C_2H_4Cl_2$; [107-06-2]

1, 2 - Dibromoethane; $C_2H_4Br_2$; [106-93-4]

The data due to Skirrow (5) and Gjaldbaek and Andersen (7) respectively on these two solvents at 298.15 K may be accepted tentatively until some further measurements are made. In fact the very recent measurement by Lühring and Schumpe (12) on 1,2-dichloroethane at 293.2 K is 1% lower than Skirrow's value at 298.15 K, and whilst the evaluator believes it to be somewhat low, it may be taken tentatively also.

5. Hexadecafluoroheptane; C_7F_{16}; [335-57-9]

Hexafluorobenzene; C_6F_6; [392-56-3]

The solubilities of carbon monoxide at temperatures around 298.1 K in these perfluorinated solvents, measured by Gjaldbaek (8) and by Evans and Battino (9) respectively, are probably quite reliable due to the high quality of the experimental work of these authors. Obviously further confirmation is highly desirable. It is noteworthy that these solubilities are four to five times higher than for the other solvents considered in this section.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Organic compounds containing halogen

EVALUATOR:

Robert W. Cargill,
Department of Molecular
and Life Sciences,
Dundee Institute of Technology,
Bell Street, Dundee DD1 1HG, U.K.

March 1989

CRITICAL EVALUATION:

6. Chlorobenzene; C_6H_5Cl; [108-90-7]

The measurements of Horiuti (3) on chlorobenzene as solvent from 232 K to 353 K are likely to be quite reliable, like the rest of his solubility work. The data and the smoothing equation given on the data sheet can be accepted tentatively.

7. Trifluoroacetic acid; CF_3CO_2H; [76-05-1]

Fujioca and Cady (10) measured the solubility of carbon monoxide in trifluoroacetic acid, at a partial pressure of 646 mmHg (0.85 bar) and 299 K, by a volumetric technique. They reported an Ostwald coefficient of 0.0. This measurement would need to be quantified more carefully, and no data sheet has been prepared from this work.

8. Fomblin; perfluorinated polyether; [25038-02-2]

The measurements of Matsumato and Satterfield (11) on the solubility of carbon monoxide, at a partial pressure of 0.5-0.8 MPa and at 473-533 K, have been included in this section. The data may be accepted provisionally until, as with most other halogen containing solvents for carbon monoxide, further experimental evidence is available.

References

1. Leites, I.L.; Adlivankina, M.A. *Chim. Prom. (Moscow)* 1966, 848.

2. Leites, I.L.; Argunova, V.I. *Zh. fiz. chim.* 1972, *46*, 523.
Russian J. Phys. Chem. 1972, *46*, 304.

3. Horiuti, J. *Sci. Pap. Inst. Phys. Chim. Res. (Jpn)* 1931/32, *17*, 125.

4. Tominaga, T.; Battino, R.; Gorowara, H.K.; Dixon, R.D.
J. Chem. Eng. Data 1986, *31*, 175.

5. Skirrow, F.W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139.

6. Just, G. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1901, *37*, 342.

7. Gjaldbaek, J.C.; Andersen, E.K. *Acta Chem. Scand.* 1954, *8*, 1398.

8. Gjaldbaek, J.C. *Acta Chem. Scand.* 1952, *6*, 623.

9. Evans, D.F.; Battino, R. *J. Chem. Thermodyn.* 1971, *3*, *753*.

10. Fujioka, G.S.; Cady, G.H. *J. Amer. Chem. Soc.* 1957, *79*, 2451.

11. Matsumato, D.; Satterfield, C.
Ind. Eng. Chem. Process Dev. 1985, *24*, 1297.

12. Lühring, P.; Schumpe, A.
J. Chem. Eng. Data 1989, *34*, 250.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Freon; Trifluoromethane; CHF_3; [75-46-7]

   or

   Tetrafluoromethane; CF_4; [75-73-0]

ORIGINAL MEASUREMENTS:

Leites, I.L.; Adlivankina, M.A.

Chim. Prom. (Moscow) 1966, 848-850.

VARIABLES:

p_1/kPa = 0 - 80
T/K = 93 - 175

PREPARED BY:

Yu. P. Yampol'skii
R.W. Cargill

EXPERIMENTAL VALUES:

T/K	$10^{-4}K_H$/mmHg*	$10^{-4}K_H$/kPa**	10^2x_1**
Trifluoromethane; CHF_3			
123	6.5	0.87	1.17
133	8.5	1.13	0.89
148	11.0	1.47	0.69
175	14.0	1.86	0.54
Tetrafluoromethane; CF_4***			
93	0.81	0.11	9.4
108	1.6	0.21	4.8
123	2.6	0.35	2.9
133	3.2	0.43	2.4

* values read off graph in source where K_H was plotted against $1/T$.

** K_H/kPa and mol fraction solubility x_1 at partial pressure of 101.3 kPa calculated by compiler.

*** Heat of solution of CO in tetrafluoromethane given as - 3.72kJ mol^{-1} over 93 - 133 K.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility was determined using static method. Pentane, methylcyclohexane and other hydrocarbons and their mixtures were used as coolants. Measurements were made in double-walled cryostat described in ref.1

SOURCE AND PURITY OF MATERIALS:

(1) Impurities in carbon monoxide (mainly N_2) 0.5%

(2) Impurities: in CHF_3 0.1%; $CHClF_2$ and 0.1% N_2; in CF_4: ≤ 1.5% N_2.

ESTIMATED ERROR:

Reproducibility 2-3% at lower temperatures, 5-6% at higher temperatures. Error of Henry constants ~ 2%.

REFERENCES:

1. Angerer E. *Technika fisicheskogo experimenta.* Fizmatgiz Ed., Moscow, 1962, 252.

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Chlorotrifluoromethane; $CClF_3$; [75-72-9]	ORIGINAL MEASUREMENTS: Leites, I.L.; Adlivankina, M.A. *Chim. Prom. (Moscow)* <u>1966</u>, 848-850.
VARIABLES: p_1/kPa = 0 - 80 T/K = 93 - 175	PREPARED BY: Yu. P. Yampol'skii R.W. Cargill

EXPERIMENTAL VALUES:

T/K	$10^{-4}K_H/\text{mmHg}^*$	$10^{-4}K_H/\text{kPa}^{**}$	$10^2x_1^{**}$
93	0.56	0.075	13.6
95	0.57	0.076	13.3
103	1.1	0.15	6.91
123	3.0	0.40	2.53
153	6.5	0.87	1.17
158	7.5	1.00	1.01
167	7.5	1.00	1.01
173	7.6	1.01	1.00

* values read off graph in source where K_H was plotted against $1/T$.

** K_H/kPa and mol fraction solubility x_1 at partial pressure of 101.3 kPa calculated by compiler

Heat of solution given as -1.42 kJ mol^{-1} at 163 K and -6.90 kJ mol^{-1} at 93 K.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility was determined using static method. Pentane, methylcyclohexane and other hydrocarbons and their mixtures were used as coolants. Measurements were made in double-walled cryostat described in ref.1

SOURCE AND PURITY OF MATERIALS:

(1) Impurities in carbon monoxide (mainly N_2) 0.5%

(2) Impurities in $CClF_3$: 0.2% CCl_2F_2 and 0.1% N_2

ESTIMATED ERROR:

Reproducibility 2-3% at lower temperatures, 5-6% at higher temperatures. Error of Henry constants ~ 2%.

REFERENCES.

1. Angerer E. *Technika fisicheskogo experiment* Fizmatgiz Ed., Moscow, 1962, 252.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Freon: Chlorodifluoromethane; $CHClF_2$; [75-45-6]
   or
   Dichlorodifluoromethane; CCl_2F_2; [75-71-8]

ORIGINAL MEASUREMENTS:

Leites, I.L.; Argunova, V.I.

Zh. fiz. chim. <u>1972</u>, *46*, 523-524.

Russian J. Phys. Chem. <u>1972</u>, *46* 304-305.

VARIABLES:

p_1/kPa = 101.3
T/K = 133 - 213

PREPARED BY:

Yu. P. Yampol'skii
R.W. Cargill

EXPERIMENTAL VALUES:

T/K	log (K_H/mmHg)*	$10^{-4}K_H$/mmHg	$10^{-4}K_H$/kPa**	10^2x_1**
Chlorodifluoromethane; $CHClF_2$				
132	5.01	10.2	1.36	0.75
151	5.12	13.2	1.76	0.58
192	5.19	15.5	2.06	0.49
212	5.18	15.1	2.01	0.50
Dichlorodifluoromethane; CCl_2F_2				
134	4.76	5.75	0.77	1.32
154	4.96	9.12	1.22	0.83
172	5.09	12.3	1.64	0.62
193	5.22	16.6	2.21	0.46

* values read off graph in source where log K_H was plotted against $1/T$.

** K_H/kPa and mol fraction solubility x_1 at partial pressure of 101.3 kPa calculated by compiler

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

not specified

SOURCE AND PURITY OF MATERIALS:

not specified

ESTIMATED ERROR:

not specified

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Tetrachloromethane or carbon tetrachloride; CCl_4; [56-23-5]

ORIGINAL MEASUREMENTS:

Horiuti, J.

Sci. Pap. Inst. Phys. Chem. Res. (Jpn) 1931/32, *17*, 125 - 256.

VARIABLES:

T/K: 253.25 - 333.25

p_1/kPa: 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient α/cm^3 (STP) cm^{-3} atm^{-1}	Ostwald Coefficient L/cm^3 cm^{-3}
253.25	8.128	0.1981	0.1837
273.15	8.303	0.1977	0.1977
293.15	8.586	0.1996	0.2142
313.25	8.881	0.2018	0.2314
333.25	9.327	0.2072	0.2528

The mole fraction and Bunsen coefficient values were calculated by the compiler with the assumption the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 253.25 and 333.25 K.

$$\ln x_1 = -12.0523 + 6.2562/(T/100\text{K}) + 2.6553 \ln (T/100\text{K})$$

The standard error about the regression line is 2.56×10^{-6}.

T/K	Mol Fraction 10^4x_1
258.15	8.164
273.15	8.303
288.15	8.494
298.15	8.646
308.15	8.816
318.15	9.003
333.15	9.313

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a gas buret, a solvent reservoir, and an absorption pipet. The volume of the pipet is determined at various meniscus heights by weighing a quantity of water. The meniscus height is read with a cathetometer.

The dry gas is introduced into the degassed solvent. The gas and solvent are mixed with a magnetic stirrer until saturation. Care is taken to prevent solvent vapor from mixing with the solute gas in the gas buret. The volume of gas is determined from the gas buret readings, the volume of solvent is determined from the meniscus height in the absorption pipet.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by dropping formic acid onto conc. H_2SO_4. The gas was passed through several wash solutions to remove CO_2 and O_2, dried by H_2SO_4 & P_2O_5.

(2) Tetrachloromethane. Kahlbaum. Dried over P_2O_5 and distilled. Boiling point (760 mmHg) 76.74°C.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.05$

$\delta x_1/x_1 = 0.01$

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Tetrachloromethane (carbon tetrachloride); CCl_4; [56-23-5]

ORIGINAL MEASUREMENTS:

Tominaga, T.; Battino, R.; Gorowara, H. K.; Dixon, R. D.; Wilhelm, E.

J. Chem. Eng. Data 1986, *31*, 175-180.

VARIABLES:

T/K : 282.76 - 308.14
p_1/kPa : 101.325 (1 atm)

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

T/K	Ostwald Coefficient $L_{2,1}$/cm^{3}cm^{-3}	Henry Coefficient $10^{-6}H_{2,1}$/Pa	Mol Fraction* 10^4x_1
282.76	0.2064	119.1	8.51
282.76	0.2076	118.5	8.55
298.14	0.2184	116.5	8.70
308.14	0.2245	115.7	8.76

* calculated by compiler

Smoothed data: for $282.7 < T/\text{K} < 318.2$,

$$\ln L_{2,1} = -0.57915 - 281.50\ (\text{K}/T)$$

$$\ln H_{2,1} = 18.2607 + 93.84\ (\text{K}/T)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Equilibrium between the gas and the solvent was achieved by stirring in an apparatus after the design of Ben Naim and Baer (1). Pressure control and measurement of gas volume was microprocessor driven. Mercury is absent from the apparatus.

Solvent was degassed by vacuum pumping and stirring (2).

Temperature control to ±0.1 K was in an air thermostat.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co., purity >99.8%.

(2) Tetrachloromethane. Fisher certified 99 mol % pure, redistilled, protected from light.

ESTIMATED ERROR:

$\delta L/L = \pm 0.01$
$\delta T/\text{K} = \pm 0.1$

REFERENCES:

1. Ben-Naim, A.; Baer, S. *Trans. Faraday Soc.* 1963, *59*, 2735.

2. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Trichloromethane or chloroform; $CHCl_3$; [67-66-3]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
293.15	6.32	0.177	0.1897
298.15	6.44	0.179	0.1954

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Trichloromethane. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. Timofejew, W. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. Steiner, P. *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Trichloromethane; $CHCl_3$; [67-66-3] 1,2-Dichloroethane; $C_2H_4Cl_2$; [107-06-2]	**Skirrow, F. W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.
VARIABLES:	PREPARED BY:
$T/K = 298.15$ $p_1/kPa = 101.325$ (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3 (STP) cm^{-3} atm^{-1}$	Ostwald Coefficient $L/cm^3 cm^{-3}$
Trichloromethane			
298.15	6.82	0.190	0.207[1]
	6.79	0.189	0.206[2]
1,2-Dichloroethane or ethylene chloride			
298.15	4.77	0.135	0.147

[1] See Tables 20 and 23 in the paper.

[2] See Table 26 in the paper.

The Bunsen coefficient and the mole fraction values were calculated by the compiler assuming ideal gas behavior. The values are adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) assuming Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of the liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the solvent volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Trichloromethane.
1,2-Dichloroethane.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$

REFERENCES:

1. **Just, G.**
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. 1,2 - Dichloroethane; $C_2H_4Cl_2$; [107-06-2]	Lühring, P.; Schumpe, A. *J. Chem. Eng. Data* 1989, *34*, 250-252.
VARIABLES: T = 293.2 K p_1 = 101.3 kPa (1 atm)	PREPARED BY: R.W. Cargill

EXPERIMENTAL VALUES:

Temperature = 293.2 K

Henry's constant H/kPa m^3 mol^{-1}	Bunsen coefficient* α/cm^3 (STP) cm^{-3} atm^{-1}	mol fraction solubility* at 101.3 kPa, 10^4x_1
16.93	0.134	4.72

* calculated by compiler, assuming ideal gas behaviour and that Henry's law is obeyed; also that the density of 1,2 - dichloroethane at 293.2 K is 1.255 g cm^{-3}

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A barometric method of measurement (reference 1). A glass vessel containing 349.6 cm^3 liquid and 589.9 cm^3 gas, divided by a perforated glass plate, was stirred-magnetically. Liquid was previously degassed by evacuation. Dry gas was admitted, and the pressure decrease monitored by a micromanometer. Saturation was achieved within 3-6 minutes.

Reported value is mean of 3 determinations.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: no information.

(2) 1, 2-Dichloroethane: from Merck, "highest available purity".

ESTIMATED ERROR:

$\Delta T = \pm 0.1$K
$\delta x/x = \pm 2\%$ (authors)

REFERENCES:

1. Schumpe, A.; Quicker, G.; Deckwer, W.D. *Adv. Biochem. Eng.* 1982, *24*, 1.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) 1,2-Dibromoethane; $C_2H_4Br_2$; [106-93-4]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

T/K = 298.15
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
298.15	2.98	0.0771	0.0842
	3.04	0.0785	0.0857

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent). 99.6 - 99.9% rest being atmospheric air.

(2) 1,2-Dibromoethane. Merck and Co. Purified by fractional freezing. M.p./°C = 9.5 - 9.8, refractive index, $n_D(20°C)$ = 1.5390, density $\rho(20.6°C)/g\ dm^{-3}$ = 2.179.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.
2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Hexadecafluoroheptane; C_7F_{16}; [335-57-9]	Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623 - 633.
VARIABLES: T/K = 298.05 p_1/kPa = 101.325 (1 atm)	PREPARED BY: J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
298.06	3.90	0.385	0.420
298.05	3.90	0.385	0.420
298.15	3.85	0.380	0.415

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5 % CO + 0.5 % N_2

(2) Hexadecafluoroheptane. E. I. du Pont Co. Described by Gjaldbaek, J. C. and Hildebrand, J. H. *J. Am. Chem.Soc.* 1949, *71*, 3147. B.p. (753.7 mmHg)/°C = 82.3 - 82.4.

ESTIMATED ERROR:

$\delta T/\text{K} = \pm\ 0.05$
$\delta x_1/x_1 = \pm\ 0.015$

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.
2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Hexafluorobenzene; C_6F_6; [392-56-3]

ORIGINAL MEASUREMENTS:

Evans, D. F.; Battino, R.

J. Chem. Thermodyn. 1971, *3*, 753-760.

VARIABLES:

T/K: 298.12, 298.48
p_1/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

t/°C	T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3\text{(STP)}\,\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
24.97	298.12	2.147	0.415	0.453
25.33	298.48	2.196	0.406	0.444

The Bunsen coefficients were calculated by the compiler.

The solubility values were adjusted to an oxygen partial pressure of 101.325 kPa (1 atm) by Henry's law.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility apparatus is based on the design of Morrison and Billett (1) and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus is that described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is intermittently applied through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass helical tube containing solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Either Air Products and Chemicals Inc. or the Matheson Co., Inc. Purest grade available. Minimum purity 99.0 mole per cent (usually > 99.9 mole per cent).

(2) Hexafluorobenzene. Imperiel Smelting Co., Avnomouth, U.K. GC purity 99.7%, density, $\rho_{298.15} = 1.60596\ \text{g cm}^{-3}$. Purification described *Anal. Chem.* 1968, *40*, 224.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.03$
$\delta p/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.005$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino, R.; Evans, F. D.; Danforth, W. F. *J. Am. Oil Chem. Soc.* 1968, *45*, 830.
3. Battino, R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Chlorobenzene; C_6H_5Cl; [108-90-7]

ORIGINAL MEASUREMENTS:

Horiuti, J.

Sci. Pap. Inst. Phys. Chem. Res. (Jpn) 1931/32, *17*, 125 - 256.

VARIABLES:

T/K: 232.70 - 353.50

p_1/kPa: 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
232.70	6.039	0.1410	0.1201
251.85	6.022	0.1381	0.1273
273.15	6.118	0.1375	0.1375
293.15	6.269	0.1382	0.1483
313.15	6.459	0.1396	0.1600
333.15	6.718	0.1423	0.1735
353.50	7.072	0.1467	0.1898

The mole fraction and Bunsen coefficient values were calculated by the compiler with the assumption the gas is ideal and that Henry's law is obeyed.

Smoothed Data: For use between 232.70 and 353.50 K.

$$\ln x_1 = -12.5466 + 6.6418/(T/100\text{K}) + 2.7010 \ln (T/100\text{K})$$

The standard error about the regression line is 1.70×10^{-6}.

T/K	Mol Fraction 10^4x_1	T/K	Mol Fraction 10^4x_1
233.15	6.043	298.15	6.309
243.15	6.020	308.15	6.416
258.15	6.038	323.15	6.601
273.15	6.107	338.15	6.811
288.15	6.217	353.15	7.045

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a gas buret, a solvent reservoir, and an absorption pipet. The volume of the pipet is determined at various meniscus heights by weighing a quantity of water. The meniscus height is read with a cathetometer.

The dry gas is introduced into the degassed solvent. The gas and solvent are mixed with a magnetic stirrer until saturation. Care is taken to prevent solvent vapor from mixing with the solute gas in the gas buret. The volume of gas is determined from the gas buret readings; the volume of solvent is determined from the meniscus height in the absorption pipet.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by dropping formic acid onto conc. H_2SO_4. The gas was passed through several wash solutions to remove CO_2 and O_2, dried by H_2SO_4 & P_2O_5.

(2) Chlorobenzene. Kahlbaum. Dried and distilled. Boiling point (760 mmHg) 131.96°C.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.05$

$\delta x_1/x_1 = 0.01$

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Fomblin YR (perfluorinated polyether); [25038-02-2]	Matsumato, D. K.; Satterfield, C. N. *Ind. Eng. Chem. Process Des. Dev.* 1985, *24*, 1297-1300.
VARIABLES:	PREPARED BY:
$T/\mathrm{K} = 473 - 533$ $p_1/\mathrm{MPa} = 0.5 - 0.8$	R. W. Cargill

EXPERIMENTAL VALUES:

T/K	solubility/ $\mathrm{mol\ m^{-3}\ MPa^{-1}}$	Henry's constant/ MPa	mole fraction* x_1
473.16	103.8	6.42	0.156
503.16	105.4	6.14	0.163
533.16	109.4	5.68	0.176

* calculated by compiler; inverse of Henry's constant, to give mol fraction solubility at 1 MPa partial pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solvent is weighed into a 1 $\mathrm{dm^3}$ stainless steel bomb, wrapped in heating tapes. After flushing and reaching temperature equilibrium, gas is charged into the bomb at the required pressure (up to about 1 MPa).

Equilibrium is established by mechanical rocking for 6 hours.

Amount of gas absorbed is obtained from pressure measurements, and calculation of a mole balance.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson CP grade.

(2) Fomblin YR. Montedison; M.W. 3500.

ESTIMATED ERROR:

$\delta x/x = \pm 5\%$ (authors)

REFERENCES:

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Compounds containing sulfur	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

Carbon disulfide [75-15-0]
The disagreement between the three sets of data which are available for carbon monoxide at a partial pressure of 101.3 kPa dissolving in carbon disulfide, makes it impossible to recommend any values even tentatively. Just's values (1) at 293.15 K and 298.15 K correspond closely with one of Skirrow's (2) at 298.15 K, but Skirrow's second value at this temperature is about 16% higher. The more recent work of Gjaldbaek (3) gives values at 298.15 K which are about 70% higher. It may be that the solvent used by Gjaldbaek was of significantly greater purity. Further measurements are necessary to resolve the discrepancy. In this context it is worth noting that for the solubility of nitrogen in this solvent, the values given by Just (1) were about 35% lower than those given by Gjaldbaek and Hildebrand (5) at these temperatures.

Skirrow's paper (2) contains data on the solubility of carbon monoxide in mixtures of carbon disulfide and 1,2-dichloroethane [107-06-2]. These solubilities appear to go through a maximum as the composition of the solvent changes through about 50% by volume. The data, however, need to be read with caution in the absence of any corroborating evidence. The solubility in mixtures of carbon disulfide and acetone, also due to Skirrow, may be referred to in an earlier section of this volume dealing with acetone.

Hydrogen sulfide [7783-06-4]

The work of Fredenslund and Mollerup (4) at 203-293 K and 0.15-24 MPa may be consulted for the carbon monoxide - hydrogen sulfide system. There is no reason to reject the data, but confirmation is necessary by some additional work on this system.

Reference

1. Just, G.
   Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.
2. Skirrow, F.W.
   Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139.
3. Gjaldbaek, J.C.
   Acta Chem. Scand. 1952, *6*, 623.
4. Fredensland, A.; Mollerup, J.
   J. Chem. Thermodynamics 1975, *7*, 677.
5. Gjaldbaek, J.C.; Hildebrand, J.H.
   J. Amer. Chem. Soc, 1949, *71*, 3147.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Carbon disulfide; CS_2; [75-15-0]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
293.15	2.03	0.0756	0.08112
298.15	2.06	0.0762	0.08314

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Carbon disulfide. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Carbon disulfide; CS_2; [75-15-0]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

T/K = 298.15
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
298.15	2.38	0.0879	0.0959[1]
	2.06	0.076	0.083[2]

[1] See Table 21 in the paper.

[2] See Table 27 in the paper.

The Bunsen coefficient and the mole fraction values were calculated by the compiler assuming ideal gas behavior. The values are adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) assuming Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of the liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the solvent volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Carbon disulfide. No information.

ESTIMATED ERROR:

$\delta L/\text{cm}^3 = \pm 0.001$

REFERENCES:

1. **Just, G.**

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Carbon disulfide; CS_2; [75-15-0]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.

Acta Chem. Scand. 1952, *6*, 623 - 633.

VARIABLES:

$T/K = 298.05$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
298.05	3.61	0.133	0.145
298.05	3.59	0.132	0.144

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid. 99.5% CO + 0.5% N_2.

(2) Carbon disulfide. Merck and Co. Analytical reagent. B.p. (760 mmHg)/°C = 46.21 - 46.26.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.
2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Carbon disulfide; CS_2; [75-15-0]

(3) 1,2-Dichloroethane or ethylene chloride; $C_2H_4Cl_2$; [107-06-2]

ORIGINAL MEASUREMENTS:

Skirrow, F. W.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139-60.

VARIABLES:

$T/K = 298.2$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Carbon Disulfide	Ostwald Coefficient
$t/°C$	T/K	$10^2\phi_2$/vol %	L/cm^3cm^{-3}
25.0	298.2	0.0	0.147
		25.0	0.159
		49.0	0.160
		81.6	0.140
		100	0.083

The author also reported the refractive index and the vapor pressure of the solvent.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the liquid volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Carbon disulfide.
(3) 1,2-Dichloroethane.

No information.

ESTIMATED ERROR:

$\delta L/cm^3 = \pm 0.001$ (Author)

REFERENCES:

1. **Just, G.**

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Hydrogen sulfide; H_2S; [7783-06-4]

ORIGINAL MEASUREMENTS:

Fredenslund, A.; Mollerup, J.

J. Chem. Thermodynamics 1975, *7*, 677-682.

VARIABLES:

$T/K = 203 - 293$
$p/MPa = 0.16 - 24$

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor, x_{CO}
203.15	0.158	0.00043	0.6196
	0.219	0.00069	0.7218
	0.391	0.0014	0.8456
	0.887	0.0035	0.9298
	1.577	0.0061	0.9600
	1.990	0.0075	0.9663
	3.113	0.0111	0.9756
	5.035	0.0150	0.9810
	6.956	0.0172	0.9820
	10.39	0.0187	0.9801
	13.53	0.0185	0.9770
	21.87	0.0150	0.9652
233.15	0.355	0.00050	0.2900
	0.602	0.0016	0.5450
	1.065	0.0038	0.7430
	1.985	0.0081	0.8500
	3.728	0.0158	0.9072
	5.749	0.0243	0.9290
	8.366	0.0351	0.9342
	13.355	0.0547	0.9317
	22.646	0.0873	0.9128
263.15	0.872	0.00048	0.1050
	1.533	0.0036	0.4560
	2.398	0.0077	0.6320
	3.297	0.0121	0.7112

contd.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Recirculating vapor flow apparatus. Temperature measured with Platinum resistance thermometer. Pressure measured with dead weight piston gauge coexisting phases analysed by gas chromatography. Details in ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. Dansk Ilt og. Brint sample; purity 99.97 mole per cent.

2. Dansk Ilt og Brint sample 98.5 mole per cent pure more volatile impurities measured by crude fractionation.

ESTIMATED ERROR:

$\delta T/K = \pm 0.01$; $\delta p/MPa = \pm 0.1\%$
$\delta x \simeq \delta y = \pm 0.2\%$

REFERENCES:

1. Fredenslund, A.; Mollerup, J. Christiansen, L.J., *Cryogenics* 1973, *13*, 414

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrogen sulfide; H_2S; [7783-06-4]

ORIGINAL MEASUREMENTS:

Fredenslund, A.; Mollerup, J.

J. Chem. Thermodynamics 1975, *7*, 677-682.

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in vapor x_{CO}
263.15	4.286	0.0170	0.7583
	5.087	0.0208	0.7815
	6.680	0.0286	0.8133
	8.729	0.0385	0.8340
	12.757	0.0580	0.8415
	19.368	0.0900	0.8281
293.15	3.115	0.0072	0.3580
	3.735	0.0109	0.4410
	5.749	0.0238	0.5808
	6.661	0.0297	0.6165
	7.221	0.0336	0.6330
	8.390	0.0412	0.6576
	9.168	0.0469	0.6695
	10.566	0.0569	0.6847
	12.115	0.0679	0.6951
	13.680	0.0792	0.7015
	16.202	0.0986	0.7001
	17.280	0.1072	0.6958
	18.319	0.1158	0.6907
	19.409	0.1255	0.6841
	20.050	0.1311	0.6800
	20.746	0.1379	0.6750
	21.893	0.1499	0.6659
	23.192	0.1648	0.6548
	23.724	0.1720	0.6495

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Organic compounds containing nitrogen	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. February 1989

CRITICAL EVALUATION:

Data have been published on the solubility of carbon monoxide in nine solvents of this class. Most refer to temperatures near 298 K and partial pressures of about 1 bar. In only a few cases has it been possible to compare values from different sources, so that a fully critical evaluation has not always been possible.

1. N-Ethylethanamine (diethylamine); $C_4H_{11}N$; [109-89-7]

2. N, N-Diethylethanamine (triethylamine); $C_6H_{15}N$; [121-44-8]

Taqui Khan and Halligudi (1) measured the solubility of carbon monoxide in these amines, and in various mixtures of each of them with water, at partial pressures near 3.2 MPa and 343-373 K. The data sheets to consult are in the (water + organic solvent) section of this volume. The experimental values may be used with caution. They need to be confirmed by further measurements since the data on carbon monoxide in water from the same set of experiments showed some discrepancies from other published data. (See evaluation of the high pressure solubility of carbon monoxide in water).

3. Benzeneamine (aniline); C_6H_7N; [62-53-3]

Just (2), Skirrow (3), and Gjalbaek and Andersen (4) have provided data on the solubility of carbon monoxide in benzeneamine at a partial pressure of 101.3 kPa and at 298.15 K. Gjaldbaek and Andersen's value may be more accurate due to their careful purification of the solvent, but it is about 5% lower than the others which agree within 1%. A mol fraction solubility of 1.94×10^{-4} is recommended, with a possible error of ± 2%. Just's value at 293.15 K may be accepted provisionally.

4. Nitrobenzene; $C_6H_5NO_2$; [98-95-3]

At 298.15 K and a partial pressure of 101.3 kPa, data from the same three laboratories may again be compared (2, 3, 4). Once more the value of Gjaldbaek and Andersen is about 5% lower than the other two values which agree closely. However, given that the solvent used by Gjaldbaek and Andersen was thoroughly purified, the average of their six measurements is recommended for this system, $x_1 = 3.73 \times 10^{-4}$. Just's value at 293.15 K may be accepted provisionally.

5. Pyridine; C_5H_5N; [110-86-1]

Gjaldbaek and Andersen's (4) value at 298.15 K and 101.3 kPa may be accepted tentatively. The data of Vasilieva *et al* (5) for a partial pressure of carbon monoxide of 5-30 MPa and at 313-513 K have to be taken with some caution in the absence of confirmatory evidence. However, extrapolation of those data at 313.2 K from 5 MPa to 0.1 MPa gives a value similar to Gjaldbaek and Andersen's experimental one.

6. 1,1-Dimethylhydrazine; $N_2H_2(CH_3)_2$ [57-14-7]

Chang *et al.*(6) have given mol fraction solubilities for carbon monoxide in this solvent at 253-298 K and partial pressures in the range 1-2 bar. Their data are the only ones for this system. Although there is no reason to doubt their validity, some confirmation would be highly desirable.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Organic compounds containing nitrogen

EVALUATOR:

Robert W. Cargill,
Department of Molecular
and Life Sciences,
Dundee Institute of Technology,
Bell Street, Dundee, DD1 1HG, U.K.

February 1989

CRITICAL EVALUATION:

7. Propanenitrile; C_3H_5N; [107-12-0]

8. Benzeneacetonitrile (benzyl cyanide); C_8H_7N; [140-29-4]

The values at 298.15 K and a partial pressure of 101.3 kPa for each of these solvents given by Gjaldbaek and Andersen (4) may be taken tentatively until some further evidence is available.

9. N,N-Dimethylformamide; C_3H_7NO; [68-12-2]

The data of Haidegger *et al.* (7) at 278.15, 293.15, and 313.15 K show some irregular variations with pressure, and a large possible error exists. They should be used only with very great caution.

References

1. Taqui Khan, M.M; Halligudi, S.B.
J. Chem. Eng. Data, 1988, *33*, 276.

2. Just, G.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

3. Skirrow, F.W.
Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1902, *41*, 139.

4. Gjaldbaek, J.C.; Andersen, E.K.
Acta Chem. Scand. 1954, *8*, 1398.

5. Vasilieva, I.I.; Naumova, A.A.; Poliakov, A.A.; Tyvina, T.N.; Fokina, V.V.
Zh. Prikl. Chim. 1987, 60, 559.

6. Chang, E.T.; Gocken, N.A.; Poston, T.M.
J. Chem. Eng. Data 1971, *16*, 404.

7. Haidegger, E.; Szebenyi, I.; Szekely, A.
Megy. Kem. Foly. 1958, *64*, 365.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Benzenamine or aniline; C_6H_7N; [62-53-3]	Just, G. *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* <u>1901</u>, *37*, 342-67.
VARIABLES: T/K = 293.15, 298.15 p_1/kPa = 101.325 (1 atm)	PREPARED BY: M. E. Derrick H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient α/cm^3 (STP) cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
293.15	1.92	0.0471	0.05055
298.15	2.00	0.0491	0.05358

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Benzenamine. No information.

ESTIMATED ERROR:

$\delta L/L$ = 0.03 (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* <u>1890</u>, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, <u>1894</u>, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Benzenamine or aniline; C_6H_7N; [62-53-3]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

$T/K = 298.15$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient. $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
298.15	1.90	0.0465	0.0508
	1.89	0.0462	0.0504
	1.90	0.0465	0.0508

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent). 99.6 - 99.9% CO, the rest being atmospheric air.

(2) Benzenamine. Merck and Co. Puriss, Fractional distillation in vacuum. B.p. (760 mmHg)/°C = 184.32 - 184.34, refractive index $n_D(20°C) = 1.5864$.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$

$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Carbon monoxide; CO; [630-08-0] (2) Nitrobenzene; $C_6H_5NO_2$; [98-95-3] Benzeneamine; C_6H_7N; [62-53-3]	**Skirrow, F. W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1902, *41*, 139-60.

VARIABLES:	PREPARED BY:
T/K = 298.15 p_1/kPa = 101.325 (1 atm)	H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3(STP)cm^{-3}atm^{-1}	Ostwald Coefficient L/cm^{3}cm^{-3}
Nitrobenzene			
298.15	3.92	0.085	0.093
Benzenamine or aniline			
298.15	1.98	0.049	0.053

The Bunsen coefficient and the mole fraction values were calculated by the compiler assuming ideal gas behavior. The values are adjusted to a carbon monoxide partial pressure of 101.325 kPa (1 atm) assuming Henry's law is obeyed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald type apparatus similar to that described by Just (1) was used.

The apparatus consists of a water-jacketed gas buret, a manometer, and an absorption flask.

The volume of dry gas absorbed by a known volume of the liquid is obtained as the difference between the initial and final gas buret readings at atmospheric pressure.

The absorbed gas volume is calculated at the partial pressure of the solute gas over the liquid by means of the previously measured liquid vapor pressure. The ratio of the calculated gas volume to the solvent volume is the Ostwald coefficient.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the action of sulfuric acid and heat on oxalic acid. The gas was passed through KOH to remove CO_2.

(2) Nitrobenzene. Benzeneamine.

No information.

ESTIMATED ERROR:

δL/cm^3 = ± 0.001

REFERENCES:

1. **Just, G.**

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Nitrobenzene; $C_6H_5NO_2$; [98-95-3]

ORIGINAL MEASUREMENTS:

Just, G.

Z. Phys. Chem., Stoechiom. Verwandtschaftsl. 1901, *37*, 342-67.

VARIABLES:

T/K = 293.15, 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

M. E. Derrick
H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
293.15	3.89	0.0848	0.09105
298.15	3.95	0.0858	0.09366

The author measured the Ostwald coefficient at a pressure of about 746 mmHg. The compiler assumed the Ostwald coefficient to be independent of pressure, and calculated the mole fraction and Bunsen coefficient values at 101.325 kPa (1 atm) partial pressure of the gas.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An Ostwald apparatus as modified by Timofejew (1), and Steiner (2) is used. The apparatus consists of a gas buret, an absorption flask, and a mercury manometer. The system is thermostated with a water jacket.

The gas is introduced into the degassed liquid. The gas volume absorbed is determined by the gas buret. The solvent volume is determined at the end of the experiment by pouring the solvent into a graduated flask.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by the decomposition of oxalic acid by sulfuric acid and heat. Carbon dioxide was removed by passing the gas through a KOH solution.

(2) Nitrobenzene. No information.

ESTIMATED ERROR:

$\delta L/L = 0.03$ (compiler)

REFERENCES:

1. **Timofejew, W.** *Z. Phys. Chem., Stoechiom. Verwandtschaftsl.* 1890, *6*, 141.
2. **Steiner, P.** *Ann. Phys. (Leipzig)*, 1894, *52*, 275.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Nitrobenzene; $C_6H_5NO_2$; [98-95-3]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

$T/K = 298.15$
$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^4x_1	Bunsen Coefficient $\alpha/cm^3(STP)cm^{-3}atm^{-1}$	Ostwald Coefficient L/cm^3cm^{-3}
298.15	3.75	0.0819	0.0894
	3.77	0.0823	0.0898
	3.70	0.0808	0.0882
	3.69	0.0805	0.0879
	3.73	0.0814	0.0888
	3.70	0.0808	0.0882

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent). 99.6 - 99.9% CO, the rest being atmospheric air.

(2) Nitrobenzene. Purified by fractional freezing and by fractional distillation in vacuum. M.p./°C = 5.75, b.p. (760 mmHg)/°C = 211.94 - 211.95, refractive index, $n_D(20°C)$ = 1.5524 - 1.5527.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Pyridine; C_5H_5N; [110-86-1]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

T/K = 298.15
p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient α/cm^3 (STP) cm^{-3} atm^{-1}	Ostwald Coefficient L/cm^3 cm^{-3}
298.15	3.86	0.107	0.117
	3.86	0.107	0.117

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent). 99.6 - 99.9% CO, the rest being atmospheric air.

(2) Pyridine. Fractionated by distillation, B.p. (760 mmHg)/°C = 115.51 - 115.55, refractive index n_D(20°C) = 1.5100 - 1.5101.

ESTIMATED ERROR:

$\delta T/\mathrm{K} = \pm 0.05$
$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]

2. Pyridine; C_5H_5N; [110-86-1]

ORIGINAL MEASUREMENTS:

Vasilieva, I.I.; Naumova, A.A.; Poliakov, A.A.; Tyvina, T.N.; Fokina, V.V.

Zh. prikl. chim. 1987, *60*, 559-562.

VARIABLES:

$T/K = 313.2 - 513.2$
p_1 MPa = 5.0 - 30.0

PREPARED BY:

Yu. P. Yampol'skii

EXPERIMENTAL VALUES:

Pressure	Mole fraction of pyridine (x_2) in liquid phase at temperature					
p_1/MPa	313.2 K	353.2 K	393.2 K	433.2 K	473.2 K	513.2 K
30.0	0.894	0.864	0.847	0.820	0.796	0.770
25.0	0.906	0.886	0.865	0.847	0.825	0.805
20.0	0.921	0.905	0.888	0.872	0.855	0.839
15.0	0.940	0.927	0.916	0.902	0.890	0.876
10.0	0.962	0.952	0.945	0.936	0.928	0.918
5.0	0.981	0.977	0.973	0.970	0.968	0.966

Henry's constant (see ref. 1) K_H/MPa = $(p_1/MPa)/x_1$, and heat of solution ΔH/kJ mol^{-1}, given below.

	Temperature/K					
	313.2	353.2	393.2	433.2	473.2	513.2
K_H/MPa	269	224	183	151	122	96
ΔH/kJ mol^{-1}	3.6	4.8	6.2	7.7	9.5	11.3

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static apparatus was used of the type described in Tsiklis, D.S. *Technica fizikochimicheskich issledivanni pri vysokich davlenijack*; 4th Ed. Moscow, "Chimia", 1976, 431pp.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. purity 99.7%

(2) Pyridine. "pure" grade; n_D^{20} = 1.5092

ESTIMATED ERROR:

REFERENCES:

1. Krichevski, I.R. *Fasovyie* ravnovesija v rastvorach pri vysokich davlenjach; Moscow Goschimizdat, 1952.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. 1,1-Dimethylhydrazine; $N_2H_2(CH_3)_2$; [57-14-7]

ORIGINAL MEASUREMENTS:

Chang, E.T.; Gocken, N.A.; Poston, T.M.

J. Chem. Engng. Data. 1971, *16*, 404-8.

VARIABLES:

Temperature, pressure

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	p^+atm	p^+/kPa	Mole fraction of carbon monoxide in liquid, x_{CO}
253.24	0.9302	94.25	0.000462
	1.0190	103.25	0.000499
	1.5276	154.78	0.000760
	1.7539	177.71	0.000860
278.13	0.8772	88.88	0.000459
	1.0861	110.05	0.000570
	1.6077	162.90	0.000846
	1.8643	188.90	0.000980
298.16	1.0391	105.29	0.000586
	1.4056	142.42	0.000795
	1.8454	186.99	0.001046
	2.1012	212.90	0.001189

+ partial pressure of carbon monoxide.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Volumetric apparatus consisting of solvent vessel and buret with three calibrated bulbs. Pressure measured with mercury manometer and cathetometer. Solvent stirred with magnet enclosed in glass. Mole fraction absorbed calculated from knowledge of amount of gas before and after absorption. Solvent carefully degassed.

SOURCE AND PURITY OF MATERIALS:

1. Research grade gas, purity 99.8 mole per cent minimum.
2. Sample of purity 99 mole per cent, further purified by vacuum distillation.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$; $\delta p/kPa = \pm 0.01$; $\delta x_{CO} < \pm 2\%$

REFERENCES:

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Propanenitrile; C_3H_5N; [107-12-0]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

$T/K = 298.15$

$p_1/kPa = 101.325$ (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/cm^3 (STP) cm^{-3} atm^{-1}$	Ostwald Coefficient $L/cm^3 cm^{-3}$
298.15	6.30	0.199	0.217
	6.30	0.199	0.217

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent), 99.6 - 99.9% CO, the rest being atmospheric air.

(2) Propanenitrile. Rubber Industries and Sherman Chemicals. Fractionated by distillation. B.p. (760 mmHg)/°C = 97.31-97.35, refractive index n_D(20°C) = 1.3664 - 1.3665.

ESTIMATED ERROR:

$\delta T/K = \pm 0.05$

$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.

2. Gjaldbaek, J. C. *Acta Chem. Scand.* 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Benzeneacetonitrile or benzyl cyanide; C_8H_7N; [140-29-4]

ORIGINAL MEASUREMENTS:

Gjaldbaek, J. C.; Andersen, E. K.

Acta Chem. Scand. 1954, *8*, 1398 - 1413.

VARIABLES:

T/K = 298.15

p_1/kPa = 101.325 (1 atm)

PREPARED BY:

J. Chr. Gjaldbaek

EXPERIMENTAL VALUES:

T/K	Mol Fraction $10^4 x_1$	Bunsen Coefficient $\alpha/\text{cm}^3 (\text{STP})\text{cm}^{-3}\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\text{cm}^{-3}$
298.15	3.57	0.0692	0.0755
	3.55	0.0687	0.0750
	3.60	0.0698	0.0762
	3.60	0.0698	0.0762

The mole fraction and Ostwald coefficient values were calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of a calibrated all-glass manometer and bulb enclosed in an air thermostat. The solvent is added and degassed in the apparatus. The gas is added. The apparatus and contents are shaken until equilibrium is attained. Mercury is used for calibration and as the confining liquid.

The absorbed volume of gas is calculated from the initial and final amounts of gas, both saturated with solvent vapor. The amount of solvent is determined by the weight of displaced mercury. Further details are in the references (1, 2).

The mole fraction values are at one atm pressure assuming Henry's law is obeyed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared from formic acid (Merck, analytical reagent). 99.6 - 99.9% CO, the rest being atmospheric air.

(2) Benzeneacetonitrile. Fractional distillation in vacuum. B.p. (760 mmHg)/°C = 233.49 - 233.55, refractive index $n_D(20°C)$ = 1.5233.

ESTIMATED ERROR:

$\delta T/\text{K} = \pm 0.05$

$\delta x_1/x_1 = \pm 0.015$

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

2. Gjaldbaek, J. C.
Acta Chem. Scand. 1952, *6*, 623.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) *N*,*N*-Dimethylformamide; C_3H_7NO; [68-12-2]

ORIGINAL MEASUREMENTS:

Haidegger, E.; Szebenyi, I.; Szekely, A.

Magy. Kem. Foly. 1958, *64*, 365-71.

VARIABLES:

T/K = 278.15 - 313.15

p_1/kPa = 26.66 - 119.99

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Pressure	Absorption Coefficient	Bunsen Coefficient
t/°C	T/K	p_1/mmHg	/cm^3(STP)cm^{-3}	α/cm^3(STP)cm^{-3}atm^{-1}
5	278.15	600	0.09	0.11
		760	0.23	0.23
		900	0.27	0.23
20	293.15	660	0.04	0.05
		760	0.12	0.12
		900	0.29	0.24
40	313.15	660	0.01	0.01
		760	0.06	0.06
		900	0.13	0.11

The compiler calculated the Bunsen coefficients.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus consists of an absorption flask in a thermostated bath and a water-jacketed buret.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. No information.

(2) *N*,*N*-Dimethylformamide. Distilled, dried. Refractive index n_D^{25} = 1.4265, density ρ_4^{25} = 0.9451 g cm^{-3}. The water content was 0.2 wt percent.

ESTIMATED ERROR:

$\delta\alpha/\alpha = \pm\ 0.30$ (compiler)

At pressures 600 mmHg and above.

REFERENCES:

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Biological fluids	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

A number of workers have measured the solubility of carbon monoxide in a variety of fluids of biological origin. In view of the importance of monitoring and understanding the toxicity of carbon monoxide it is surprising that more work has not been done in this area. In fact the data available on most of these solvents are rather scarce and fragmentary, and the experimental conditions are subject to such variation that comparison to produce a meaningful evaluation is very difficult. Data have been compiled for the following solvents. In most cases the partial pressure of carbon monoxide is around 1 atm.

1. Olive oil

Battino *et al.* (1) and Power and Stegall (2) have provided data covering 298-328 K and 285 - 310 K respectively. The discrepancy between the two sets of data is quite small (about 2%) and may be due to differences in the olive oil samples used. The values from Battino *et al.* (1) are recommended.

2. Gelatin in water

Shkol'nikova's data (3) for solutions of 1-10% by weight of gelatin in water as solvent for carbon monoxide between 283 K and 313 K appear to be of the correct magnitude and follow the normal trends.

3. Blood, serum, plasma

Findlay and Creighton (4), O'Brien and Parker (5), Power (6), and Power and Stegall (2) measured the solubility of carbon monoxide in human and animal blood and blood components at temperatures in the range 283 - 313 K. Several values are available for 310.15K, the normal physiological temperature for humans. Shkol'nikova (3) measured solubilities in 0.5 - 2.9 weight percent solutions of serum albumin in water.

Allowing for the very real possibility of variation between solvent samples and their preparation, and some differences in experimental conditions, the values in most cases confirm one another. Individual data sheets may be consulted for values which may be taken tentatively. The only set of data which deviates considerably from the others is that for deaerated ox serum due to Findlay and Creighton (4). At 754 mmHg pressure, their solubility value appears to be about ten times too small. Data from O'Brien and Parker (5) are to be preferred for this system.

For blood itself, two complementary sets of data are available; (i) from Findlay and Creighton (4) on untreated blood, and (ii) from Power (6) on blood in which the formation of carboxyhemoglobin is prevented by the addition of specific salts. According to these data, carbon monoxide is about five times less soluble in the inhibited sample than in natural blood. The solubility in serum and plasma is similarly about five times smaller. Findlay and Creighton's data were obtained over partial pressures of carbon monoxide between 0.1 and 0.2 MPa and show clearly that Henry's law is not obeyed. All this is evidence for the special interaction of carbon monoxide with hemoglobin in blood, and its role in the toxicity process. One of the earliest studies on the interaction of carbon monoxide with blood was by Hufner and Kulz (7), but no data sheet was compiled from their work because of uncertainties in experimental conditions.

4. Pulmonary and placental tissue

Power's data (6) on human lung tissue and sheep placental tissue at 310.15 K and 45 - 96 kPa partial pressure of carbon monoxide may be taken tentatively, noting again that inhibitors to the formation of carboxyhemoglobin were added to the solvent samples, and that the results have an appropriate correction factor applied to them.

COMPONENTS:	EVALUATOR.
1. Carbon monoxide; CO; [630-08-0] 2. Biological fluids	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. March 1989

CRITICAL EVALUATION:

References

1. Battino, R.; Evans, F.D.; Danforth, W.F. *J . Am. Oil Chem. Soc.* 1968, *45*, 830.

2. Power, G.G.; Stegall, H. *J. Appl. Physiology* 1970, *29*, 145.

3. Shkol'nikova, R.I. *Uch Zap. Leningr. Gos. Univ. Ser. Khim. Nauk.* 1959, *18*, 64.

4. Findlay, A.; Creighton, H.J.M. *Biochem J.* 1910, *5*, 294.

5. O'Brien, H.R.; Parker, W.L. *J.Biol. Chem.* 1922, *50*, 289.

6. Power, G.G. *J. Appl. Physiology* 1968, *24*, 468.

7. Hüfner, G.; Külz, R. *J. Pract. Chem.* 1883, *28*, 256.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Olive oil

ORIGINAL MEASUREMENTS:

Battino, R.; Evans, F. D.; Danforth, W. F.

J. Am. Oil Chem. Soc. 1968, *45*, 830 - 833.

VARIABLES:

T/K: 297.94 - 327.93
P/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3(\text{STP})\ \text{cm}^{-3}\ \text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\ \text{cm}^{-3}$
297.94	3.64	0.08352	0.09110
298.21	3.68	0.08433	0.09206
308.15	3.79	0.08637	0.09744
308.19	3.84	0.08749	0.09872
317.59	3.85	0.08743	0.1016
327.93	4.01	0.09044	0.1086

The solubility values were adjusted to a partial pressure of carbon monoxide of 101.325 kPa (1 atm) by Henry's law.

Smoothed Data: For 298.15 - 328.15 K.

$$\ln x_1 = -4.6570 - 2.8328/(T/100\text{K})$$

The standard error about the regression line is 3.71×10^{-5}.

T/K	Mol Fraction 10^3x_1
298.15	3.67
308.15	3.79
318.15	3.90
328.15	4.00

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus is based on the design by Morrison and Billett (1) and the version used is a modification of the apparatus of Clever, Battino, Saylor and Gross (2).

Degassing. The solvent is sprayed into an evacuated chamber of an all glass apparatus; it is stirred and heated until the pressure drops to the vapor pressure of the liquid. Solubility Determination. The degassed liquid passes in a thin film down a glass spiral tube at a total pressure of one atm of solute gas plus solvent vapor. The gas absorbed is measured in the attached buret system, and the solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Linde Co. The minimum volume per cent purity is 99.5.

(2) Olive oil. A. U.S.P. Fisher Scientific Co., 0.58% free fatty acid.
B. Nutritional Biochemicals Corp. 0.30% free fatty acid. The density was measured and fitted to the equation $\rho/\text{g cm}^{-3} = 0.9152 - 0.000468t/\text{C}$. The average mol wt is 884 ± 45.

ESTIMATED ERROR:

$\delta T/K = \pm 0.03$
$\delta P/\text{mmHg} = \pm 0.5$
$\delta X_1/X_1 = \pm 0.03$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Clever, H. L.; Battino, R.; Saylor, J. H.; Gross, P. M. *J. Phys. Chem.* 1957, *61*, 1078.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Olive oil.

ORIGINAL MEASUREMENTS:

Power, G.G.; Stegall, H.

J. Appl. Physiology, 1970, *29*, 145-9.

VARIABLES:

T/K = 285.15 - 310.15

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	Bunsen coefficient, α	S.D.*	No. of measurements.
310.15	0.0858	0.0002	5
298.15	0.0859	0.0002	5
285.15	0.0860	0.0003	5

* Standard deviation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Liquid saturated with gas in a stirred cell. 5.0 cm^3 samples of liquid removed in a calibrated syringe and amount of gas extracted by two extractions in a van Slyke apparatus determined. Details in source and ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. Matheson Co. sample, purity better than 99.7 mole per cent.
2. No details given.

ESTIMATED ERROR:

δT/K = ±0.1

REFERENCES:

1. Power, G.G. *J. Appl. Physiology*, 1968, *24*, 468.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Gelatin

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shkol'nikova, R. I.

Uch. Zap. Leningr. Gos. Univ. Ser. Khim. Nauk. 1959, *18*, 64 - 86.

Chem. Abstr. 1961, *55*, 25443b.

VARIABLES:

T/K = 283.15 - 313.15
P/kPa = 101.325 (1 atm)
Gelatin/wt % = 1 - 10

PREPARED BY:

H. L. Clever
A. L. Cramer

EXPERIMENTAL VALUES:

T/K	Gelatin/1 wt %		Gelatin/5 wt %		Gelatin/10 wt %	
	Bunsen Coefficient $10^3\alpha$	Ostwald Coefficient 10^3L	Bunsen Coefficient $10^3\alpha$	Ostwald Coefficient 10^3L	Bunsen Coefficient $10^3\alpha$	Ostwald Coefficient 10^3L
283.15	18.3	19.1	17.6	18.1	14.6	15.1
288.15	17.8	18.8	15.8	16.4	13.4	14.2
293.15	15.5	16.7	14.0	15.0	12.2	13.1
298.15	13.5	14.7	12.4	13.5	11.2	12.2
303.15	11.9	13.2	10.8	12.0	10.1	11.2
308.15	11.1	12.5	10.4	11.7	9.2	10.4
313.15	10.8	12.1	9.9	11.0	8.1	9.6

The enthalpies of solution from the temperature coefficient of the Bunsen coefficient are 2960 cal mol^{-1} in water, and 3300, 3360, and 3250 cal mol^{-1} for the 1, 5, and 10 wt % gelatin solution, respectively.

The values for the solubility of carbon monoxide in water were not given in the paper.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus and procedure were modified Lannung (1).

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Source not given. Stated to be 100 per cent.

(2) Gelatin
(3) Water

No information.

ESTIMATED ERROR:

REFERENCES:

1. Lannung, A.
J. Am. Chem. Soc. 1930, *52*, 68.

COMPONENTS:

1. Carbon monoxide; CO; [130-08-0]
2. Ox blood and ox serum

ORIGINAL MEASUREMENTS:

Findlay, A.; Creighton, H. J. M.
Biochem. J.
1910, *5*, 294-305.

VARIABLES:

T = 298.15 K
p/MPa = 0.1 - 0.2

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	Density of soln. /g cm^{-3}	p_{CO}/mmHg	p_{CO}/MPa	Solubility, $S^{\dagger}$
		Blood		
298.15	1.061	751	0.100	0.0979
		944	0.126	0.0828
		1144	0.152	0.0745
		1371	0.183	0.0658
		1434	0.191	0.0657
		1528	0.204	0.0641
		Deaerated Blood		
298.15	1.061	751	0.100	0.0949
		871	0.116	0.0826
		1056	0.141	0.0746
		1140	0.152	0.0710
		1274	0.170	0.0661
		1543	0.206	0.0582
		Deaerated Ox Serum		
298.15	1.028	754	0.101	0.0014
		859	0.115	0.0035
		1061	0.141	0.0051
		1243	0.166	0.0066
		1372	0.183	0.0078
		1509	0.201	0.0086

† Solubility, S, given as $\dfrac{\text{Concentration of gas in the liquid phase}}{\text{Concentration of gas in the gas phase}}$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas buret and adsorption pipet similar to that of Geffcken (1) except that the manometer tube was longer to give the higher pressures.

SOURCE AND PURITY OF MATERIALS:

1. Obtained by heating pure potassium ferrocyanide with conc. sulfuric acid.
2. Obtained from slaughter house. Deaerated samples kept under a reduced pressure of ∿2 kPa for one hour.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$; $\delta S/S = \pm 2\%$
(estimated by compiler).

REFERENCES:

1. Geffcken, G.
   Z. Phys. Chem.
   1904, *49*, 257.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Beef serum (ox serum)	O'Brien, H.R.; Parker, W.L. *J. Biol. Chem.* 1922, *50*, 289-300.
VARIABLES: $T/K = 288.1 - 310.1$	PREPARED BY: R.W. Cargill

EXPERIMENTAL VALUES:

T/K	Bunsen coefficient $10^2\alpha/cm^3$ (STP) cm^{-3} atm^{-1} experimental	Bunsen coefficient mean	Ostwald coefficient* $10^2L/cm^3$ cm^{-3} mean
288.15	2.03 2.03	2.03	2.14
293.15	1.85 1.76	1.81	1.94
298.15	1.57 1.66	1.61	1.76
303.15	1.50 1.40	1.45	1.61
310.15	1.36 1.17 1.36 1.26	1.29	1.46

* Ostwald coefficient calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas was bubbled through a sample of serum, equilibrated in a thermostat, for 15 minutes, at atmospheric pressure. Frothing was prevented by adding a drop of caprylic alcohol. Gas extracted from serum was analysed in a Van Slyke apparatus under standard conditions.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Made by dropping formic acid into conc. sulfuric acid at 150°C; washed through potassium hydroxide solution, stored over water.

(2) Beef serum. Blood from slaughter house clotted then centrifuged, serum poured off.

ESTIMATED ERROR:

$\delta\alpha/\alpha = \pm 0.05$ (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Sheep serum

ORIGINAL MEASUREMENTS:

O'Brien, H.R.; Parker, W.L.

J. Biol. Chem. 1922, *50*, 289-300.

VARIABLES:

T/K = 288.1 - 310.1

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	Bunsen coefficient		Ostwald coefficient *
	$10^2\alpha/\text{cm}^3\ (\text{STP})\ \text{cm}^{-3}\ \text{atm}^{-1}$		$10^2L/\text{cm}^3\ \text{cm}^{-3}$
	experimental	mean	
288.15	2.10		
	2.01	2.06	2.17
293.15	1.83		
	1.91	1.87	2.01
298.15	1.48		
	1.48		
	1.73	1.56	1.70
303.15	1.50		
	1.41		
	1.58		
	1.69		
	1.50	1.53	1.70
310.15	1.53		
	1.44		
	1.35	1.44	1.64

* Ostwald coefficient calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas was bubbled through a sample of serum equilibrated in a thermostat, for 15 minutes, at atmospheric pressure. Frothing was prevented by adding a drop of caprylic alcohol. Gas extracted from serum was analysed in a Van Slyke apparatus under standard conditions.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Made by dropping formic acid into conc. sulfuric acid at 150°C; washed through potassium hydroxide solution, stored over water.

(2) Sheep serum. Blood from slaughter house clotted then centrifuged, serum poured off.

ESTIMATED ERROR:

$\delta\alpha/\alpha = \pm\ 0.05$ (compiler)

REFERENCES:

COMPONENTS: 1. Carbon monoxide; CO; [630-08-0] 2. Human serum	ORIGINAL MEASUREMENTS: O'Brien, H.R.; Parker, W.L. *J. Biol. Chem.* 1922, *50*, 289-300
VARIABLES: $T/K = 288.1 - 310.1$	PREPARED BY: R.W. Cargill

EXPERIMENTAL VALUES:

T/K	Bunsen coefficient $10^2\alpha/\text{cm}^3\ (\text{STP})\ \text{cm}^{-3}\ \text{atm}^{-1}$ experimental	mean	Ostwald coefficient * $10^2L/\text{cm}^3\ \text{cm}^{-3}$ mean
288.15	2.09	2.09	2.20
293.15	1.80	1.80	1.93
298.15	1.83		
	1.83	1.83	2.00
303.15	1.58	1.58	1.75
310.15	1.43		
	1.42	1.42	1.61

* Ostwald coefficient calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas was bubbled through a sample of serum, equilibrated in a thermostat, for 15 minutes, at atmospheric pressure. Frothing was prevented by adding a drop of caprylic alcohol. Gas extracted from serum was analysed in a Van Slyke apparatus under standard conditions.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Made by dropping formic acid into conc. sulfuric acid at 150°C; washed through potassium hydroxide solution, stored over water.

(2) Human serum. Blood clotted and centrifuged, serum poured off.

ESTIMATED ERROR:

$\delta\alpha/\alpha = \pm\ 0.05$ (compiler)

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Beef plasma

ORIGINAL MEASUREMENTS:

O'Brien, H.R.; Parker, W.L.

J. Biol. Chem. 1922, *50*, 289-300

VARIABLES:

T/K = 288.1 - 310.1

PREPARED BY:

R.W. Cargill

EXPERIMENTAL VALUES:

T/K	Bunsen coefficient $10^2\alpha/\text{cm}^3$ (STP) cm^{-3} atm^{-1} experimental	Bunsen coefficient $10^2\alpha/\text{cm}^3$ (STP) cm^{-3} atm^{-1} mean	Ostwald coefficient * $10^2L/\text{cm}^3$ cm^{-3} mean
288.15	2.03		
	1.95	1.98	2.09
293.15	1.81		
	1.81	1.81	1.94
298.15	1.73		
	1.64	1.69	1.84
303.15	1.47		
	1.47	1.47	1.63
310.15	1.31		
	1.50		
	1.27		
	1.31		
	1.31	1.34	1.52

* Ostwald coefficient calculated by compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Gas was bubbled through a sample of plasma, equilibrated in a thermostat, for 15 minutes, at atmospheric pressure. Frothing was prevented by adding a drop of caprylic alcohol. Gas extracted from plasma was analysed in a Van Slyke apparatus under standard conditions.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Made by dropping formic acid into conc. sulfuric acid at 150°C; washed through potassium hydroxide solution, stored over water.

(2) Beef plasma. Fresh blood ($100\ \text{cm}^3$) mixed with sodium oxalate (0.2g) fluoride (0.3g) and citrate (0.4g) as preservative; centrifuged for 3-4 hours; plasma pipetted off.

ESTIMATED ERROR:

REFERENCES:

$\delta\alpha/\alpha = \pm\ 0.05$ (compiler)

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Serum albumin

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shkol'nikova, R. I.

Uch. Zap. Leningr. Gos. Univ. Ser. Khim. Nauk. 1959, *18*, 64 - 86.

Chem. Abstr. 1961, *55*, 25443b.

VARIABLES:

T/K = 283.15 - 313.15
P/kPa = 101.325 (1 atm)
Serum albumin/Wt % = 0.575 - 2.87

PREPARED BY:

H. L. Clever
A. L. Cramer

EXPERIMENTAL VALUES:

T/K	Bunsen Coefficient, $10^3\alpha$ /cm^3(STP)$cm^{-3}atm^{-1}$				
	0.575 wt %	1.15 wt %	1.68 wt %	1.99 wt %	2.87 wt %
283.15	23.9	22.4	22.1	21.4	19.1
288.15	23.1	21.8	21.2	19.7	18.8
293.15	20.8	20.4	18.1	17.8	17.2
298.15	18.8	16.9	15.4	17.3	16.9
303.15	15.8	14.5	11.9	10.5	7.8
308.15	14.9	13.9	11.1	10.1	7.2
313.15	14.2	13.4	10.8	9.4	6.7

T/K	Ostwald Coefficient, 10^3L /cm^3cm^{-3}				
	0.575 wt %	1.15 wt %	1.68 wt %	1.99 wt %	2.87 wt %
283.15	24.8	23.2	22.9	22.2	19.8
288.15	24.4	23.0	22.4	20.8	19.8
293.15	22.2	21.9	19.4	19.1	18.5
298.15	20.5	18.4	16.8	18.9	18.4
303.15	17.5	16.1	13.2	11.6	8.6
308.15	16.8	15.7	12.5	11.4	8.1
313.15	16.3	15.4	12.4	10.8	7.6

The enthalpies of solution of carbon monoxide calculated from the temperature coefficient of the Bunsen coefficient, are 2960 cal mol^{-1} in water, and 4160, 4040, 4499, and 5825 cal mol^{-1} for 0.575, 1.15, 1.68, and 1.99 wt % serum albumin solutions, respectively.

The solubility of carbon monoxide in water is not given in the paper.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Modifications of the apparatus and procedure of Lannung (1) are used.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Source not given. Stated to be 100 per cent pure.

(2) Serum albumin.
(3) Water.

No information.

ESTIMATED ERROR:

REFERENCES:

1. Lannung, A. *J. Am. Chem. Soc.* 1930, *52*, 68.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Human blood

ORIGINAL MEASUREMENTS:

Power, G. G.

J. Appl. Physiology 1968, *24*, 468-474.

VARIABLES:

T = 310.15 K
p/kPa = 45 - 94

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K = 310.15

Treatment	P_{CO}/mmHg	P_{CO}/kPa	Bunsen Coefficient, α	Corrected Bunsen Coefficient, α
$K_3Fe(CN)_6$, 3.2g/100 ml saponin	706	94.1	0.0186	0.0199
$NaNO_2$, 0.05g/100 ml	318	42.4	0.0178	0.0181
	318	42.4	0.0175	0.0178
	318	42.4	0.0172	0.0175
$NaNO_2$, 1.0g/100 ml	343	45.7	0.0177	0.0182
	343	45.7	0.0176	0.0181
	343	45.7	0.0182	0.0187
	343	45.7	0.0180	0.0185
	343	45.7	0.0193	0.0198
$NaNO_2$, 1.0g/100 ml freeze-thaw hemolysis	340	45.3	0.0189	0.0194
	340	45.3	0.0187	0.0192
	340	45.3	0.0197	0.0202
	340	45.3	0.0191	0.0196
	340	45.3	0.0189	0.0194
	340	45.3	0.0191	0.0196
			Average	0.0189 ± 0.0008

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Liquid samples were equilibrated with gas and then the dissolved gas was stripped out under vacuum and measured in a manometric Van Slyke apparatus. Various amounts of $K_3Fe(CN)_6$ or $NaNO_2$ were added to the blood to prevent the formation of carboxyhemoglobin. The above results have been corrected for the decrease in solubility due to the presence of these salts.

SOURCE AND PURITY OF MATERIALS:

Details given under method.

ESTIMATED ERROR:

δT/K = ±0.03.

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Phosphate buffer and human red cell ghosts in phosphate buffer.

ORIGINAL MEASUREMENTS:

Power, G.G.; Stegall, H.

J. Appl. Physiology, 1970, *29*, 145-9

VARIABLES:

T/K = 285.15 - 310.15

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	Bunsen coefficient, α	S.D.*	No. of measurements
	Phosphate Buffer		
310.15	0.01886	0.00002	6
	Ghosts suspension in buffer		
310.15	0.01940	0.00008	5

T/K	Solubility coefficient,	α°Ghosts	S.D.*	No. of measurements
310.15	0.094	0.006		5
298.15	0.044	0.015		5
285.15	0.021	0.021		4

* Standard deviation.

$\alpha°$ Ghosts = (α ghost suspension $-$ α buffer) / g ghost cm^{-3}

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

5 to 12 cm^{-3} samples placed in a stirrer cell and gas saturated with water vapor passed through liquid for 30-60 mins. Samples of saturated liquid withdrawn and transferred to Van Slyke apparatus. Dissolved gas removed under reduced pressure. Red cell ghosts prepared by centrifugation of human blood and lysing the cells using phosphate buffer of pH 7.4. Ghost separated by high speed centrifugation. Washed with phosphate buffer containing 0.01 M sodium nitrite.

SOURCE AND PURITY OF MATERIALS:

1. Matheson sample, purity better than 99.7 mole per cent.
2. See method.

ESTIMATED ERROR:

δT/K = ±0.1

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Human pulmonary tissue

ORIGINAL MEASUREMENTS:

Power, G. G.

J. Appl. Physiology 1968, *24*, 468-474.

VARIABLES:

T = 310.15 K
p/kPa = 45 - 96

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K = 310.15

Treatment	P_{CO}/mmHg	P_{CO}/kPa	Bunsen Coefficient, α	Corrected Bunsen Coefficient, α
$NaNO_2$, 1.0g/100 ml	717	95.6	0.0175	0.0180
	717	95.6	0.0182	0.0187
	713	95.1	0.0159	0.0164
	713	95.1	0.0176	0.0181
	713	95.1	0.0177	0.0182
	713	95.1	0.0177	0.0182
	346	46.1	0.0181	0.0186
	346	46.1	0.0173	0.0178
	346	46.1	0.0173	0.0178
	346	46.1	0.0173	0.0178
	346	46.1	0.0176	0.0181
	346	46.1	0.0176	0.0181
	346	46.1	0.0165	0.0170
	346	46.1	0.0175	0.0180
$K_3Fe(CN)_6$, 32g/100 ml saponin	340	45.3	0.0166	0.0180
	340	45.3	0.0161	0.0175
	340	45.3	0.0167	0.0181
	340	45.3	0.0169	0.0183
	340	45.3	0.0162	0.0176
	340	45.3	0.0172	0.0186
	340	45.3	0.0163	0.0177
	340	45.3	0.0170	0.0184

Average ... 0.0179

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Sample of tissue homogenised; no effort was made to remove blood. Samples were equilibrated with gas and then dissolved gas was stripped out under vacuum and measured in a manometric Van Slyke apparatus. Various amounts of $K_3 Fe (CN)_6$ or $NaNO_2$ were added to the tissue to prevent formation of carboxy-hemoglobin. The above results have been corrected for the decrease in solubility due to the presence of these salts.

SOURCE AND PURITY OF MATERIALS:

Details given under method.

ESTIMATED ERROR:

δT/K = ±0.03.

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Sheep placental tissue

ORIGINAL MEASUREMENTS:

Power, G. G.

J. Appl. Physiology 1968, *24*, 468-474.

VARIABLES:

T = 310.15 K
p/kPa = 45 - 56

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K = 310.15

Treatment	P_{CO}/mmHg	P_{CO}/kPa	Bunsen Coefficient, α	Corrected Bunsen Coefficient, α
$K_3Fe(CN)_6$, 2.9g/100 ml Triton-X	340	45.3	0.0174	0.0185
	340	45.3	0.0176	0.0187
	340	45.3	0.0170	0.0181
$NaNO_2$, 0.9g/100 ml Triton-X	340	45.3	0.0202	0.0206
	340	45.3	0.0202	0.0206
	340	45.3	0.0174	0.0178
$NaNO_2$, 1.0g/100 ml	342	45.6	0.0152	0.0157
	342	45.6	0.0180	0.0185
	342	45.6	0.0182	0.0187
	342	55.6	0.0167	0.0172
			Average	0.0184 ± 0.0012

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Sample of tissue homogenised; no effort was made to remove blood. Samples were equilibrated with gas and then dissolved gas stripped out under vacuum and measured in a manometric Van Slyke apparatus. Various amounts of $K_3Fe(CN)_6$ or $NaNO_2$ were added to the tissue to prevent formation of carboxyhemoglobin. The above results have been corrected for the decrease in solubility due to the presence of these salts.

SOURCE AND PURITY OF MATERIALS:

Details given under method.

ESTIMATED ERROR:

δT/K = ±0.03.

REFERENCES:

COMPONENTS:	EVALUATOR:
1. Carbon monoxide; CO; [630-08-0] 2. Miscellaneous fluids	Robert W. Cargill, Department of Molecular and Life Sciences, Dundee Institute of Technology, Bell Street, Dundee DD1 1HG, U.K. April 1989

CRITICAL EVALUATION:

Carbon dioxide [124-38-9]

The work of Kaminishi *et al.*(1) is complemented by that of Christiansen *et al.*(2) on the solubility of carbon monoxide in carbon dioxide at pressures of 0.7-14.1 MPa between 223 K and 283 K. There are no serious contradictions between the two sets of data, and each may be accepted tentatively for the actual temperatures and pressures quoted on the data sheets.

The paper by Christiansen *et al.* (2) also provided data on the three-component system, carbon monoxide, methane [74-82-8], carbon dioxide, at 223.15 K and 253.15 K and pressures around 3.4 MPa and 7 MPa. The given values may also be accepted tentatively pending other investigations of this system. A similar comment may be made about the data from Yokoyama *et al.* (3) on the carbon monoxide, hydrogen [1333-74-0], carbon dioxide system, at 253-303 K and 4-9 MPa.

Hydrogen fluoride [7664-39-3]; Boron trifluoride [7637-07-2]

Kudo and Sugita (4) published a study of the solubility of carbon monoxide in hydrogen fluoride at 253-313 K and 1.57-30.5 MPa, and of the three-component system, carbon monoxide, hydrogen fluoride, boron trifluoride, at 273.1 K. Their published paper contains only graphs of their results, but on request, N. Sugita kindly supplied the original numerical data which now appear on the data sheet. The work appears to have been carried out carefully with high purity materials, and the values may be accepted tentatively meantime.

Octamethylcyclotetrasiloxane [556-67-2]

The data of Wilcock *et al.*(5) for this solvent may be accepted tentatively for carbon monoxide at a partial pressure of 1 atm and temperature 292-313 K. The data sheet contains a smoothing equation which may be used within the limits stated.

Triphenylphosphine [603-35-0]

Herman *et al.*(6) give the mol fraction solubility of carbon monoxide in triphenylphosphine to be 0.032 at 363.2, 378.2, and 393.2 K and pressures between 5 MPa and 6 MPa. These values are given with a possible error of 5% and require further confirmation

References

1. Kaminishi, G.; Arai, Y.; Saito, S.; Maeda, S.
   J. Chem. Eng. Japan 1968, *1*, 109.

2. Christiansen, L.J.; Fredenslund, A., Gardner, N.
   Adv. Cryog. Eng. 1974, *19*, 309.

3. Yokoyama, C.; Arai, K.; Saito, S.; Mori, H.
   Fluid Phase Equilib. 1988, *39*, 101.

4. Kudo, K.; Sugita, N.
   Chem. Express 1986, *1*, 5.

5. Wilcock, R.J.; McHale, J.L.; Battino, R.; Wilhelm, E.
   Fluid Phase Equilib. 1978, 2, 225.

6. Herman, J.M.; Gerritsen, L.A.; de Loos, T.W.
   J. Chem. Eng. Data, 1981, 26, 185.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Carbon dioxide; CO_2; [124-38-9]

ORIGINAL MEASUREMENTS:

Kaminishi, G.; Arai, Y.; Saito, S.; Maeda, S.
J. Chem. Engng. Japan
1968, *1*, 109-116.

VARIABLES:

T/K = 223.15 - 283.15
p/MPa = 2 - 13.1

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}	in gas, y_{CO}
223.15	2.39	-	0.652
	4.98	-	0.777
	9.55	0.223	0.787
	12.13	0.323	0.755
233.15	2.79	-	0.606
	5.41	0.101	0.707
	9.19	0.204	0.733
	11.75	0.298	0.705
	12.73	0.347	-
	13.08	0.369	0.647
253.15	5.27	0.082	0.501
	8.19	0.155	0.577
	9.98	0.213	0.576
	11.75	0.228	0.552
273.15	6.20	0.066	0.299
	8.19	0.124	0.371
	9.98	0.191	0.375
	10.58	0.228	0.356
283.15	6.20	0.043	0.173
	8.19	0.102	0.257
	9.19	0.142	0.265
	9.57	0.165	0.257

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Static cell fitted with magnetic stirrer. Temperature measured with liquid in glass thermometer and pressure measured with Bourdon gauge. After equilibrium established vapor and liquid samples analysed by a volumetric technique. Carbon dioxide was absorbed in potassium hydroxide solution.

SOURCE AND PURITY OF MATERIALS:

1. Takachiho Chemical Industry Co. sample, purity better than 99.8 mole per cent.

2. No details given.

ESTIMATED ERROR:

δT/K = ±0.1; δP/MPa = ±0.01;
δx_{CO}, δy_{CO} = ±1% (estimated by compiler).

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Carbon dioxide; CO_2; [124-38-9]

ORIGINAL MEASUREMENTS:

Christiansen, L.J.; Fredenslund, A.; Gardner, N.

Adv. Cryog. Eng. 1974, *19*, 309-19.

VARIABLES:

T/K = 223.15 - 283.15
p/MPa = 0.6 - 14.2

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	$P/10^5$Pa	Mole fraction of carbon monoxide in liquid, x_{CO}	Mole fraction of carbon monoxide in vapor y_{CO}
223.15	6.75	0.0000	0.000
	8.27	0.0028	0.155
	14.23	0.0148	0.491
	22.50	0.0318	0.641
	38.34	0.061	0.747
	58.31	0.106	0.790
	81.43	0.161	0.800
	100.72	0.222	0.789
	134.75	0.392	0.700
	141.53	0.463	0.649
243.15	14.26	0.0000	0.000
	16.46	0.0037	0.112
	23.37	0.0162	0.338
	34.15	0.0360	0.506
	49.36	0.066	0.610
	77.06	0.139	0.666
	99.02	0.205	0.667
	111.77	0.254	0.649
	122.55	0.304	0.619
	130.21	0.364	0.570
	131.42	0.387	0.548
263.15	26.42	0.0000	0.000
	30.26	0.0064	0.093

contd.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Recirculating vapor flow apparatus. Temperature measured with platinum resistance thermometer. Pressure measured with dead weight piston gauge. Coexisting samples analysed by gas chromatography. Details in source and ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. and 2. Research grade chemicals purities better than 99.99 mole per cent.

ESTIMATED ERROR:

$\delta T/K = \pm 0.01$; $\delta P/10^5 Pa = \pm 0.01$;
δx_{CO}, δy_{CO} = ±0.5%

REFERENCES:

1. Fredenslund, A.; Mollerup, J.; Christiansen, L.J.

   Cryogenics, 1973, *13*, 414.

COMPONENTS:	ORIGINAL MEASUREMENTS:
1. Carbon monoxide; CO; [630-08-0] 2. Carbon dioxide; CO_2; [124-38-9]	Christiansen, L.J.; Fredenslund, A.; Gardner, N. *Adv. Cryog. Eng.* 1974, *19*, 309-19.

EXPERIMENTAL VALUES:

T/K	$P/10^5$Pa	Mole fraction of carbon monoxide in liquid x_{CO}	in vapor y_{CO}
263.15	37.83	0.0189	0.226
	48.87	0.0387	0.344
	64.44	0.071	0.432
	81.74	0.116	0.477
	94.98	0.155	0.486
	102.25	0.180	0.480
	109.84	0.214	0.463
	113.54	0.240	0.441
283.15	44.93	0.0000	0.000
	50.98	0.0106	0.073
	57.44	0.0230	0.133
	67.76	0.0436	0.202
	81.75	0.080	0.255
	88.14	0.099	0.263
	97.18	0.141	0.242

COMPONENTS:

1. Carbon monoxide, CO; [630-08-0]
2. Methane; CH_4; [74-82-8]
3. Carbon dioxide; CO_2; [124-38-9]

ORIGINAL MEASUREMENTS:

Christiansen, L.J.; Fredenslund, A.
Gardner, N.

Adv. Cryog. Eng. 1974, *19*, 309-19

VARIABLES:

T/K = 223.15, 253.15
p/MPa = 3.4 - 6.9

PREPARED BY:

C.L. Young

EXPERIMENTAL VALUES:

T/K	$P/10^5$Pa	Mole fractions in liquid x_{CO_2}	x_{CH_4}	x_{CO}	Mole fractions in gas y_{CO_2}	y_{CH_4}	y_{CO}
223.15	66.82	0.830	0.035	0.135	0.198	0.106	0.696
		0.789	0.087	0.125	0.199	0.246	0.555
		0.753	0.139	0.108	0.207	0.357	0.436
		0.685	0.229	0.086	0.211	0.500	0.289
		0.550	0.397	0.053	0.218	0.656	0.127
	34.46	0.922	0.020	0.058	0.261	0.116	0.623
		0.904	0.051	0.045	0.262	0.287	0.450
		0.880	0.096	0.024	0.264	0.512	0.224
		0.868	0.116	0.016	0.264	0.591	0.145
253.15	68.99	0.835	0.051	0.114	0.344	0.154	0.503
		0.808	0.099	0.094	0.348	0.271	0.381
		0.764	0.167	0.068	0.347	0.409	0.244
		0.744	0.203	0.053	0.349	0.471	0.180
	34.17	0.951	0.006	0.043	0.499	0.041	0.461
		0.944	0.020	0.037	0.495	0.123	0.382
		0.931	0.049	0.020	0.497	0.303	0.200
		0.923	0.066	0.011	0.495	0.394	0.111

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Recirculating vapor flow apparatus. Temperature measured with platinum resistance thermometer. Pressure measured with dead weight piston gauge. Coexisting samples analysed by gas chromatography. Details in source and ref. (1).

SOURCE AND PURITY OF MATERIALS:

1. 2. and 3. Research grade chemicals purities better than 99.99 mole per cent.

ESTIMATED ERROR:

δT/K = ±0.01; $\delta P/10^5$Pa = ±0.01; δx, δy = ±0.5%.

REFERENCES:

1. Fredenslund, A.; Mollerup, J.; Christiansen, L.J.; *Cryogenics*, 1973, *13*, 414.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrogen; H_2; [1333-74-0]
3. Carbon dioxide; CO_2; [124-38-9]

ORIGINAL MEASUREMENTS:

Yokoyama, C.; Arai, K.; Saito, S.; Mori, H.

Fluid Phase Equilibria

1988, *39*, 101-110.

VARIABLES:

T/K = 253 - 303
p/MPa = 4 - 9

PREPARED BY:

C. L. Young

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fractions in liquids x_{CO}	 x_{H_2}	 x_{CO_2}
253.55	4.022	0.0007	0.0097	0.9896
258.10	4.173			
263.10	4.380			
268.12	4.636			
274.15	5.010			
277.85	5.273			
283.17	5.703			
288.07	6.153			
292.70	6.622			
293.15	6.682			
294.15	6.787			
295.15	6.895			
296.20	7.016			
297.15	7.131			
298.15	7.243			
299.15	7.356			
300.15	7.468			
301.15	7.565			
302.15	7.706			
303.15	7.754			

(cont.)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Glass capillary cell fitted with magnetic stirrer. Pressure measured with a dead weight gauge. Temperature measured with a quartz thermometer. Bubble point determined by measuring pressure as first bubble appears on decreasing pressure at constant temperature. Details in source and ref. (1).

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

δT/K = ±0.02; δP/MPa =±0.004; δx = ±0.001.

REFERENCES:

1. Arai, Y.; Kaminshi, G.; Saito, S. *J. Chem. Eng. Japan* 1971, *4*, 113.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrogen; H_2; [1333-74-0]
3. Carbon dioxide; CO_2; [124-38-9]

ORIGINAL MEASUREMENTS:

Yokoyama, C.; Arai, K.; Saito, S.; Mori, H.

Fluid Phase Equilibria

1988, *39*, 101-110.

EXPERIMENTAL VALUES:

		Mole fractions in liquids		
T/K	*P*/MPa	x_{CO}	x_{H_2}	x_{CO_2}
253.29	5.982	0.0015	0.0191	0.9794
257.81	5.972			
262.63	6.032			
267.65	6.123			
272.97	6.307			
278.15	6.550			
283.98	6.883			
289.55	7.262			
293.03	7.527			
294.65	7.626			
295.65	7.706			
297.20	7.832			
298.65	7.954			
300.15	8.055			
301.15	8.118			
302.20	8.156			
302.65	8.150			
253.15	8.591	0.0025	0.0320	0.9655
260.00	8.303			
267.13	8.150			
271.87	8.131			
277.85	8.180			
283.16	8.293			
288.12	8.458			
293.14	8.643			
294.65	8.675			
296.15	8.732			
297.65	8.782			
299.15	8.815			
300.65	8.802			
301.65	8.745			
302.05	8.682			

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrogen fluoride; HF; [7664-39-3]

ORIGINAL MEASUREMENTS:

Kudo, K.; Sugita, N.

Chem. Express 1986, *1*, 5-8.

VARIABLES:

$T/\mathrm{K} = 253 - 313$

$p/\mathrm{MPa} = 1.86 - 30.5$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

(Original paper contains only graphical representation of data: see reference 1)

T/K	pressure $p_1/\mathrm{kg\ cm^{-2}}$	pressure p_1/MPa*	fugacity $f_1/\mathrm{kg\ cm^{-2}}$	fugacity f_1/MPa*	mol fraction: $10^2 x_1$
253.1	28	2.75	27	2.65	1.3784
	54	5.30	52	5.10	2.6694
	82	8.04	78	7.65	4.0231
	112	11.0	106	10.4	5.5662
	142	13.9	134	13.1	7.2642
	180	17.7	168	16.5	8.8377
	210	20.6	196	19.2	10.5080
	238	23.3	223	21.9	12.6142
	265	26.0	250	24.5	13.2839
	285	28.0	271	26.6	14.5292
273.1	16	1.57	16	1.57	0.7500
	31.5	3.09	30.5	2.99	1.4170
	41.5	4.07	40.5	3.97	1.9530
	61.5	6.03	60	5.89	2.9830
	80.5	7.90	78	7.65	3.9410
	99.5	9.76	97	9.52	4.7600
	123.5	12.1	120	11.8	5.8190
	139.5	13.7	137	13.4	6.7020
	159.5	15.6	157	15.4	7.9051
	193.5	19.0	187	18.3	9.3410

contd.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Carbon monoxide was charged and stirred into a stainless-steel autoclave containing the solvent, in a thermostat bath.

After equilibrium was reached, stirring was stopped and a sample of the solution was extracted from the bottom of the autoclave into ice-water.

After warming to room temperature, the volume of liberated carbon monoxide was measured (0.8 - 1.2 $\mathrm{dm^3}$).

The aqueous hydrofluoric acid solutions were analysed chemically.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by action of hot sulphuric acid on formic acid; purity >99%, by gas chromatography.

(2) Hydrogen fluoride. Osaka Kinzoku Works, Japan; purity >99.7%, by electrical conductivity.

ESTIMATED ERROR:

$\delta T/\mathrm{K} = \pm 0.5$

$\delta x_1/x_1 = \pm 0.02$

REFERENCES:

1. Personal communication from N. Sugita (1988) gave the numerical data compiled on these pages. Original paper contains only graphical data.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Hydrogen fluoride; HF; [7664-39-3]

ORIGINAL MEASUREMENTS:

Kudo, K.; Sugita, N.

Chem. Express 1986, *1*, 5-8.

EXPERIMENTAL VALUES (continued):

(Original paper contains only graphical representation of data: see reference 1)

T/K	pressure		fugacity		mol fraction:
	p_1/kg cm^{-2}	p_1/MPa*	f_1/kg cm^{-2}	f_1/MPa*	10^2x_1
273.1	235	23.1	229	22.5	11.2510
	266.5	26.1	261	25.6	12.8813
	284.5	27.9	280	27.5	13.1814
	301.5	29.6	298	29.2	14.4502
	302.5	29.7	299	29.3	14.6193
293.1	26	2.55	26	2.55	1.1669
	48	4.71	48	4.71	2.1913
	68	6.67	67	6.57	2.8792
	94	9.22	93	9.12	4.1391
	123	12.0	122	11.9	5.2967
	154	15.1	153	15.0	7.1004
	181	17.8	179	17.6	8.3174
	201	19.7	200	19.6	9.2238
	219	21.5	219	21.5	9.9208
	250	24.5	252	24.7	11.5388
	274	26.9	279	27.4	12.7373
	303	29.7	311	30.5	13.8560
313.1	19	1.86	19	1.86	0.7689
	48	4.71	48	4.71	2.0495
	76	7.46	76	7.46	3.2317
	105	10.3	105	10.3	4.4083
	150	14.7	151	14.8	6.6633
	180	17.7	182	17.9	7.8906
	210	20.6	215	21.1	9.2482
	237	23.2	245	24.0	10.6156
	265	26.0	279	27.4	11.7819
	285	28.0	301	29.5	13.0147
	311	30.5	331	32.5	13.8731

* Calculated by compiler using conversion factor 0.09807.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Boron trifluoride; BF_3; [7637-07-2]
3. Hydrogen fluoride; HF; [7664-39-3]

ORIGINAL MEASUREMENTS:

Kudo, K.; Sugita, N.

Chem. Express 1986, *1*, 5-8.

VARIABLES:

T/K = 273.1

p/MPa = 4.8 - 19.6

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

(Original paper contains only graphical representation of data: see reference 1)

Temperature = 273.1 K

	initial conditions		fugacity	solution composition (moles)			mol fraction
n_3	p_2/kg cm^{-2}*	p_1/kg cm^{-2}*	f_1/kg cm^{-2}*	10^2n_1	10^2n_2	n_3	10^2x_1
2.39	20.0	49	48	5.70	17.40	1.6231	3.07
2.79	10.0	52	51	2.42	3.84	0.8426	2.67
3.81	19.4	101	98	4.51	7.77	0.7041	5.45
2.55	23.7	101	98	8.13	16.72	1.2020	5.60
3.52	10.4	97	94	3.54	3.94	0.5950	5.29
2.91	20.1	152	146	3.68	4.23	0.3633	8.32
3.93	20.0	200	193	4.27	3.10	0.3248	10.72
3.93	20.0	200	193	5.17	3.60	0.3910	10.80

* To convert to MPa, multiply by 0.09807

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Carbon monoxide was charged and stirred into a stainless-steel autoclave containing the solvent, in a thermostat bath.

After equilibrium was reached, stirring was stopped and a sample of the solution was extracted from the bottom of the autoclave into ice-water.

After warming to room temperature, the volume of liberated carbon monoxide was measured (0.3 - 1.2 dm^3).

The aqueous hydrofluoric acid solutions were analysed chemically.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Prepared by action of hot sulphuric acid on formic acid; purity >99%, by gas chromatography.

(2) Hydrogen fluoride. Osaka Kinzoku Works, Japan; purity >99.7%, by electrical conductivity.

(3) Boron trifluoride. Baker and Adamson Works, USA; purity >99.5% by chemical analysis.

ESTIMATED ERROR:

δT/K = ±0.5

$\delta x_1/x_1$ = ±0.02

REFERENCES:

1. Personal communication from N. Sugita (1988) gave the numerical data compiled on this page. Original paper contains only graphical data.

COMPONENTS:

(1) Carbon monoxide; CO; [630-08-0]

(2) Octamethylcyclotetrasiloxane; $C_9H_{24}O_4Si_4$; [556-67-2]

ORIGINAL MEASUREMENTS:

Wilcock, R. J.; McHale, J. L.; Battino, R.; Wilhelm, E.

Fluid Phase Equilib. 1978, *2*, 225-230.

VARIABLES:

T/K: 292.15 - 313.12
p/kPa: 101.325 (1 atm)

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

T/K	Mol Fraction 10^3x_1	Bunsen Coefficient $\alpha/\text{cm}^3\,(\text{STP})\,\text{cm}^{-3}\,\text{atm}^{-1}$	Ostwald Coefficient $L/\text{cm}^3\,\text{cm}^{-3}$
292.15	3.240	0.2351	0.2514
298.42	3.257	0.2345	0.2562
313.12	3.269	0.2313	0.2651

The solubility values were adjusted to a gas partial pressure of 101.325 kPa by Henry's law.

The Bunsen coefficients were calculated by the compiler.

Smoothed Data: For use between 292.15 and 313.12 K.

$$\ln x_1 = -5.6067 + 0.3635/(T/100\text{K})$$

The standard error about the regression line 6.33×10^{-6}.

T/K	Mol Fraction 10^3x_1
298.15	3.252
308.15	3.264

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The apparatus is based on the design of Morrison and Billett (1), and the version used is described by Battino, Evans, and Danforth (2). The degassing apparatus and procedure are described by Battino, Banzhof, Bogan, and Wilhelm (3).

Degassing. Up to 500 cm^3 of solvent is placed in a flask of such size that the liquid is about 4 cm deep. The liquid is rapidly stirred, and vacuum is applied intermittently through a liquid N_2 trap until the permanent gas residual pressure drops to 5 microns.

Solubility Determination. The degassed solvent is passed in a thin film down a glass spiral tube containing the solute gas plus the solvent vapor at a total pressure of one atm. The volume of gas absorbed is found by difference between the initial and final volumes in the buret system. The solvent is collected in a tared flask and weighed.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide. Matheson Co. Stated to be 99.5 mole percent minimum purity.

(2) Octamethylcyclotetrasiloxane. General Electeic Co. Distilled, density at 298.15 K was 0.9500 g cm^{-3}.

ESTIMATED ERROR:

$\delta T/\text{K} = 0.03$
$\delta P/\text{mmHg} = 0.5$
$\delta x_1/x_1 = 0.1$

REFERENCES:

1. Morrison, T. J.; Billett, F. *J. Chem. Soc.* 1948, 2033.
2. Battino,R.;Evans,F.D.;Danforth,W.F. *J.Am.Oil Chem.Soc.* 1968, *45*, 830.
3. Battino,R.; Banzhof, M.; Bogan, M.; Wilhelm, E. *Anal. Chem.* 1971, *43*, 806.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Triphenylphosphine; $C_{18}H_{15}P$; [603-35-0]

ORIGINAL MEASUREMENTS:

Herman, J.M.; Gerritsen, L.A. de Loos, T.W.

J. Chem. Eng. Data. 1981, *26*, 185-187.

VARIABLES:

T/K = 363.2 - 393.2
p/MPa = 5.25 - 5.79

PREPARED BY:

C.L. Young.

EXPERIMENTAL VALUES:

T/K	P/MPa	Mole fraction of carbon monoxide in liquid, x_{CO}
363.2	5.79	0.032
378.2	5.54	0.032
393.2	5.25	0.032

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Cailletet tube with sample of known composition confined over mercury. Pressure on the sample was increased by small increments until bubble point reached. Equilibrium established at each step. Sample stirred with magnetically operated device. Pressure measured using Bourdon gauge.

SOURCE AND PURITY OF MATERIALS:

1. Union Carbide sample, purity 99.5 mole per cent.
2. Fluka sample, purity 99.5 wt per cent.

ESTIMATED ERROR:

δT/K = ±0.1; δP/MPa = ±0.001
δx_{CO} = ±5%.

REFERENCES:

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Butanamine (n butylamine); $C_4H_{11}N$; [109-73-9]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Taqui Khan, M. M.; Halligudi, S.B.; Shukla, S.

J. Chem. Eng. Data 1989, *34*, 353-355.

VARIABLES:

T/K = 393 - 433
p/MPa = 0.3 - 2.3

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

	393 K		413 K		433 K	
mol frn x_2	$10^{-2}p_1$/ kPa	10^2S/ kmol m^{-3}	$10^{-2}p_1$/ kPa	10^2S/ kmol m^{-3}	$10^{-2}p_1$/ kPa	10^2S/ kmol m^{-3}
0	9.61	2.17	8.75	2.12	8.07	2.23
	22.80	5.08	22.27	5.67	19.89	5.34
0.02	10.09	2.32	11.64	2.95	10.09	3.02
	21.75	5.21	20.03	5.23	16.78	5.12
0.49	6.87	6.69	5.84	6.98	3.61	5.36
	20.40	20.10	18.69	22.06	17.32	25.75
1.0	7.38	11.38	7.21	14.11	5.50	11.13
	20.23	31.40	18.86	36.54	16.29	32.78

Note: these data were published too late to be evaluated or put in their proper place in this volume.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas under pressure in an autoclave of 300 cm^3 capacity at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure where the volume of gas is measured by displacement of gas-saturated water at constant temperature (1).

Corrections are made for vapour pressures of solvent mixtures, and for the solubility of the gas at atmospheric pressure.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from British Oxygen Co, UK; purity >99.96%.

(2) n Butylamine: AR grade, twice distilled before use.

(3) Water: no information.

ESTIMATED ERROR:

δp_1 = 3 kPa
δT = 0.1 K
δS = ±3% (authors)

REFERENCES:

1. Chaudhary, V. R.; Parande, M. G.; Brahme, P. H. *Ind. Eng. Chem. Fundam.* 1982, *21*, 472.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. N,N-dimethylformamide; C_3H_7NO; [68-12-2]
3. Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Taqui Khan, M. M.; Halligudi, S. B.; Shukla, S.

J. Chem. Eng. Data 1989, *34*, 353-355.

VARIABLES:

$T/\mathrm{K} = 393 - 433$
$p/\mathrm{MPa} = 0.8 - 2.3$

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

	393 K		413 K		433 K	
mol frn x_2	$10^{-2}p_1$/kPa	10^2S/kmol m^{-3}	$10^{-2}p_1$/kPa	10^2S/kmol m^{-3}	$10^{-2}p_1$/kPa	10^2S/kmol m^{-3}
0	9.61	2.17	8.75	2.12	8.07	2.23
	22.80	5.08	22.27	5.67	19.89	5.34
0.3	9.82	2.92	9.34	3.01	9.05	3.13
	19.35	5.77	20.50	6.56	21.36	7.31
0.5	9.20	2.76	8.54	2.89	8.20	2.80
	18.65	6.60	18.31	5.75	17.28	5.70
1.0	10.73	4.85	10.60	5.17	11.15	5.98
	19.80	9.68	19.85	9.77	19.55	9.78

Note: these data were published too late to be evaluated or put in their proper place in this volume.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas under pressure in an autoclave of 300 cm^3 capacity at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure where the volume of gas is measured by displacement of gas-saturated water at constant temperature (1).

Corrections are made for vapour pressures of solvent mixtures, and for the solubility of the gas at atmospheric pressure.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from British Oxygen Co, UK; purity >99.96%.

(2) Dimethylformamide: AR grade, twice distilled before use.

(3) Water: no information.

ESTIMATED ERROR:

$\delta p_1 = 3$ kPa
$\delta T = 0.1$ K
$\delta S = \pm 3\%$ (author)

REFERENCES:

1. Chaudhary, V. R.; Parande, M. G.; Brahme, P. H. *Ind. Eng. Chem. Fundam.* 1982, *21*, 472.

COMPONENTS:

1. Carbon monoxide; CO; [630-08-0]
2. Cyclohexene; C_6H_{10}; [110-83-8]
3. Ethanol; C_2H_6O; [64-17-5]

ORIGINAL MEASUREMENTS:

Taqui Khan, M. M.; Halligudi, S. B.; Shukla, S.

J. Chem. Eng. Data 1989, *34*, 353-355.

VARIABLES:

T/K = 373 - 413
p/MPa = 0.3 - 2.3

PREPARED BY:

R. W. Cargill

EXPERIMENTAL VALUES:

	373 K		393 K		413 K	
mol frn x_2	$10^{-2}p_1$/ kPa	10^2S/ kmol m^{-3}	$10^{-2}p_1$/ kPa	10^2S/ kmol m^{-3}	$10^{-2}p_1$/ kPa	10^2S/ kmol m^{-3}
0	8.75	10.19	7.90	11.12	5.67	10.09
	21.60	25.77	20.23	28.58	16.81	29.82
0.06	5.50	6.67	5.33	7.64	2.93	5.24
	20.57	24.91	20.58	29.41	18.86	33.78
0.43	9.53	12.95	9.46	14.70	10.35	19.02
	20.85	28.25	19.28	30.04	20.04	36.77
1.0	9.27	14.64	9.61	16.84	6.36	12.24
	20.57	32.42	22.40	39.60	20.06	38.69

Note: these data were published too late to be evaluated or put in their proper place in this volume.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A known volume of solvent is equilibrated for about 3 hours with gas under pressure in an autoclave of 300 cm^3 capacity at the required temperature.

A known volume of gas-saturated solvent is withdrawn into a gas-burette at atmospheric pressure where the volume of gas is measured by displacement of gas-saturated water at constant temperature (1).

Corrections are made for vapour pressures of solvent mixtures, and for the solubility of the gas at atmospheric pressure.

SOURCE AND PURITY OF MATERIALS:

(1) Carbon monoxide: from British Oxygen Co, UK; purity >99.96%.

(2) Cyclohexene: prepared by dehydration of cyclohexanol with conc. H_2SO_4; purity 99.8%, by GLC.

(3) Ethanol: AR grade, twice distilled before use.

ESTIMATED ERROR:

δp_1 = 3 kPa
δT = 0.1 K
δS = ±3% (authors)

REFERENCES:

1. Chaudhary, V. R.; Parande, M. G.; Brahme, P. H. *Ind. Eng. Chem. Fundam.* 1982, *21*, 472.

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