COMPONENTS:	EVALUATOR:
(1) Propane; C_3H_8; [74-98-6] Butane; C_4H_{10}; [106-97-8] 2-Methylpropane; C_4H_{10}; [75-28-5] (2) Common solvents or aqueous solutions or suspensions of biological substances	Walter Hayduk Department of Chemical Engineering University of Ottawa Ottawa, Canada K1N 9B4 November, 1984

CRITICAL EVALUATION:

The solubilities of *propane*, *butane* and *2-methylpropane* in common solvents or aqueous solutions or suspensions of biological substances are all of qualitative value only. In no case is the composition of the solvent unequivocally specified so that the measurement can be reproduced elsewhere. Nonetheless, the data may be of value to those requiring such information. These data remain unclassified.

The early solubility of *propane* in turpentine as reported by Lebeau[1] is expected to be too low as are some of the other data reported by this author. Nor can the composition of turpentine be explicitly defined because its composition is dependent on its source and process for its production. The solubilities of *propane* and *butane* are available in kerosene A-3, and in gasoline solvents[2]; these data are of low accuracy (10 - 15%) and are also for solvents that are essentially mixed solvents containing many components. The solubilities of all three gases are available in aqueous suspensions of one or more egg phospholipid components[3]. General comments that may be made are that the order of solubilities of the three gases is the same as that observed in most organic solvents rather than that in water and that the solubilities are many times those in water alone. Finally, data are available for solubilities of *butane* in aqueous solutions (5 mass %) of human hemoglobin and bovine serum albumin[4]. These latter data were read from a graph and are of low accuracy.

References

1. Lebeau, P. *Compt. Rend.* 1905, *140*, 1454-6 and 1572.

2. Miller, K.W.; Hammond, L.; Porter, E.G. *Chem. Phys. Lipids* 1977, *20*, 229-241.

3. Hannaert, H.; Haccuria, M.; Mathieu, M.P. *Ind. Chim. Belg.* 1967, *32*, 156-164.

4. Wishnia, A. *Proc. Natl. Acad. Sci Biochem.* 1962, *43*, 2200-2204.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Propane; C_3H_8; [74-98-6] (2) Water, Benzene, Ethanol, Diethylether, Chloroform, Turpentine	Lebeau, P. *Compt. Rend.* 1905, *140*, 1454-6 and 1572. *Bull. Soc. Chim.* [3] 1905, *33*, 1137-9.
VARIABLES: T/K = 290.8 - 294.8 p/kPa = 100.4 - 100.9	PREPARED BY: H. L. Clever

EXPERIMENTAL VALUES:

Temperature t/°C	Temperature T/K	Pressure[a] p/mmHg	Solubility Volume propane/100 Volumes Solvent
Water; H_2O; [7732-18-5]			
17.8	291.0	753	6.5
Benzene; C_6H_6; [71-43-2]			
21.5	294.7	757	1452
Ethanol; C_2H_6O; [64-17-5]			
16.6	290.8	754	790
1,1'-Oxybisethane or diethylether; $C_4H_{10}O$; [60-29-7]			
16.6	290.8	757	926
Chloroform or trichloromethane; $CHCl_3$; [67-66-3]			
21.6	294.8	757	1299
Oil of turpentine			
17.7	290.9	757	1587

[a] Not clear whether this is total pressure or propane partial pressure. It is probably total pressure.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Details not given. The data are reported in both papers.	(1) Propane. Prepared by author from carefully purified propyl iodide by reaction with sodium in liquid ammonia. Melting point/°C = -195 Boiling point/°C = -44.5 Critical temperature/°C = 102. (2) Solvents. No information.
	ESTIMATED ERROR:
	REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Propane; C_3H_8; [74-98-6] (2) Kerosene A-3 Gasoline	Hannaert, H.; Haccuria, M.; Mathieu, M. P. *Ind. Chim. Belge* 1967, *32*, 156 - 164.
VARIABLES: T/K = 243.15 - 293.15	PREPARED BY: E. L. Boozer H. L. Clever

EXPERIMENTAL VALUES:

Temperature Interval of Measurements T/K	Propane Mol % Range $10^2 x_1$/mol %	$K\pi\nu$/atm[1] at 293.15 K	Enthalpy of Dissolution ΔH/kcal mol^{-1}	Constant A
Kerosene A-3				
243.15-293.15	5 - 15	7.0	4.14	3.93
Gasoline				
243.15-293.15	2 - 15	7.15	4.08	3.90

[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 $H_{1,2}$/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.A. was used for these systems.

SOURCE AND PURITY OF MATERIALS:

(1) Propane. Matheson Co. Inc. Chemical pure. Fractionated, purity > 99.9 per cent.

(2) Kerosene and gasoline distillation density

	range °C	gcm^{-} ,20°C	mol wt
A-3	207-255	0.784	192
gasoline	99-168	0.7521	122

ESTIMATED ERROR:

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Butane; C_4H_{10}; [106-97-8] (2) Kerosene A-3 Gasoline	Hannaert, H.; Haccuria, M.; Mathieu, M. P. *Ind. Chim. Belge* 1967, *32*, 156-164.
VARIABLES: T/K = 243.15 - 293.15	**PREPARED BY:** E. L. Boozer H. L. Clever

EXPERIMENTAL VALUES:

Temperature Interval of Measurements T/K	Butane Mol % Range $10^2 x_1$/mol %	$K\pi\nu$/atm[1] at 293.15 K	Enthalpy of Dissolution ΔH/kcal mol^{-1}	Constant A
Kerosene A-3				
243.15-293.15	10 - 40	2.03	5.575	4.47
Gasoline				
243.15-293.15	10 - 50	1.4	5.44	4.32

[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.A. was used for this system.

SOURCE AND PURITY OF MATERIALS:

(1) Butane. Matheson Co., Inc. Fractionated, purity > 99.5 per cent.

(2) Kerosene and gasoline.

	Distillation Range, t/°C	Density ρ^{20}/g cm^{-3}	mol wt
A-3	207-255	0.784	192
Gasoline	94-168	0.7521	122

ESTIMATED ERROR:

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Propane; C_3H_8; [74-98-6] (2) Phospholipids	Miller, K. W.; Hammond, L.; Porter, E. G. *Chem. Phys. Lipids* 1977, *20*, 229-241.
VARIABLES: T/K: 298.4 P/kPa: 101.3	PREPARED BY: C. L. Young

EXPERIMENTAL VALUES:

T/K = 298.4 t/°C = 25.2

96 mole per cent egg phosphatidylcholine
+ 4 mole per cent egg phosphatidic acid sonicated vesticles

Bunsen coefficient 3.6 ± 0.21
(3 measurements)

68.2 mole per cent egg phosphatidylcholine
+ 2.8 mole per cent egg phosphatidic acid sonicated vesticles
+ 29 mole per cent cholesterol

Bunsen coefficient 1.12

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Samples of lipids were prepared as a translucent aqueous suspension containing 5-10 mg/ml of phospholipids. Samples saturated with gas at ambient pressure and then analysed by stripping out gas. Gas so obtained was analysed by gas chromatography using helium as a carrier gas and a Poropak Q column. Details in source. Bunsen coefficient calculated from experimental data on lipid solution and of pure water.

SOURCE AND PURITY OF MATERIALS:

1. Matheson Gas Products sample; purity 99 mole per cent.

2. Grade 1 samples from Lipid Products, Nutford, England.

ESTIMATED ERROR:

δT/K = ±0.05; δp/kPa = ±0.5%;
$\delta\alpha/\alpha$ = ±8% (estimated by compiler).

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Butane; C_4H_{10}; [106-97-8] (2) Phospholipids	Miller, K. W.; Hammond, L.; Porter, E. G. *Chem. Phys. Lipids* 1977, *20*, 229-241.
VARIABLES: T/K: 273.2-303.2 P/kPa: 101.3	PREPARED BY: C. L. Young

EXPERIMENTAL VALUES:

T/K = 298.4 t/°C = 25.2

96 mole per cent egg phosphatidylcholine
+ 4 mole per cent egg phosphatidic acid sonicated vesticles

Bunsen coefficient 17

68.2 mole per cent egg phosphatidylcholine
+ 2.8 mole per cent egg phosphatidic acid sonicated vesticles
+ 29 mole per cent cholesterol

Bunsen coefficient 14

T/K		Bunsen Coefficient
298.2	80 mole per cent egg phosphatidylcholine + 20 mole per cent egg phosphatidic acid sonicated vesticles	16
	Phosphatidylserine	17
	Dioleoylphosphatidylcholine	17
	Dimyristoylphosphatidylcholine	15
	Erythrocyte ghosts	4
303.2	Egg lecithin	13
273.2	Egg lecithin	56
298.2	Egg lecithin containing 33% cholesterol	16
273.2	Egg lecithin containing 33% cholesterol	70

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Samples of lipids were prepared as a translucent aqueous suspension containing 5-10 mg/ml of phospholipids. Samples saturated with gas at ambient pressure and then analysed by stripping out gas. Gas so obtained was analysed by gas chromatography using helium as a carrier gas and a Poropak Q column. Details in source. Bunsen coefficient calculated from experimental data on lipid solution and of pure water.

SOURCE AND PURITY OF MATERIALS:

1. Matheson Gas Products sample; purity 99 mole per cent.
2. Grade 1 samples from Lipid Products, Nutford, England.

ESTIMATED ERROR:

δT/K = ±0.05; δp/kPa = ±0.5%;
$\delta\alpha/\alpha$ = ±8% (estimated by compiler).

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1)2-Methylpropane (*iso*butane); C_4H_{10}; [75-28-5] (2)Phospholipids	Miller, K. W.; Hammond, L.; Porter, E. G. *Chem. Phys. Lipids* 1977, *20*, 229-241.
VARIABLES: T/K: 298.4 P/kPa: 101.3	PREPARED BY: C. L. Young

EXPERIMENTAL VALUES:

T/K = 298.4 t/°C = 25.2

96 mole per cent egg phosphatidylcholine
+ 4 mole per cent egg phosphatidic acid sonicated vesticles

Bunsen coefficient 9.5

68.2 mole per cent egg phosphatidylcholine
+ 2.8 mole per cent egg phosphatidic acid sonicated vesticles
+ 29 mole per cent cholesterol

Bunsen coefficient 7.4

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Samples of lipids were prepared as a translucent aqueous suspension containing 5-10 mg/ml of phospholipids. Samples saturated with gas at ambient pressure and then analysed by stripping out gas. Gas so obtained was analysed by gas chromatography using helium as a carrier gas and a Poropak Q column. Details in source. Bunsen coefficient calculated from experimental data on lipid solution and of pure water.

SOURCE AND PURITY OF MATERIALS:

1. Matheson Gas Products sample; purity 99 mole per cent.

2. Grade 1 samples from Lipid Products, Nutford, England.

ESTIMATED ERROR:

δT/K = ±0.05; δp/kPa = ±0.5%;
$\delta\alpha/\alpha$ = ±8% (estimated by compiler).

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Butane; C_4H_{10}; [106-97-8] (2) Bovine serum albumin (BSA), Human hemoglobin (Hb) (3) Water; H_2O; [7732-18-5]	Wishnia, A. *Proc. Natl. Acad. Sci., Biochem.* 1962, *43*, 2200-2204.
VARIABLES: T/K: 283.15-308.15 c_2/mass %: 5 P/kPa: 101.325	PREPARED BY: W. Hayduk

EXPERIMENTAL VALUES:

t/°C	T/K	Solubility in water s_0/mMol(kg)$^{-1}$	Solubility in Aqueous protein s/mMol(kg)$^{-1}$	Butane solubilization Ratio/s s_0^{-1}
		Aqueous bovine serum albumin (BSA), 5 mass %:		
10	283.15	2.5	8.0	3.20
15	288.15	2.1	6.6	3.14
20	293.15	1.7	5.7	3.35
25	298.15	1.4	4.8	3.43
30	303.15	1.2	4.0	3.33
35	308.15	1.1	3.4	3.09
		Aqueous human hemoglobin (Hb), 5 mass %:		
10	283.15		5.0	2.00
15	288.15		4.1	1.95
20	293.15		3.4	2.00
25	298.15		2.9	2.07
30	303.15		2.6	2.17
35	308.15		2.2	2.00

Values of solubilities read from graph of s versus t by compiler; butane solubilization ratio calculated. No numerical data given. Additional graphical data for propane gas and aqueous sodium lauryl sulfate could not be read with sufficient accuracy to warrant reproduction.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility was determined at pressures from 0.15 to 0.70 atm and extrapolated to a gas partial pressure of 1 atm using Henry's law.

An all-glass apparatus was used which consisted of a calibrated liquid contactor, 10 cm^3 in volume and a 5-10 cm^3 gas storage tube. The solution was deaerated in the contactor under vacuum. The pressure was measured with a manometer. The initial and final gas pressures and volumes, together with the compressibilities were used to compute the molal solubilities. The quantity of solvent charged was determined by weight.

SOURCE AND PURITY OF MATERIALS:

1. Phillips Petroleum, research grade. Purity not specified.

2a. Crystalline BSA from Pentex (Lot BX3) deionized on Dowex-1 and Dowex-50 ion exchangers.

2b. Human hemoglobin; no further details given.

3. Deaerated.

ESTIMATED ERROR:

δT/K = 0.01 (author)

$\delta s/s$ = 0.08 (compiler)

REFERENCES: