

COMPONENTS:		EVALUATOR:			
(1) n-Butane; C ₄ H ₁₀ ; [106-97-8]		Rubin Battino			
(2) Water; H ₂ O; [7732-18-5]		Department of Chemistry			
		Wright State University			
		Dayton, Ohio 45435 U.S.A.			
		November, 1983			
CRITICAL EVALUATION:					
<p>The solubility of n-butane in water at approximately atmospheric pressure has been reported in sixteen papers (1-16), but only the data from eight papers (1-8) were used for the final smoothing equation for this system. After the data from all of the papers were converted to mole fraction solubilities at 0.101325 MPa partial pressure, they were fitted by the following equation:</p>					
$\ln x_1 = A_0 + A_1/T + A_2 \ln T + A_3 T + A_4 T^2 \quad \text{where } T = T/100 \text{ K.} \quad (1)$					
<p>Fitting to a polynomial in the reciprocal of the Kelvin temperature gave no significant improvement over equation (1) for the same number of terms. Furthermore, the use of more than three terms gave no significant reduction in the standard deviation of the fit. The fitting process was repeated several times, deleting in each instance those points which deviated by about two standard deviations or more from the smoothed line. Also, a knowledge of the original papers and experimental methods used were considered in making the decision about which points or whose work to delete. The smoothing equation which follows was based on four data points from reference (1), ten from (2), twelve from (3), two from (4), five from (5), five from (6), five from (7) (extrapolated to 0.101325 MPa), and two from reference (8).</p>					
$\ln x_1 = -102.029 + 146.040/T + 38.7599 \ln T \quad (2)$					
<p>The standard deviation in $\ln x_1$ was 0.026 and in x_1 about 2.6%. The smoothed data were available for the range from 273 to 349 K.</p>					
<p>Smoothed values obtained from Equation (2) for the mole fraction at 0.101325 MPa partial pressure of gas and the Ostwald coefficient are presented at 5 K intervals in Table 1. Also given in this table are the thermodynamic functions for the transfer of the gas from the vapor phase at 0.101325 MPa partial pressure of gas to the (hypothetical) solution of unit mole fraction. Taking appropriate derivatives of equation (2) gave a constant value of $\Delta \bar{C}_{p,1}^\circ$ of 322 J mol⁻¹ K⁻¹.</p>					
<p>Table 1. The solubility and thermodynamic properties for the solubility of n-butane in water at 0.101325 MPa partial pressure of gas.</p>					
T/K	10 ⁵ x ₁	L	$\Delta \bar{G}_1^\circ /$ kJ mol ⁻¹	$\Delta \bar{H}_1^\circ /$ kJ mol ⁻¹	$\Delta \bar{S}_1^\circ /$ J mol ⁻¹ K ⁻¹
273.15	6.666	0.08293	21.84	-33.40	-202.2
278.15	5.150	0.06525	22.83	-31.79	-196.4
283.15	4.065	0.05241	23.80	-30.17	-190.6
288.15	3.274	0.04293	24.74	-28.56	-185.0
293.15	2.687	0.03581	25.65	-26.95	-179.4
298.15	2.244	0.03039	26.54	-25.34	-174.0
303.15	1.906	0.02621	27.39	-23.73	-168.6
308.15	1.645	0.02295	28.22	-22.12	-163.4
313.15	1.440	0.02038	29.03	-20.51	-158.2
318.15	1.278	0.01835	29.80	-18.89	-153.1
323.15	1.150	0.01673	30.56	-17.28	-148.0
328.15	1.047	0.01543	31.28	-15.67	-143.1
333.15	0.965	0.01440	31.99	-14.06	-138.2
338.15	0.899	0.01358	32.67	-12.45	-133.4
343.15	0.847	0.01294	33.32	-10.84	-128.7
348.15	0.805	0.01244	33.95	-9.23	-124.0
353.15	0.772	0.01207	34.56	-7.62	-119.4

<p>COMPONENTS:</p> <p>(1) n-Butane; C₄H₁₀; [106-97-8]</p> <p>(2) Water; H₂O; [7732-18-5]</p>	<p>EVALUATOR:</p> <p>Rubin Battino Department of Chemistry Wright State University Dayton, Ohio 45435 U.S.A.</p> <p>November, 1983</p>
<p>CRITICAL EVALUATION: ...continued</p> <p><u>References</u></p> <ol style="list-style-type: none"> 1. Wen, W.-Y.; Hung, J.H., <i>J. Phys. Chem.</i> <u>1970</u>, <i>74</i>, 170-80. 2. Kresheck, G.C.; Schneider, H.; Scheraga, H.A., <i>J. Phys. Chem.</i> <u>1965</u>, <i>69</i>, 3132-44. 3. Morrison, T.J.; Billett, F., <i>J. Chem. Soc.</i> <u>1952</u>, 3819-22. 4. Claussen, W.F.; Polglase, M.F., <i>J. Am. Chem. Soc.</i> <u>1952</u>, <i>74</i>, 4817-9. 5. Ben-Naim, A.; Wilf, J.; Yaacobi, M., <i>J. Phys. Chem.</i> <u>1973</u>, <i>77</i>, 95-102. 6. Rice, P.A.; Gale, R.P.; Barduhn, A.J., <i>J. Chem. Eng. Data</i> <u>1976</u>, <i>21</i>, 204-6. 7. Umano, S.; Nakano, Y., <i>Kogyo Kagaku Zasshi</i> <u>1958</u>, <i>61</i>, 536-44. 8. Wetlaufer, D.B.; Malik, S.K.; Stoller, L.; Coffin, R.L., <i>J. Am. Chem. Soc.</i> <u>1964</u>, <i>86</i>, 508-14. 9. Moudgil, B.M.; Somasundaran, P.; Lin, I.J., <i>Rev. Sci. Instrum.</i> <u>1974</u>, <i>45</i>, 406-9. 10. Denton, W.H.; Smith, M.J.S.; Klaschka, J.T.; Forgan, R. et al., <i>Fourth Int. Symp. Fresh Water Sea</i> <u>1973</u>, <i>3</i>, 291-311. 11. Namiot, A., Yu., <i>Zh. Strukt. Khim.</i> <u>1961</u>, <i>2</i>, 408-17. <i>J. Struct. Chem. (Engl. Transl.)</i> <u>1961</u>, <i>2</i>, 381-9. 12. Barone, G.; Crescenzi, V.; Pispisa, B.; Quadrifoglio, F., <i>J. Macromol. Chem.</i> <u>1966</u>, <i>1</i>, 761-71. 13. McAuliffe, C., <i>J. Phys. Chem.</i> <u>1966</u>, <i>70</i>, 1267-75. <i>Nature</i>, <u>1963</u>, <i>200</i>, 1092-3. 14. Wishnia, A., <i>Proc. Natl. Acad. Sci., Biochem.</i> <u>1962</u>, <i>48</i>, 2200-4. 15. Rudakov, E.S.; Lutsyk, A.I., <i>Zh. Fiz. Khim.</i> <u>1979</u>, <i>53</i>, 1298-1300. <i>Russ. J. Phys. Chem.</i> <u>1979</u>, <i>53</i>, 731-3. 16. Lebeau, P., <i>Bull. Acad. Roy. Belg.</i> <u>1908</u>, 300-4. 	

COMPONENTS:			ORIGINAL MEASUREMENTS:		
(1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]			Wen, W.-Y.; Hung, J.H. <i>J. Phys. Chem.</i> 1970, 74, 170-180.		
VARIABLES:			PREPARED BY:		
T/K: 278.15-308.15 P/kPa: 101.325 (1 atm)			W. Hayduk		
EXPERIMENTAL VALUES:					
t/°C	T/K	Solubility ¹ s/cm ³ (STP) kg ⁻¹	Mole Fraction ² /10 ⁵ x ₁	Ostwald Coefficient ² L/cm ³ cm ⁻³	Bunsen Coefficient ² α/cm ³ (STP) cm ⁻³
5	278.15	62.00 ± 0.10	5.194	0.0631	0.0618
15	288.15	39.20 ± 0.05	3.267	0.0413	0.0388
25	298.15	26.34 ± 0.06	2.186	0.0287	0.0259
35	308.15	19.27 ± 0.06	1.594	0.0216	0.0189
¹ Original data. ² Calculated by compiler assuming authors considered gas to be ideal, and using real gas molar volumes: $x_1 = (18.016) s T [273.15 (1000) V_t]^{-1}; V_t / \text{cm}^3 \text{mol}^{-1} \text{ at } T.$					
AUXILIARY INFORMATION					
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:		
<p>The apparatus was similar to that described by Ben-Naim and Baer (1). Teflon needle valves were used in place of stopcocks.</p> <p>The apparatus consists of three main parts, a dissolution cell of 300 to 600 cm³ capacity, a gas volume measuring column, and a manometer.</p> <p>The solvent is degassed in the dissolution cell, the gas is introduced and dissolved while the liquid is kept stirred by a magnetic stirrer immersed in the water bath. Dissolution of the gas results in the change in the height of a column of mercury which is measured by a cathetometer.</p>			<ol style="list-style-type: none"> Matheson Co. Stated to be better than 99.9 per cent pure. Distilled from an all-Pyrex apparatus. Specific conductivity 1.5 x 10⁻⁶ (ohm cm)⁻¹. 		
			ESTIMATED ERROR:		
			$\delta T/K = \pm 0.005$ $\delta s_1/s_1 = \pm 0.003$		
			REFERENCES:		
			<ol style="list-style-type: none"> Ben-Naim, A.; Baer, S. <i>Trans. Faraday Soc.</i> 1963, 59, 2735. 		

<p>COMPONENTS:</p> <p>(1) Butane; C₄H₁₀; [106-97-8]</p> <p>(2) Water; H₂O; [7732-18-5]</p>	<p>ORIGINAL MEASUREMENTS:</p> <p>Moudgil, B. M.; Somasundaran, P.; Lin, L. J.</p> <p><i>Rev. Sci. Instrum.</i> <u>1974</u>, <i>45</i>, 406-9.</p>															
<p>VARIABLES:</p> <p>$T/K = 298.15$ $p_1/kPa = 101.325$</p>	<p>PREPARED BY:</p> <p>H. L. Clever</p>															
<p>EXPERIMENTAL VALUES:</p> <table border="1" data-bbox="178 521 1042 705"> <thead> <tr> <th colspan="2">Temperature</th> <th>Solubility/</th> <th>Mol Fraction</th> <th>Ostwald</th> </tr> <tr> <th>$t/^{\circ}C$</th> <th>T/K</th> <th>cm³ (STP) kg⁻¹</th> <th>$10^5 x_1$</th> <th>Coefficient L/cm³ cm⁻³</th> </tr> </thead> <tbody> <tr> <td>25.0</td> <td>298.15</td> <td>26.00</td> <td>2.090</td> <td>0.02830</td> </tr> </tbody> </table> <p>The mole fraction and Ostwald coefficient values were calculated by the compiler assuming ideal gas behavior.</p>		Temperature		Solubility/	Mol Fraction	Ostwald	$t/^{\circ}C$	T/K	cm ³ (STP) kg ⁻¹	$10^5 x_1$	Coefficient L/cm ³ cm ⁻³	25.0	298.15	26.00	2.090	0.02830
Temperature		Solubility/	Mol Fraction	Ostwald												
$t/^{\circ}C$	T/K	cm ³ (STP) kg ⁻¹	$10^5 x_1$	Coefficient L/cm ³ cm ⁻³												
25.0	298.15	26.00	2.090	0.02830												
<p>AUXILIARY INFORMATION</p>																
<p>METHOD/APPARATUS/PROCEDURE:</p> <p>The apparatus is based on the design of Ben Naim and Baer (1). The apparatus consists of an absorption cell, a gas measuring column and the pressure control system.</p> <p>The pressure control system is automated.</p>	<p>SOURCE AND PURITY OF MATERIALS:</p> <p>(1) Butane. Matheson Co., Inc. Stated to be 99.9 percent.</p> <p>(2) Water. Triple distilled. Specific conductivity $1.5 \times 10^{-6} \Omega^{-1} \text{ cm}^{-1}$.</p> <p>ESTIMATED ERROR: $\delta t/K = \pm 0.1$ $\delta p/kg \text{ cm}^{-2} = \pm 0.1$ Maximum error in solubility is ± 0.4 percent (authors).</p> <p>REFERENCES:</p> <p>1. Ben Naim, A.; Baer, S. <i>Trans. Faraday Soc.</i> <u>1963</u>, <i>59</i>, 2735.</p>															

COMPONENTS:		ORIGINAL MEASUREMENTS:			
(1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		Kresheck, G. C.; Schneider, H.; Scheraga, H. A. J. Phys. Chem. <u>1965</u> , 69, 3132-44.			
VARIABLES: $T/K = 274.15 - 328.15$ $p_1/kPa = 101.325$		PREPARED BY: H. L. Clever			
EXPERIMENTAL VALUES:					
Temperature		Mol Fraction ^a		Molarity	Molality
$t/^{\circ}C$	T/K	$10^5 x_1$		$10^3 c_1/mol\ dm^{-3}$	$10^3 m_1/mol\ kg^{-1}$
1	274.15	6.919			
4	277.15	5.802, 5.773			
	277.15 ^b	5.79 ± 0.01		3.21 ± 0.01	3.21 ± 0.01
10	283.15	4.328, 4.219			
15	288.15	3.379, 3.328			
20	293.15	2.740, 2.716			
25	298.15	2.282, 2.259			
	298.15 ^b	2.27 ± 0.01		1.26 ± 0.01	1.26 ± 0.01
30	303.15	1.929			
35	308.15	1.672, 1.647			
40	313.15	1.452			
45	318.15	1.322, 1.352			
50	323.15	1.188			
	323.15 ^b	1.19 ± 0.01		0.66 ± 0.01	0.66 ± 0.01
55	328.15	1.106, 1.084			
<p>a The experimental values of the mole fraction solubility were provided by H. Schneider. The last figure is not significant.</p> <p>b Smoothed values from the original paper.</p>					
AUXILIARY INFORMATION					
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:		
<p>A known quantity of the gas was introduced from a gas buret into a calibrated volume which contained a weighed quantity of water. The water was stirred until equilibrium was attained (3 to 4 hours). The amount of gas in the vapor phase at equilibrium was determined from the partial pressure of the butane and the volume of the vapor space. The volume was the difference in the empty vessel volume and the water volume. The amount of dissolved gas was obtained by difference.</p> <p>Handbook values of water density were used. The gas volume was corrected for non-ideal behavior by use of a compressibility factor (1). At each temperature the solubility was measured at two partial pressures which ranged from 0.5 to 0.7 atm at 4 °C to 1.2 to 1.6 atm at 50 °C. All solubility data were normalized to a partial pressure of 1 atm.</p>			<p>(1) Butane. Matheson Co., Inc. 99.94 mole per cent.</p> <p>(2) Water. Laboratory distilled water was deionized prior to use.</p>		
			ESTIMATED ERROR:		
			$\delta x_1/x_1 = \pm 0.005$		
			REFERENCES:		
			1. Silberberg, I. H.; Kuo, P. K.; McKetta, J. J. <i>Petrol. Engr.</i> <u>1954</u> , 24, 9C.		

COMPONENTS: (1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		ORIGINAL MEASUREMENTS: Morrison, T.J.; Billet, F. <i>J. Chem. Soc.</i> <u>1952</u> , 3819-3822.			
VARIABLES: <i>T</i> /K: 284.05-349.25 <i>P</i> /kPa: 101.325		PREPARED BY: W. Hayduk			
EXPERIMENTAL VALUES:					
<i>t</i> /°C	<i>T</i> ² /K	Solubility ¹ s/cm ³ (STP) kg ⁻¹	Mole Fraction ² /10 ⁵ <i>x</i> ₁	Ostwald Coefficient ² L/cm ³ cm ⁻³	Bunsen Coefficient ² α/cm ³ (STP) cm ⁻³
10.9	284.05	43.85	3.66	0.0456	0.0436
14.1	297.25	38.28	3.04	0.0382	0.0361
20.0	293.15	30.83	2.56	0.0330	0.0305
25.0	298.15	25.88	2.15	0.0282	0.0255
30.1	303.25	22.18	1.84	0.0245	0.0218
35.0	308.15	19.41	1.605	0.0218	0.0190
40.1	313.25	16.98	1.402	0.0193	0.0166
45.0	318.15	15.14	1.248	0.0175	0.0147
49.9	323.05	13.77	1.134	0.0161	0.0133
58.0	331.15	11.99	0.985	0.0143	0.0115
65.4	338.55	10.86	0.891	0.0132	0.0104
66.0	339.95	10.72	0.881	0.0131	0.0103
70.8	343.95	10.16	0.831	0.0125	0.00967
76.1	349.25	9.71	0.795	0.0121	0.00922
¹ Original data expressed as cm ³ (STP) per 1000 g water at a total pressure of 101.325 kPa(1 atm). Smoothing equation given by authors (ref. 1 below): $\log_{10} s = -109.258 + 5995/(T/K) + 36.60 \log_{10}(T/K)$. ² Calculated by compiler assuming that authors considered gas to be ideal, and using real gas molar volumes: $x_1 = 18.016sT[273.15(1000) V_t]^{-1}$; $V_t/\text{cm}^3\text{mol}^{-1}$ at <i>T</i> .					
AUXILIARY INFORMATION					
METHOD/APPARATUS/PROCEDURE: The equipment consisted of a solvent degassing system, an absorption spiral and a gas buret for measuring the gas volume. Degassed solvent was allowed to flow down the absorption spiral containing the gas, saturated with solvent vapor, at a total pressure of one atmosphere. The volume of gas absorbed was measured by means of the attached buret system. Details were previously described (2).			SOURCE AND PURITY OF MATERIALS: 1. Prepared from Grignard reagent. Some supplied by Anglo-Iranian Oil Co., Specified as 99 per cent pure, giving same results. 2. Degassed. No additional details given.		
			ESTIMATED ERROR: $\delta T/K = 0.02$ $\delta s/s = 0.01$ (compiler)		
			REFERENCES: 1. Morrison, T.J. <i>J. Chem. Soc.</i> <u>1952</u> , 3814. 2. Morrison, T.J.; Billet, F. <i>J. Chem. Soc.</i> <u>1948</u> , 2033.		

<p>COMPONENTS:</p> <p>(1) Butane; C_4H_{10}; [106-97-8]</p> <p>(2) Water; H_2O; [7732-18-5]</p>	<p>ORIGINAL MEASUREMENTS:</p> <p>Umano, S.; Nakano, Y.</p> <p><i>Kogyo Kagaku Zasshi</i> <u>1958</u>, <i>61</i>, 536-44.</p>																																			
<p>VARIABLES:</p> <p>$T/K = 273 - 293$</p> <p>$p_1/kPa = 99.29 - 101.01$</p>	<p>PREPARED BY:</p> <p>H. L. Clever</p>																																			
<p>EXPERIMENTAL VALUES:</p> <table border="1" data-bbox="268 520 1037 891"> <thead> <tr> <th colspan="2">Temperature</th> <th>Total Pressure</th> <th>Butane Partial Pressure</th> <th>Mol Fraction</th> </tr> <tr> <th>$t/^\circ C$</th> <th>T/K</th> <th>p/atm</th> <th>p_1/atm</th> <th>$\cdot 10^5 x_1$</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>273</td> <td>1.0030</td> <td>0.9969</td> <td>6.793</td> </tr> <tr> <td>5</td> <td>278</td> <td>1.0030</td> <td>0.9944</td> <td>4.925</td> </tr> <tr> <td>10</td> <td>283</td> <td>1.0030</td> <td>0.9908</td> <td>3.952</td> </tr> <tr> <td>15</td> <td>288</td> <td>1.0030</td> <td>0.9865</td> <td>3.353</td> </tr> <tr> <td>20</td> <td>293</td> <td>1.0030</td> <td>0.9799</td> <td>2.776</td> </tr> </tbody> </table>		Temperature		Total Pressure	Butane Partial Pressure	Mol Fraction	$t/^\circ C$	T/K	p/atm	p_1/atm	$\cdot 10^5 x_1$	0	273	1.0030	0.9969	6.793	5	278	1.0030	0.9944	4.925	10	283	1.0030	0.9908	3.952	15	288	1.0030	0.9865	3.353	20	293	1.0030	0.9799	2.776
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<p>METHOD/APPARATUS/PROCEDURE:</p> <p>The apparatus consists of a gas supply, a manometer-buret system, a thermostated mixing cell, and a solvent cell. The apparatus is constructed of glass with vinyl tubing connectors. A gasoline insoluble type stopcock grease is used.</p> <p>The apparatus is evacuated, then filled with gas to condition the glass surfaces, vinyl chloride tubing and stopcock grease. The solvent is degassed by boiling under reduced pressure in the solvent reservoir. The solvent is transferred to the evacuated mixing cell, the gas added to establish the pressure of the measurement. The mixing cell is shaken until equilibrium is attained.</p>	<p>SOURCE AND PURITY OF MATERIALS:</p> <p>(1) Butane. Oakford Gas and Appliance Co. Stated to be greater than 99 mol percent purity. The impurity is higher molecular weight hydrocarbons.</p> <p>(2) Water.</p> <p>ESTIMATED ERROR:</p> <p>$\delta T/K = 0.05$</p> <p>$\delta x_1/x_1 = 0.01$ (compiler)</p> <p>REFERENCES:</p>																																			

COMPONENTS:		ORIGINAL MEASUREMENTS:		
(1) Butane; C ₄ H ₈ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		Claussen, W.F.; Polglase, M.F. <i>J. Am. Chem. Soc.</i> <u>1952</u> , <i>74</i> , 4817-4819.		
VARIABLES:		PREPARED BY:		
T/K: 292.95, 302.95 P/kPa: 101.325		W. Hayduk		
EXPERIMENTAL VALUES:				
$t^1/^\circ\text{C}$	T/K	Mole Fraction ² /10 ⁵ x ₁	Ostwald Coefficient ² L/cm ³ cm ⁻³	Bunsen Coefficient ¹ α/cm ³ (STP)cm ⁻³ atm ⁻¹
19.8	292.95	2.75	0.0354	0.0321, 0.0333, 0.0330, 0.0326, 0.0325 (0.03270) ³
29.8	302.95	1.96	0.0262	0.0230, 0.0236, 0.0233, 0.0234, 0.0230 (0.02326) ³
<p>¹Original data reported as the Bunsen coefficients.</p> <p>²Calculated by compiler using the average value of the Bunsen coefficients and real gas molar volumes.</p> <p>³Average value of Bunsen coefficients.</p>				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:		SOURCE AND PURITY OF MATERIALS:		
<p>The gas solubility was determined by a micro combustion technique. It involved stripping the gas from a saturated water solution with oxygen, catalytically oxidizing the hydrocarbon and then adsorbing and weighing the carbon dioxide produced. Gas was bubbled through the water via a sintered glass disc until saturated. The train for analysis consisted of an oxygen tank, pressure regulators, mercury manometer, preheater, absorption tube containing ascarite and anhydrone, aerator, combustion tube containing copper oxide at 973 K, weighing tubes containing ascarite and anhydrone, and finally the Mariotte flask. Further details are given in the paper.</p>		<p>1. Ohio Chemical Co., specified as 99 per cent pure.</p> <p>2. Doubly distilled.</p>		
		ESTIMATED ERROR:		
		<p>$\delta T/K = 0.1$</p> <p>$\delta \alpha/\alpha = 0.01$ (estimated by compiler)</p>		
		REFERENCES:		

COMPONENTS: (1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		ORIGINAL MEASUREMENTS: Ben-Naim, A.; Wilf, J.; Yaacobbi, M. <i>J. Phys. Chem.</i> <u>1973</u> , <i>77</i> , 95-102.		
VARIABLES: <i>T</i> /K: 278.15-298.15 <i>P</i> /kPa: 101.325		PREPARED BY: W. Hayduk		
EXPERIMENTAL VALUES:				
<i>t</i> ¹ /°C	<i>T</i> ² /K	Ostwald Coefficient ¹ L/cm ³ cm ⁻³	Bunsen Coefficient ² α/cm ³ (STP)cm ⁻³	Mole Fraction ² /10 ⁵ <i>x</i> ₁
5	278.15	0.0641	0.0628	5.27
10	283.15	0.0511	0.0490	4.12
15	288.15	0.0416	0.0391	3.29
20	293.15	0.0346	0.0319	2.69
25	298.15	0.0293	0.0265	2.23
¹ Original data. ² Calculated by compiler using real gas molar volumes.				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE: The method of Ben-Naim and Baer (1) was modified to include the use of Teflon stopcocks. Degassed liquid initially in a volumetric container was forced by a stirrer-created vortex up side-arms and through tubes containing the gas, which was saturated with vapor. The gas uptake at constant pressure was determined by means of a buret.		SOURCE AND PURITY OF MATERIALS: 1. Matheson Co. Minimum specified purity 99.95%. 2. Not specified.		
		ESTIMATED ERROR: δ <i>L</i> / <i>L</i> = 0.01 (compiler)		
		REFERENCES: 1. Ben-Naim, A.; Baer, S. <i>Trans. Faraday Soc.</i> <u>1963</u> , <i>59</i> , 2735-2741.		

COMPONENTS: (1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]	ORIGINAL MEASUREMENTS: Rice, P. A.; Gale, R. P.; Barduhn, A. J. <i>J. Chem. Eng. Data</i> <u>1976</u> , <i>21</i> , 204-6.
VARIABLES: $T/K = 276.15 - 292.15$ $p_1/kPa = 67.58, 101.325$	PREPARED BY: H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Partial Pressure p_1/atm	Butane Solubility	
$t/^{\circ}C$	T/K		ppm	Mol Fraction $10^5 x_1$
3	276.15	1	182.4	5.65
6	279.15	1	152.4	4.72
9	282.15	1	134.5	4.17
14	287.15	1	109.6	3.40
19	292.15	1	91.9	2.85
19	292.15	0.667	61.3	1.90

The mole fraction values were calculated by the compiler.

The solubility values are the average of three to nine separate injections into the total carbon analyzer.

Smoothed Data: A least square regression of the ppm solubility data at one atm gives

$$\ln(\text{ppm}) = -222.3536 + 333.0672/(T/100 \text{ K}) + 105.281 \ln(T/100 \text{ K})$$

with a standard error about the regression line of 1.9 which ranges from 1.0 to 2.1 % of the experimental values.

ppm = parts per million by weight

AUXILIARY INFORMATION**METHOD/APPARATUS/PROCEDURE:**

The solubility equilibrium was established in a one liter pyrex cell with a Plexiglass top with ports for sampling, pressure connection, vacuum line, and introduction of the gas.

About 700 cm³ of solvent was placed in the cell, it was sealed, thermostated, and degassed by reducing the pressure to the vapor pressure of the solvent for about one hour.

Butane was added to the system and the system was stirred for 24 - 48 hours. It was assumed that equilibrium was established when no pressure change was observed in a four hour period. Saturation was approached from both a higher and a lower temperature. Samples of the liquid were taken in a microliter syringe. The samples were injected directly into a total carbon analyzer. Three to nine injections were made.

SOURCE AND PURITY OF MATERIALS:

- (1) Butane. Source not given. Stated to be of 99.5 % instrument purity.
- (2) Water. No information.

ESTIMATED ERROR:

$$\begin{aligned} \delta T/K &= \pm 0.02 \\ \delta \text{ppm/ppm} &= \pm 0.01 \\ \delta x_1/x_1 &= \pm 0.01 \end{aligned}$$

REFERENCES:

<p>COMPONENTS:</p> <p>(1) Butane; C₄H₁₀; [106-97-8]</p> <p>(2) Water; H₂O; [7732-18-5]</p>	<p>ORIGINAL MEASUREMENTS:</p> <p>Namiot, A. Yu.</p> <p><i>Zh. Strukt. Khim.</i> <u>1961</u>, 2, 408-17.</p> <p>*<i>J. Struct. Chem. (Engl. Transl.)</i> <u>1961</u>, 2, 381-9.</p>												
<p>VARIABLES:</p> <p style="padding-left: 40px;">$T/K = 283$</p> <p style="padding-left: 40px;">$p_1/kPa = 101.3$</p>	<p>PREPARED BY: H. L. Clever</p>												
<p>EXPERIMENTAL VALUES:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Temperature</th> <th>Henry's Constant</th> <th>Mol Fraction at One Atm (Compiler)</th> </tr> <tr> <th>$t/^{\circ}C$</th> <th>T/K</th> <th>K/atm</th> <th>$10^5 x_1$</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">283.15</td> <td style="text-align: center;">27400</td> <td style="text-align: center;">3.65</td> </tr> </tbody> </table> <p style="text-align: center;">Henry's constant, $K/atm = (p_1/atm)/x_1$.</p>		Temperature		Henry's Constant	Mol Fraction at One Atm (Compiler)	$t/^{\circ}C$	T/K	K/atm	$10^5 x_1$	10	283.15	27400	3.65
Temperature		Henry's Constant	Mol Fraction at One Atm (Compiler)										
$t/^{\circ}C$	T/K	K/atm	$10^5 x_1$										
10	283.15	27400	3.65										
<p>AUXILIARY INFORMATION</p>													
<p>METHOD/APPARATUS/PROCEDURE:</p> <p>No experimental details are given.</p> <p>The paper does not make clear whether this is a new experimental value or a literature value.</p> <p>The paper does contain literature values of other thermodynamic information.</p>	<p>SOURCE AND PURITY OF MATERIALS:</p> <p>No experimental details are given.</p> <p>ESTIMATED ERROR:</p> <p>REFERENCES:</p>												

COMPONENTS:		ORIGINAL MEASUREMENTS:			
(1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		Denton, W.H.; Smith, M.J.S.; Klaschka, J.T.; Forgan, R. <i>et al.</i> <i>Fourth Int. Symp. Fresh Water Sea</i> <u>1973, 3, 291-311.</u>			
VARIABLES:		PREPARED BY:			
T/K: 298.15 P/kPa: 0.101-101.325		W. Hayduk			
EXPERIMENTAL VALUES:					
T/K	Gas Partial Pressure ¹ P/atm	Solubility ¹ z/mol(10 ⁶ mol) ⁻¹	Mole Fraction ² /10 ⁵ x ₁	Ostwald Coefficient ² L/cm ³ cm ⁻³	Bunsen Coefficient ² α
298.15	1.00 0.10 0.01 0.001	21.0 2.1 0.21 0.021	2.10	0.0275	0.0249
<p>¹Results presented only on a log-log graph which was replotted by compiler for estimation of values shown here. Values show that Henry's law is obeyed; the slope of the graph is 1.</p> <p>²Calculated by compiler using a real gas molar volume.</p>					
AUXILIARY INFORMATION					
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:		
A chromatographic technique for analysis of butane in water and aqueous sodium chloride solutions stated to be capable of detecting concentrations down to 0.001 mg dm ⁻³ was used. Details not given.			Sources and purities not specified.		
			ESTIMATED ERROR:		
			δz/z = 0.02 (authors)		
			REFERENCES:		

COMPONENTS: (1) Butane; C ₄ H ₈ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		ORIGINAL MEASUREMENTS: Wetlaufer, D.B.; Malik, S.K.; Stoller, L.; Coffin, R.L. <i>J. Am. Chem. Soc.</i> <u>1964</u> , <i>86</i> , 508-514.		
VARIABLES: <i>T</i> /K: 278.15-318.15 <i>P</i> /kPa: 101.325		PREPARED BY: W. Hayduk, C.L. Young		
EXPERIMENTAL VALUES:				
<i>T</i> /K	Solubility ¹ s/mmole dm ⁻³	Mole Fraction ² /10 ⁵ x ₁	Ostwald Coefficient ² L/cm ³ cm ⁻³	Bunsen Coefficient ² α/cm ³ (STP)cm ⁻³ atm ⁻¹
278.15	2.85	5.14	0.0624	0.0611
298.15	1.16	2.10	0.0275	0.0249
318.15	0.69	1.26	0.0176	0.0148
¹ Original data reported as millimoles per litre at a gas partial pressure of 101.325 kPa. ² Calculated by compiler using real gas molar volumes. ³ No correction was made for the amount of gas retained by the solvent during extraction, estimated by the authors to be 1-1.5 per cent; hence the results are expected to be too low by that amount.				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE: A modified Van Slyke-Neill manometric blood gas apparatus, fitted with a magnetic stirrer was used. The solvent was saturated with gas; then a sample was transferred to the Van Slyke extraction chamber for gas desorption and volume measurement.		SOURCE AND PURITY OF MATERIALS: 1. Matheson Co. C.P. grade of minimum specified purity 99.0 per cent. 2. Distilled.		
		ESTIMATED ERROR: $\delta T/K = 0.05$ $\delta s/s = 0.02$ (authors) ³		
		REFERENCES:		

COMPONENTS:		ORIGINAL MEASUREMENTS:		
(1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		McAuliffe, C. <i>J. Phys. Chem.</i> <u>1966</u> , <i>70</i> , 1267-1275. <i>Nature</i> , <u>1963</u> , <i>200</i> , 1092-1093.		
VARIABLES:		PREPARED BY:		
<i>T</i> /k: 298.15 <i>P</i> /kPa: 101.325		W. Hayduk		
EXPERIMENTAL VALUES:				
<i>T</i> /K	Solubility ¹ s/g(10 ⁶ g water) ⁻¹	Mole Fraction ² /10 ⁵ <i>x</i> ₁	Ostwald Coefficient ² L/cm ³ cm ⁻³	Bunsen Coefficient ² α/cm ³ (STP)cm ⁻³ atm ⁻¹
298.15	61.4	1.94	0.0255	0.0231
<p>¹Original data at 1 atm total pressure.</p> <p>²Calculated by compiler correcting for vapor pressure of water.</p> <p>The same data appear in both sources.</p>				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:		SOURCE AND PURITY OF MATERIALS:		
<p>The equipment consisted of a gas reservoir, contacting bottle, stripping column and a gas chromatographic analyzer. A rubber balloon maintained at essentially atmospheric pressure served as the gas reservoir which was connected to a bottle partially filled with the water solvent. Equilibrium was established by hand shaking for 5 to 10 min after which the mixture was allowed to stand for phase separation. The solubility was determined by injection of the gas-saturated water solution into a stripping column supplied with helium. The quantity of gas was determined by a gas chromatograph equipped with a hydrogen-flame ionization detector.</p>		<p>1. Phillips Petroleum Co. of minimum specified purity 99.0%.</p> <p>2. Distilled.</p>		
		ESTIMATED ERROR:		
		<p>δ<i>T</i>/K = 1.5 δ<i>s</i>/<i>s</i> = 0.04 (author)</p>		
		REFERENCES:		

COMPONENTS:		ORIGINAL MEASUREMENTS:		
(1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		Barone, G.; Crescenzi, V.; Pispisa, B.; Quadrifoglio, F. <i>J. Macromol. Chem.</i> <u>1966</u> , <i>1</i> , 761-771.		
VARIABLES:		PREPARED BY:		
<i>T</i> /K: 298.15 <i>P</i> /kPa: 101.325		W. Hayduk		
EXPERIMENTAL VALUES:				
<i>T</i> /K	Solubility ¹ s/mmol dm ⁻³	Mole Fraction ² /10 ⁵ <i>x</i> ₁	Ostwald Coefficient ² L/cm ³ cm ⁻³	Bunsen Coefficient ² α/cm ³ (STP)cm ⁻³ atm ⁻¹
298.15	1.09	1.97	0.0258	0.0234
<p>¹Original data reported as millimoles of gas per litre water at gas partial pressure of 101.325 kPa.</p> <p>²Calculated by compiler using a real gas molar volume.</p>				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:		SOURCE AND PURITY OF MATERIALS:		
A method utilizing a gas chromatographic analysis of saturated water was used. A volume of 4 cm ³ of water was saturated at constant temperature in a 20-cm ³ gas-washing bottle by means of a sintered glass bubbler. The top was sealed with a rubber stopper through which a hypodermic needle was inserted as a vent. Equilibration was continued for 1 h. Samples of 0.20-cm ³ were withdrawn by syringe and passed through a stripper where they were contacted with carrier gas, then through a CaCl ₂ tube and finally to a gas chromatograph for analysis.		1. Riviora, Turin, Italy. Specified as chromatographically pure.		
		2. Not specified.		
		ESTIMATED ERROR:		
		<i>T</i> /K = 0.02		
		δ <i>s</i> / <i>s</i> = 0.04 (authors)		
		REFERENCES:		

COMPONENTS: (1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		ORIGINAL MEASUREMENTS: Wishnia, A <i>Proc. Natl. Acad. Sci., Biochem.</i> <u>1962</u> , 48, 2200-2204.	
VARIABLES: T/K: 283.15-308.15 P/kPa: 101.325		PREPARED BY: W. Hayduk	
EXPERIMENTAL VALUES:			
t/°C	T/K	Solubility ¹ s/mMol (kg) ⁻¹	Mol Fraction ¹ /10 ³ x ₁
10	283.15	2.5	4.50
15	288.15	2.1	3.78
20	293.15	1.7	3.06
25	298.15	1.4	2.52
30	303.15	1.2	2.16
35	308.15	1.1	1.98
¹ Values read from graph of s versus t by compiler and calculated as mol fraction. No numerical data given.			
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 water 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. 2. Deaerated.	
		ESTIMATED ERROR: δT/K = 0.01 (author) δs/s = 0.08 (compiler)	
		REFERENCES:	

COMPONENTS: (1) Butane; C ₄ H ₈ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5]		ORIGINAL MEASUREMENTS: Rudakov, E.S.; Lutsyk, A.I. <i>Zh. Fiz. Khim.</i> , <u>1979</u> , <i>53</i> , 1298-1300. <i>Russ. J. Phys. Chem.</i> , <u>1979</u> , <i>53</i> , 731-733.		
VARIABLES: T/K: 298.15, 363.15		PREPARED BY: E.S. Rudakov, W. Hayduk		
EXPERIMENTAL VALUES:				
T/K	Partition coefficient ¹ k/cm ³ cm ⁻³ ₁	Ostwald coefficient ² L/cm ³ cm ⁻³	Bunsen coefficient ² α/cm ³ (STP) cm ⁻³ atm ⁻¹	Mole fraction ² 10 ⁵ x ₁
298.15	37	0.0270	0.0244	2.05
363.15	223	0.00448	0.00328	0.29
¹ Original data. ² Ostwald and Bunsen coefficients and mole fraction for 101.325 kPa calculated by compilers on basis that partition coefficient is equivalent to the inverse of the Ostwald coefficient and assuming that Henry's law applies.				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE: Gas chromatographic method used to evaluate partition coefficients. Reactor containing gas and water mechanically shaken. After phase separation a measured volume of gas introduced into carrier gas for analysis. An equal volume of solution placed into a gas stripping cell for complete stripping of the butane by the carrier gas. The ratio of areas under the butane peaks used to determine the solubility. Actual equilibrium pressure not specified.		SOURCE AND PURITY OF MATERIALS: Sources and purities not specified.		
		ESTIMATED ERROR: δk/k = 0.10 (authors)		
		REFERENCES:		

COMPONENTS: (1) Butane; C ₄ H ₁₀ ; [106-97-8] (2) Water; H ₂ O; [7732-18-5] Ethanol; C ₂ H ₆ O; [64-17-5] Diethyl ether; C ₄ H ₁₀ O; [60-29-7] Chloroform; CHCl ₃ ; [67-66-3]	ORIGINAL MEASUREMENTS: Lebeau, P. <i>Bull. Acad. Roy. Belg.</i> <u>1908</u> , 300-4.																																								
VARIABLES: $T/K = 290, 291$ $p/kPa = 102.9 - 104.8$	PREPARED BY: H. L. Clever																																								
EXPERIMENTAL VALUES: <table border="1" data-bbox="248 506 1094 985"> <thead> <tr> <th colspan="2">Temperature</th> <th>Pressure^a</th> <th>Solubility</th> </tr> <tr> <th><i>t</i>/^oC</th> <th><i>T</i>/K</th> <th><i>p</i>/mmHg</th> <th>Volume Butane/Volume Solvent</th> </tr> </thead> <tbody> <tr> <td colspan="4">Water</td> </tr> <tr> <td>17</td> <td>290</td> <td>772</td> <td>0.15</td> </tr> <tr> <td colspan="4">Ethanol</td> </tr> <tr> <td>17</td> <td>290</td> <td>775</td> <td>18.83</td> </tr> <tr> <td colspan="4">Diethylether or 1,1'-oxybisethane</td> </tr> <tr> <td>18</td> <td>291</td> <td>773</td> <td>29.8</td> </tr> <tr> <td colspan="4">Chloroform or trichloromethane</td> </tr> <tr> <td>17</td> <td>290</td> <td>786</td> <td>32.5</td> </tr> </tbody> </table> <p>^a Not clear whether this is total pressure or butane partial pressure. It is probably the total pressure.</p>		Temperature		Pressure ^a	Solubility	<i>t</i> / ^o C	<i>T</i> /K	<i>p</i> /mmHg	Volume Butane/Volume Solvent	Water				17	290	772	0.15	Ethanol				17	290	775	18.83	Diethylether or 1,1'-oxybisethane				18	291	773	29.8	Chloroform or trichloromethane				17	290	786	32.5
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AUXILIARY INFORMATION																																									
METHOD/APPARATUS/PROCEDURE: Details not given.	SOURCE AND PURITY OF MATERIALS: (1) Butane. Prepared by author by the reaction of sodium in liquid ammonia on butyl iodide. The normal boiling point is 0.5 °C, and the critical temperature is 151-2 °C. (2) Solvents. No information.																																								
ESTIMATED ERROR:																																									
REFERENCES:																																									