

COMPONENTS:		EVALUATOR:	
(1) Methane; CH ₄ ; [74-82-8]		H. Lawrence Clever	
(2) Ethers		Department of Chemistry	
		Emory University	
		Atlanta, GA 30322 USA	
		1985, April	
CRITICAL EVALUATION:			
AN EVALUATION OF THE SOLUBILITY OF METHANE IN ETHERS AT PRESSURES UP TO 0.2 MPa (≈2 ATM).			
<p>Seven papers report values of the methane solubility in three dialkyl ethers, four cyclic ethers, and one aromatic alkyl ether. All of the laboratories but one used conventional volumetric procedures. One used a GLC method (ref 4) at low methane partial pressure without correction for surface adsorption. The results are discussed in the three sections below.</p>			
I. Methane + 1,1'-oxybisalkanes			
Methane + 1,1'-oxybisethane or diethyl ether [60-29-7]			
<p>Christoff (ref 1) reported methane solubility values at 273.15 and 283.15 K. Horiuti (ref 2) reported seven solubility values at temperatures between 192.75 and 293.15 K. Horiuti's work is usually reliable. His values are 5 to 7 percent larger than the Christoff values in the 273 to 283 K temperature interval. The Horiuti values are classed as tentative and the Christoff values as doubtful.</p>			
<p>A linear regression was applied to the Horiuti values which omitted the solubility value of 211.55 K to obtain the equation</p>			
$\ln x_1 = -11.6184 + 11.0406/(T/100 \text{ K}) + 2.3007 \ln (T/100 \text{ K})$			
with a standard error about the regression line of 2.96×10^{-5} .			
<p>The thermodynamic changes for the transfer of one mole of methane from the gas phase at 0.101325 MPa to the infinitely dilute solution were calculated from the equation to be</p>			
T/K	$\Delta H_1^0/kJ \text{ mol}^{-1}$	$\Delta S_1^0/J \text{ K}^{-1}, \text{ mol}^{-1}$	$\Delta C_{p1}^0/J \text{ K}^{-1} \text{ mol}^{-1}$
213.15	-5.10	-63.0	19.1
243.15	-4.53	-60.5	19.1
273.15	-3.95	-58.2	19.1
293.15	-3.57	-56.9	19.1
Smoothed values of the mole fraction solubility follow in Table 1.			

Table 1. Solubility of methane in diethyl ether. Tentative values of the mole fraction solubility as a function of temperature at a methane partial pressure of 0.101325 MPa.

T/K	$10^3 x_1$	T/K	$10^3 x_1$
193.15	12.43		
203.15	10.54	273.15	5.17
213.15	9.12	278.15	5.01
223.15	8.03	283.15	4.87
233.15	7.19	288.15	4.74
243.15	6.52	293.15	4.62
253.15	5.97		
263.15	5.53		

Methane + 1,1'-oxybispropane or dipropyl ether [111-43-3]

Guerry (ref 3) measured the methane solubility at 293.15 and 298.15 K. The value reported at 293.15 K appears to be in error and it is rejected. The value of 298.15 K corresponds to a mole fraction solubility of 4.38×10^{-3} at a methane partial pressure of 0.101325 MPa and it is classed as tentative.

Methane + 1,1'-oxybis-2-propanol or dipropylene glycol [110-98-5]

Lenoir, Renault and Renon (ref 4) report the methane solubility at temperatures of 298.2, 323.2 and 343.2 K by a GLC retention time method. The maximum methane partial pressure was 2 mmHg. The three solubility values were converted to mole fraction solubilities at atmospheric pressure and treated by a linear regression to obtain the equation

$$\ln x_1 = -10.52708 + 9.7177/(T/100 \text{ K})$$

with a standard error about the regression line 1.73×10^{-5} .

The thermodynamic changes for the transfer of one mole of methane from the gas at 0.101325 MPa to the infinitely dilute solution are

$$\Delta H_1^0/k \text{ J mol}^{-1} = -8.08 \text{ and } \Delta S_1^0/\text{J K}^{-1} \text{ mol}^{-1} = -87.5$$

These values are of larger than average magnitude for many organic solvents. They may reflect either a more water-like solvent when several O and OH groups are present or problems in converting the reported Henry's constant at very low pressure to reliable values at atmospheric pressure. Smoothed mole fraction solubility values are in Table 2.

COMPONENTS: (1) Methane; CH ₄ ; [74-82-8] (2) Ethers	EVALUATOR: H. Lawrence Clever Department of Chemistry Emory University Atlanta, GA 30322 USA 1985, April
---	---

CRITICAL EVALUATION:

Table 2. The solubility of methane in 1,1'-oxybis-2-propanol. Tentative values of the mole fraction solubility and partial molal Gibbs energy as a function of temperature at a methane partial pressure of 0.101325 MPa.

T/K	10 ⁴ x ₁	ΔG ₁ ⁰ /kJ mol ⁻¹
298.2	6.97	18.021
303.2	6.61	18.458
313.2	5.97	19.333
323.2	5.42	20.209
333.2	4.95	21.084
343.2	4.55	21.959

II. Methane + Cyclic Ethers

Methane + 1,4-Dioxane [123-91-1]

Guerry (ref 3), Ben-Naim and Yaacobi (ref 5), and Gallardo, Urieta and Gutierrez Losa (ref 7) report methane solubilities in 1,4-dioxane. Guerry's two values at 293.15 and 298.15 K are 3 and 6.5 percent, respectively, smaller than the values of the other workers. They are classed as doubtful. The results of Ben-Naim and Yaacobi and of Gallardo *et al.* agree with 0.5 percent at all temperatures between 283.15 and 303.15 K. Both laboratories used a similar apparatus and experimental technique. The Ben-Naim and Yaacobi and the Gallardo *et al.* values were combined in a linear regression to obtain the equation for the 283.15 to 303.15 K temperature interval

$$\ln x_1 = -6.91003 + 0.95526/(T/100 \text{ K})$$

with a standard error about the regression line of 5.03×10^{-6} .

The thermodynamic changes for the transfer of one mole of methane from the gas at 0.101325 MPa to the infinitely dilute solution are found from the equation to be

$$\Delta H_1^0/\text{kJ mol}^{-1} = -0.79_4 \text{ and } \Delta S_1^0/\text{J K}^{-1} \text{ mol}^{-1} = -57.5.$$

This is a much smaller enthalpy of solution than normally found for organic

solvents. The smoothed mole fraction solubility values follow in Table 3.

Table 3. The solubility of methane in 1,4-dioxane. Tentative values of the mole fraction solubility and partial molal Gibbs energy of solution as a function of temperature of a methane partial pressure at 0.101325 MPa.

T/K	$10^4 x_1$	$\Delta G_1^0/kJ\ mol^{-1}$
283.15	13.9 ₈	15.473
288.15	13.9 ₀	15.761
293.15	13.8 ₂	16.048
298.15	13.7 ₅	16.335
303.15	13.6 ₇	16.622

Methane + Tetrahydrofuran [109-99-9]

Methane + 2,3-Dihydropyran [25512-65-0]

Methane + Tetrahydro-2H-pyran [142-68-7]

Guerry (ref 3) measured the solubility of methane at 293.15 and 298.15 K in each of the three solvents. His values show a negligible temperature coefficient of the mole fraction solubility, which imply a zero to slightly positive partial molal enthalpy of solution.

Guerry's mole fraction solubility values, which are classed as tentative, are:

Solvent and Formula	Mole Fraction Solubility, $10^3 x_1$, at temperatures of	
	293.15 K	298.15 K
Tetrahydrofuran, C_4H_8O	1.94	1.94
2,3-Dihydropyran, C_5H_8O	1.94	1.94
Tetrahydro-2H-pyran, $C_5H_{10}O$	2.32	2.33

III. Methane + aryl alkyl ethers

Methane + methoxybenzene or anisole [100-66-3]

Gibanel, Urieta, and Gutierrez Losa (ref 6) measured the methane solubility at five degree intervals between 283.15 and 303.15 K. Their values are classed as tentative.

The data were fit by a linear regression to obtain the equation for the 283.15 to 303.15 K interval

COMPONENTS: (1) Methane; CH ₄ ; [74-82-8] (2) Ethers	EVALUATOR: H. Lawrence Clever Department of Chemistry Emory University Atlanta, GA 30322 USA 1985, April
---	---

CRITICAL EVALUATION:

$$\ln x_1 = -7.0524 + 1.8282/(T/100 \text{ K})$$

with a standard error about the regression line of 8.87×10^{-7} .

From the equation the thermodynamic changes for the transfer of one mole of methane from the gas at 0.101325 MPa to the infinitely dilute solution are

$$\Delta H_1^0/\text{kJ mol}^{-1} = -1.52 \text{ and } \Delta S_1^0/\text{J K}^{-1} \text{ mol}^{-1} = -58.6$$

Smoothed values of the mole fraction solubility are in Table 4.

Table 4. Solubility of methane in methoxybenzene. Tentative values of the mole fraction solubility and partial molal Gibbs energy of solution as a function of temperature at a methane partial pressure of 0.101325 MPa.

T/K	$10^4 x_1$	$\Delta G_1^0/\text{kJ mol}^{-1}$
283.15	16.50	15.083
288.15	16.32	15.376
293.15	16.14	15.669
298.15	15.98	15.962
303.15	15.82	16.255

References

- Christoff, A. *Z. Phys. Chem.* 1912, *79*, 456-60.
- Horiuti, J. *Sci. Pap. Inst. Phys. Chem. Res. (Jpn)* 1931/32, *17*, 125-256.
- Guerry, D. Jr., Ph.D. thesis, 1944, Vanderbilt University, Nashville, TN USA.
- Lenoir, J.-Y.; Renault, P.; Renon, H. *J. Chem. Eng. Data* 1971, *16*, 340-342.
- Ben-Naim, A.; Yaacobi, M. *J. Phys. Chem.* 1974, *78*, 175-178.
- Gibanel, F.; Urieta, J. S.; Gutierrez Losa, C. *J. Chim. Phys. Phys.-Chim. Biol.* 1981, *78*, 171-174.
- Gallardo, M.A.; Urieta, J. S.; Gutierrez Losa, C. *J. Chim. Phys. Phys.-Chim. Biol.* 1983, *80*, 621-625.

<p>COMPONENTS:</p> <p>(1) Methane; CH₄; [74-82-8]</p> <p>(2) 1,1'-Oxybisethane or diethyl ether; C₄H₁₀O; [60-29-7]</p>	<p>ORIGINAL MEASUREMENTS:</p> <p>Christoff, A.</p> <p><i>Z. Phys. Chem.</i> <u>1912</u>, <i>79</i>, 456-60.</p>																				
<p>VARIABLES:</p> <p>$T/K = 273.15, 283.15$</p> <p>$p_1/\text{kPa} = \text{atmospheric}$</p>	<p>PREPARED BY:</p> <p>H. L. Clever</p>																				
<p>EXPERIMENTAL VALUES:</p> <table border="1" data-bbox="175 513 1136 758"> <thead> <tr> <th colspan="2">Temperature</th> <th>Mol Fraction</th> <th>Bunsen Coefficient</th> <th>Ostwald Coefficient</th> </tr> <tr> <th>$t/^{\circ}\text{C}$</th> <th>T/K</th> <th>$10^3 x_1$</th> <th>$\alpha/\text{cm}^3 (\text{STP}) \text{cm}^{-3} \text{atm}^{-1}$</th> <th>$L/\text{cm}^3 \text{cm}^{-3}$</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>273.15</td> <td>4.77</td> <td>1.066</td> <td>1.066</td> </tr> <tr> <td>10</td> <td>283.15</td> <td>4.50</td> <td>0.992</td> <td>1.028</td> </tr> </tbody> </table> <p>The mole fraction and Bunsen coefficient values were calculated by the compiler assuming ideal gas behavior.</p>		Temperature		Mol Fraction	Bunsen Coefficient	Ostwald Coefficient	$t/^{\circ}\text{C}$	T/K	$10^3 x_1$	$\alpha/\text{cm}^3 (\text{STP}) \text{cm}^{-3} \text{atm}^{-1}$	$L/\text{cm}^3 \text{cm}^{-3}$	0	273.15	4.77	1.066	1.066	10	283.15	4.50	0.992	1.028
Temperature		Mol Fraction	Bunsen Coefficient	Ostwald Coefficient																	
$t/^{\circ}\text{C}$	T/K	$10^3 x_1$	$\alpha/\text{cm}^3 (\text{STP}) \text{cm}^{-3} \text{atm}^{-1}$	$L/\text{cm}^3 \text{cm}^{-3}$																	
0	273.15	4.77	1.066	1.066																	
10	283.15	4.50	0.992	1.028																	
<p>AUXILIARY INFORMATION</p>																					
<p>METHOD/APPARATUS/PROCEDURE:</p> <p>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.</p> <p>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 the gas and the solvent vapor from mixing in the buret, is used to connect the absorption flask and the buret.</p>	<p>SOURCE AND PURITY OF MATERIALS:</p> <p>(1) Methane. Prepared by the author. Treated with sulfuric acid and palladium to remove related gases and hydrogen.</p> <p>(2) Diethyl ether. Merck . Stated to be pure and anhydrous.</p> <p>ESTIMATED ERROR:</p> <p>$\delta L/L = \pm 0.03$</p> <p>REFERENCES:</p> <p>1. Just, G. <i>Z. Phys. Chem.</i> <u>1901</u>, <i>37</i>, 342.</p> <p>2. Skirrow, F. W. <i>Z. Phys. Chem.</i> <u>1902</u>, <i>41</i>, 139.</p>																				

COMPONENTS: (1) Methane; CH ₄ : [74-82-8] (2) 1,1'-Oxybisethane or diethyl ether; C ₄ H ₁₀ O; [60-29-7]	ORIGINAL MEASUREMENTS: Horiuti, J. <i>Sci. Pap. Inst. Phys. Chem. Res. (Jpn)</i> <u>1931/32</u> , 17, 125 - 256.																																																
VARIABLES: T/K: 192.75 - 293.15 p ₁ /kPa: 101.325 (1 atm)	PREPARED BY: M. E. Derrick H. L. Clever																																																
EXPERIMENTAL VALUES: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">T/K</th> <th style="text-align: center;">Mol Fraction 10³x₁</th> <th style="text-align: center;">Bunsen Coefficient α/cm³ (STP) cm⁻³ atm⁻¹</th> <th style="text-align: center;">Ostwald Coefficient L/cm³ cm⁻³</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">192.75</td><td style="text-align: center;">12.49</td><td style="text-align: center;">3.146</td><td style="text-align: center;">2.220</td></tr> <tr><td style="text-align: center;">196.45</td><td style="text-align: center;">11.76</td><td style="text-align: center;">2.946</td><td style="text-align: center;">2.119</td></tr> <tr><td style="text-align: center;">211.55</td><td style="text-align: center;">9.247</td><td style="text-align: center;">2.265</td><td style="text-align: center;">1.754</td></tr> <tr><td style="text-align: center;">231.85</td><td style="text-align: center;">7.314</td><td style="text-align: center;">1.739</td><td style="text-align: center;">1.476</td></tr> <tr><td style="text-align: center;">252.55</td><td style="text-align: center;">5.978</td><td style="text-align: center;">1.379</td><td style="text-align: center;">1.275</td></tr> <tr><td style="text-align: center;">273.15</td><td style="text-align: center;">5.171</td><td style="text-align: center;">1.157</td><td style="text-align: center;">1.157</td></tr> <tr><td style="text-align: center;">293.15</td><td style="text-align: center;">4.624</td><td style="text-align: center;">1.004</td><td style="text-align: center;">1.078</td></tr> </tbody> </table> <p>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.</p> <p>Smoothed Data: For use between 192.75 and 273.15 K.</p> <p>The 211.55 K value was omitted from the linear regression.</p> $\ln x_1 = -11.6184 + 11.0406/(T/100K) + 2.3007 \ln (T/100K)$ <p>The standard error about the regression line is 2.96 x 10⁻⁵.</p> <table border="1" style="width: 50%; margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">T/K</th> <th style="text-align: center;">Mol Fraction 10³x₁</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">198.15</td><td style="text-align: center;">11.41</td></tr> <tr><td style="text-align: center;">213.15</td><td style="text-align: center;">9.12</td></tr> <tr><td style="text-align: center;">228.15</td><td style="text-align: center;">7.59</td></tr> <tr><td style="text-align: center;">243.15</td><td style="text-align: center;">6.52</td></tr> <tr><td style="text-align: center;">258.15</td><td style="text-align: center;">5.74</td></tr> <tr><td style="text-align: center;">273.15</td><td style="text-align: center;">5.17</td></tr> <tr><td style="text-align: center;">288.15</td><td style="text-align: center;">4.74</td></tr> </tbody> </table>		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	192.75	12.49	3.146	2.220	196.45	11.76	2.946	2.119	211.55	9.247	2.265	1.754	231.85	7.314	1.739	1.476	252.55	5.978	1.379	1.275	273.15	5.171	1.157	1.157	293.15	4.624	1.004	1.078	T/K	Mol Fraction 10 ³ x ₁	198.15	11.41	213.15	9.12	228.15	7.59	243.15	6.52	258.15	5.74	273.15	5.17	288.15	4.74
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																																														
192.75	12.49	3.146	2.220																																														
196.45	11.76	2.946	2.119																																														
211.55	9.247	2.265	1.754																																														
231.85	7.314	1.739	1.476																																														
252.55	5.978	1.379	1.275																																														
273.15	5.171	1.157	1.157																																														
293.15	4.624	1.004	1.078																																														
T/K	Mol Fraction 10 ³ x ₁																																																
198.15	11.41																																																
213.15	9.12																																																
228.15	7.59																																																
243.15	6.52																																																
258.15	5.74																																																
273.15	5.17																																																
288.15	4.74																																																
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) Methane. Aluminum carbide was prepared from aluminum and soot carbon. The aluminum carbide was treated with hot water. The gas evolved was scrubbed to remove impurities, dried and fractionated. Final product had a density, ρ/g dm ⁻³ = 0.7168±0.0003 at normal conditions. (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: $\delta T/K = 0.05$ $\delta x_1/x_1 = 0.01$																																																
	REFERENCES:																																																

COMPONENTS: (1) Methane; CH ₄ ; [74-82-8] (2) 1,1'-Oxybispropane or dipropyl ether; C ₆ H ₁₄ O; [111-43-3]	ORIGINAL MEASUREMENTS: Guerry, D. Jr. Ph.D. thesis, 1944 Vanderbilt University Nashville, TN Thesis Director: L. J. Bircher												
VARIABLES: T/K: 293.15, 298.15 P/kPa: 101.325 (1 atm)	PREPARED BY: H. L. Clever												
EXPERIMENTAL VALUES: <table border="1" data-bbox="330 527 1065 686"> <thead> <tr> <th>T/K</th> <th>Mol Fraction $x_1 \times 10^4$</th> <th>Bunsen Coefficient α</th> <th>Ostwald Coefficient L</th> </tr> </thead> <tbody> <tr> <td>293.15</td> <td></td> <td>0.198 (sic)</td> <td>0.212 (?)</td> </tr> <tr> <td>298.15</td> <td></td> <td>0.713</td> <td>0.778</td> </tr> </tbody> </table> <p>The Ostwald coefficients were calculated by the compiler.</p>		T/K	Mol Fraction $x_1 \times 10^4$	Bunsen Coefficient α	Ostwald Coefficient L	293.15		0.198 (sic)	0.212 (?)	298.15		0.713	0.778
T/K	Mol Fraction $x_1 \times 10^4$	Bunsen Coefficient α	Ostwald Coefficient L										
293.15		0.198 (sic)	0.212 (?)										
298.15		0.713	0.778										
AUXILIARY INFORMATION													
METHOD/APPARATUS/PROCEDURE: A Van Slyke-Neill Manometric Apparatus manufactured by the Eimer and Amend Co. was used. The procedure of Van Slyke (1) for pure liquids was modified (2) so that small solvent samples (2 cm ³) could be used with almost complete recovery of the sample. An improved temperature control system was used.	SOURCE AND PURITY OF MATERIALS: (2) Dipropyl ether. Eastman Kodak Co, Refluxed four hours over Na, then distilled from Na in a N ₂ atm. B.p. (746.2 mmHg) t/°C 89.03 - 89.28 (corr.). Refractive index, density, and vapor pressure data are in the thesis.												
SOURCE AND PURITY OF MATERIALS: (1) Methane. Prepared by hydrolysis of crystalline methyl Grignard reagent. Passed through conc. H ₂ SO ₄ , solid KOH, and Dririte.	ESTIMATED ERROR: $\delta T/K = 0.05$ REFERENCES: 1. Van Slyke, D. D. <i>J. Biol. Chem.</i> 1939, 130, 545. 2. Ijams, C. C. Ph.D. thesis, 1941 Vanderbilt University												

COMPONENTS:		ORIGINAL MEASUREMENTS:		
1. Methane; CH ₄ ; [74-82-8] 2. 1,2-Epoxyethane (Ethylene oxide); C ₂ H ₂ O; [75-21-8]		Hess, L. G.; Tilton, V. V. <i>Ind. Eng. Chem.</i> <u>1950</u> , <i>42</i> , 1251-2158.		
VARIABLES:		PREPARED BY:		
		C. L. Young		
EXPERIMENTAL VALUES:				
t ^a /C	T ^b /K	Total pressure, ^a pounds per square inch /psig	Mass percent ^a in solution	Mole fraction ^b /x ₁
30	303.2	30	0.02	0.0005
30	303.2	40	0.06	0.0016
30	303.2	50	0.11	0.0030
45	318.2	50	0.06	0.0016
45	318.2	60	0.11	0.0030
45	318.2	70	0.15	0.0041
<p>^a Original data.</p> <p>^b Calculated by compiler.</p>				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:		SOURCE AND PURITY OF MATERIALS:		
<p>High pressure, steel flow apparatus consisting of two presaturators for the gas and an equilibrium vessel containing a stirrer operated by a solenoid. The gas is supersaturated in the first saturator at a temperature 10 K above the equilibrium temperature. A steady flow of gas is made for at least 2 h after which liquid and vapor samples are withdrawn for analysis at 1-h intervals. Equilibrium indicated by constant consecutive compositions of both phases.</p> <p>Details in ref. (1).</p>		<p>Source and purities not available.</p>		
		ESTIMATED ERROR:		
		$\delta T/K = 0.1$; $\delta x_1/x = \delta H/H$ $= 0.10$ (estimated by compiler).		
		REFERENCES:		
		1. Wan, S.-W.; Dodge, B. F. <i>Ind. Eng. Chem.</i> <u>1940</u> , <i>32</i> , 95.		

<p>COMPONENTS:</p> <p>1. Methane; CH₄; [74-82-8]</p> <p>2. 1,2-Epoxyethane (Ethylene oxide); C₂H₂O; [75-21-8]</p>	<p>ORIGINAL MEASUREMENTS:</p> <p>Olson, J. D.</p> <p><i>J. Chem. Engng. Data</i></p> <p>1977, 22, 326-329.</p>		
<p>VARIABLES:</p>	<p>PREPARED BY:</p> <p>C. L. Young</p>		
<p>EXPERIMENTAL VALUES:</p>			
<p>t/°C</p>	<p>T/K</p>	<p>Henry's constant^a /atm</p>	<p>Mole fraction^b x_{CH₄}</p>
<p>0 25 50</p>	<p>273.15 298.15 323.15</p>	<p>613 614 595</p>	<p>0.001631 0.001629 0.001681</p>
<p>^a Original data; Henry's constant extrapolated to zero gas partial pressure.</p> <p>^b Mole fraction calculated by compiler assuming constant <i>H</i> and gas partial pressure of 101.325 kPa. Note the normal boiling point of the solvent is 286.7 K.</p>			
<p>AUXILIARY INFORMATION</p>			
<p>METHOD/APPARATUS/PROCEDURE:</p> <p>Accurate gravimetric method for determining masses of solvent and gas charged into stainless steel bomb of predetermined volume. Gas introduced at pressures of up to 840 kPa measured by Bourdon gauge. Equilibration by shaking for 2 to 4 h aided by several loose balls in bomb. Pressure measurements along with known volumes and masses of gas and solvent permitted calculation of Henry's constant. Detailed volume change corrections made for both phases.</p>		<p>SOURCE AND PURITY OF MATERIALS:</p> <p>1. Matheson research grade sample, purity 99.99 mole per cent.</p> <p>2. UCC commercial grade. GC analysis indicated volatile impurities of less than 100 ppm.</p>	
		<p>ESTIMATED ERROR:</p> <p>$\delta T/K = \pm 0.10$; $\delta H/H(\text{RMS}) = 0.03$.</p>	
		<p>REFERENCES:</p>	

COMPONENTS: 1. Methane; CH ₄ ; [74-82-8] 2. 1,4-Dioxane; C ₄ H ₈ O ₂ ; [123-91-1]	ORIGINAL MEASUREMENTS: Ben-Naim, A.; Yaacobi, M. <i>J. Phys. Chem.</i> <u>1974</u> , <i>78</i> , 175-8.																		
VARIABLES: Temperature	PREPARED BY: C.L. Young																		
EXPERIMENTAL VALUES: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">T/K</th> <th style="text-align: center;">Ostwald coefficient, <i>L</i></th> <th style="text-align: center;">Mole fraction⁺ at partial pressure of 101.3 kPa, x_{CH_4}</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">283.15</td> <td style="text-align: center;">0.3841</td> <td style="text-align: center;">0.00139</td> </tr> <tr> <td style="text-align: center;">288.15</td> <td style="text-align: center;">0.3876</td> <td style="text-align: center;">0.00139</td> </tr> <tr> <td style="text-align: center;">293.15</td> <td style="text-align: center;">0.3907</td> <td style="text-align: center;">0.00138</td> </tr> <tr> <td style="text-align: center;">298.15</td> <td style="text-align: center;">0.3933</td> <td style="text-align: center;">0.00138</td> </tr> <tr> <td style="text-align: center;">303.15</td> <td style="text-align: center;">0.3956</td> <td style="text-align: center;">0.00137</td> </tr> </tbody> </table> <p>* Smoothed values obtained from the equation.</p> $kT \ln L = 1,099.8 + 4.781 (T/K) - 0.00988 (T/K)^2 \text{ cal mol}^{-1}$ <p>where <i>k</i> is in units of cal mol⁻¹ K⁻¹</p> <p>+ calculated by compiler assuming the ideal gas law for methane.</p>		T/K	Ostwald coefficient, <i>L</i>	Mole fraction ⁺ at partial pressure of 101.3 kPa, x_{CH_4}	283.15	0.3841	0.00139	288.15	0.3876	0.00139	293.15	0.3907	0.00138	298.15	0.3933	0.00138	303.15	0.3956	0.00137
T/K	Ostwald coefficient, <i>L</i>	Mole fraction ⁺ at partial pressure of 101.3 kPa, x_{CH_4}																	
283.15	0.3841	0.00139																	
288.15	0.3876	0.00139																	
293.15	0.3907	0.00138																	
298.15	0.3933	0.00138																	
303.15	0.3956	0.00137																	
AUXILIARY INFORMATION																			
METHOD/APPARATUS/PROCEDURE: <p>The apparatus was similar to that described by Ben-Naim and Baer (1) and Wen and Hung (2). It consists of three main parts, a dissolution cell of 300 to 600 cm³ capacity, a gas volume measuring column, and a manometer. 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>	SOURCE AND PURITY OF MATERIALS: 1. Matheson sample, purity 99.9 mol per cent. 2. AR grade.																		
ESTIMATED ERROR: $\delta T/K = \pm 0.1$; $\delta x_{\text{CH}_4} = \pm 2\%$ (estimated by compiler)																			
REFERENCES: 1. Ben-Naim, A.; Baer, S. <i>Trans. Faraday Soc.</i> <u>1963</u> , <i>59</i> , 2735. 2. Wen, W.-Y.; Hung, J.H. <i>J. Phys. Chem.</i> <u>1970</u> , <i>74</i> , 170																			

COMPONENTS: (1) Methane; CH ₄ ; [74-82-8] (2) 1,4-Dioxane; C ₄ H ₈ O ₂ ; [123-91-1]	ORIGINAL MEASUREMENTS: Gallardo, M. A.; Urieta, J. S.; Gutierrez Losa, C. <i>J. Chim. Phys. Phys. Chim. Biol.</i> 1983, 80, 621-5.												
VARIABLES: $T/K = 285.15 - 303.15$ $p_1/kPa = 101.3$	PREPARED BY: H. L. Clever												
EXPERIMENTAL VALUES: <table border="1" data-bbox="448 511 854 797" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">T/K</th> <th style="text-align: center;">Mol Fraction 10³x₁</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">285.15</td><td style="text-align: center;">1.400</td></tr> <tr><td style="text-align: center;">289.15</td><td style="text-align: center;">1.393</td></tr> <tr><td style="text-align: center;">293.15</td><td style="text-align: center;">1.383</td></tr> <tr><td style="text-align: center;">298.15</td><td style="text-align: center;">1.372</td></tr> <tr><td style="text-align: center;">303.15</td><td style="text-align: center;">1.361</td></tr> </tbody> </table> <p>The authors fitted the data to the equation</p> $-\ln x_1 = 0.461 \ln (T/K) + 3.965$ <p>from which they obtained thermo-dynamic changes for the transfer of one mole methane from the gas at one atm to the hypothetical x₁ = 1 solution of</p> $\Delta H^0/kJ \text{ mol}^{-1} = -1.14 \quad \text{and}$ $\Delta S^0/J \text{ K}^{-1} \text{ mol}^{-1} = -59.$		T/K	Mol Fraction 10 ³ x ₁	285.15	1.400	289.15	1.393	293.15	1.383	298.15	1.372	303.15	1.361
T/K	Mol Fraction 10 ³ x ₁												
285.15	1.400												
289.15	1.393												
293.15	1.383												
298.15	1.372												
303.15	1.361												
AUXILIARY INFORMATION													
METHOD/APPARATUS/PROCEDURE: <p>The apparatus is similar to that used by Ben-Naim and Baer (ref 1). It is described in detail in an earlier paper (ref 2).</p> <p>Literature 1,4-dioxane vapor pressure data were fitted to the equation</p> $\ln (p/kPa) = -4591.3/(T/K) + 16.98$	SOURCE AND PURITY OF MATERIALS: (1) Methane. Sociedad Espanola del Oxigeno. 99.95 mol percent. (2) 1,4-Dioxane. Merck and Co. Purity checked by GLC to be ≥ 99 percent.												
	ESTIMATED ERROR: $\delta T/K = \pm 0.1$ $\delta p_1/\text{mmHg} = \pm 0.04$ $\delta x_1/x_1 = \pm 0.007$ (authors ref 2)												
	REFERENCES: 1. Ben Naim, A.; Baer, S. <i>Trans. Faraday Soc.</i> 1963, 59, 2735 2. Carnicer, J.; Gibanel, F.; Urieta, J.S.; Gutierrez Losa, C. <i>Rev. Acad. Ciencias Zaragoza</i> 1979, 34, 115-22.												

COMPONENTS: (1) Methane; CH ₄ ; [74-82-8] (2) 1,4-Dioxane; C ₄ H ₈ O ₂ ; [123-91-1]	ORIGINAL MEASUREMENTS: Gallardo, M. A.; Urieta, J. S.; Gutierrez Losa, C. <i>J. Chim. Phys. Phys.-Chim. Biol.</i> <u>1983</u> , 80, 621-5.												
VARIABLES: $T/K = 285.15 - 303.15$ $p_1/kPa = 101.325$	PREPARED BY: H. L. Clever												
EXPERIMENTAL VALUES: <table border="1" data-bbox="463 499 840 850" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="border-top: 1px solid black; border-bottom: 1px solid black;">T/K</th> <th style="border-top: 1px solid black; border-bottom: 1px solid black;">$10^4 x_1$</th> </tr> </thead> <tbody> <tr> <td style="border-bottom: 1px solid black;">285.15</td> <td style="border-bottom: 1px solid black;">14.0₀</td> </tr> <tr> <td style="border-bottom: 1px solid black;">289.15</td> <td style="border-bottom: 1px solid black;">13.9₃</td> </tr> <tr> <td style="border-bottom: 1px solid black;">293.15</td> <td style="border-bottom: 1px solid black;">13.8₃</td> </tr> <tr> <td style="border-bottom: 1px solid black;">298.15</td> <td style="border-bottom: 1px solid black;">13.7₂</td> </tr> <tr> <td style="border-bottom: 1px solid black;">303.15</td> <td style="border-bottom: 1px solid black;">13.6₁</td> </tr> </tbody> </table> <p>The authors fit their data to the equation</p> $-\ln x_1 = -0.461 \ln (T/K) + 3.965$ <p>from which they obtained</p> $\Delta H_1^0/kJ \text{ mol}^{-1} = -9.04 \quad \text{and}$ $\Delta S_1^0/J \text{ K}^{-1} \text{ mol}^{-1} = -69.$		T/K	$10^4 x_1$	285.15	14.0 ₀	289.15	13.9 ₃	293.15	13.8 ₃	298.15	13.7 ₂	303.15	13.6 ₁
T/K	$10^4 x_1$												
285.15	14.0 ₀												
289.15	13.9 ₃												
293.15	13.8 ₃												
298.15	13.7 ₂												
303.15	13.6 ₁												
AUXILIARY INFORMATION													
METHOD/APPARATUS/PROCEDURE: <p>The solubility apparatus was similar to that used by Ben-Naim and Baer (ref 1). It consisted of a gas buret, mercury manometer, and solution vessel. The solvent was degassed in the solution vessel. Measurements were carried out on the vapor saturated gas. The vapor pressure of the solvent was taken from the literature.</p>	SOURCE AND PURITY OF MATERIALS: (1) Methane. Sociedad Espanol del Oxigeno. Stated to be 99.95 percent pure. (2) 1,4-Dioxane. Merck. Purity equal or better than 99 percent. Checked by GLC.												
ESTIMATED ERROR: $\delta T/K = \pm 0.1$ $\delta x_1/x_1 = \pm 0.01$													
REFERENCES: 1. Ben-Naim, A.; Baer, S. <i>Trans. Faraday Soc.</i> <u>1963</u> , 59, 2735.													

COMPONENTS: (1) Methane; CH ₄ ; [74-82-8] (2) Cyclic ethers: C ₄ H ₈ O, C ₄ H ₈ O ₂ , C ₅ H ₈ O, and C ₅ H ₁₀ O	ORIGINAL MEASUREMENTS: Guerry, D. Jr. Ph.D. thesis, 1944 Vanderbilt University Nashville, TN Thesis Director: L. J. Bircher																																																				
VARIABLES: T/K: 293.15, 298.15 P/kPa: 101.325 (1 atm)	PREPARED BY: H. L. Clever																																																				
EXPERIMENTAL VALUES: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">T/K</th> <th style="text-align: center;">Mol Fraction $x_1 \times 10^4$</th> <th style="text-align: center;">Bunsen Coefficient α</th> <th style="text-align: center;">Ostwald Coefficient L</th> </tr> </thead> <tbody> <tr> <td colspan="4" style="text-align: center;">Tetrahydrofuran; C₄H₈O; [109-99-9]</td> </tr> <tr> <td style="text-align: center;">293.15</td> <td style="text-align: center;">19.4</td> <td style="text-align: center;">0.537</td> <td style="text-align: center;">0.576</td> </tr> <tr> <td style="text-align: center;">298.15</td> <td style="text-align: center;">19.4</td> <td style="text-align: center;">0.532</td> <td style="text-align: center;">0.581</td> </tr> <tr> <td colspan="4" style="text-align: center;">1,4-Dioxane; C₄H₈O₂; [123-91-1]</td> </tr> <tr> <td style="text-align: center;">293.15</td> <td style="text-align: center;">13.4</td> <td style="text-align: center;">0.352</td> <td style="text-align: center;">0.378</td> </tr> <tr> <td style="text-align: center;">298.15</td> <td style="text-align: center;">12.9</td> <td style="text-align: center;">0.338</td> <td style="text-align: center;">0.369</td> </tr> <tr> <td colspan="4" style="text-align: center;">2,3-Dihydropyran; C₅H₈O; [25512-65-6]</td> </tr> <tr> <td style="text-align: center;">293.15</td> <td style="text-align: center;">19.4</td> <td style="text-align: center;">0.480</td> <td style="text-align: center;">0.515</td> </tr> <tr> <td style="text-align: center;">298.15</td> <td style="text-align: center;">19.4</td> <td style="text-align: center;">0.478</td> <td style="text-align: center;">0.522</td> </tr> <tr> <td colspan="4" style="text-align: center;">Tetrahydro-2H-pyran; C₅H₁₀O; [142-68-7]</td> </tr> <tr> <td style="text-align: center;">293.15</td> <td style="text-align: center;">23.2</td> <td style="text-align: center;">0.536</td> <td style="text-align: center;">0.575</td> </tr> <tr> <td style="text-align: center;">298.15</td> <td style="text-align: center;">23.3</td> <td style="text-align: center;">0.536</td> <td style="text-align: center;">0.585</td> </tr> </tbody> </table> <p>The Ostwald coefficients were calculated by the compiler.</p>		T/K	Mol Fraction $x_1 \times 10^4$	Bunsen Coefficient α	Ostwald Coefficient L	Tetrahydrofuran; C ₄ H ₈ O; [109-99-9]				293.15	19.4	0.537	0.576	298.15	19.4	0.532	0.581	1,4-Dioxane; C ₄ H ₈ O ₂ ; [123-91-1]				293.15	13.4	0.352	0.378	298.15	12.9	0.338	0.369	2,3-Dihydropyran; C ₅ H ₈ O; [25512-65-6]				293.15	19.4	0.480	0.515	298.15	19.4	0.478	0.522	Tetrahydro-2H-pyran; C ₅ H ₁₀ O; [142-68-7]				293.15	23.2	0.536	0.575	298.15	23.3	0.536	0.585
T/K	Mol Fraction $x_1 \times 10^4$	Bunsen Coefficient α	Ostwald Coefficient L																																																		
Tetrahydrofuran; C ₄ H ₈ O; [109-99-9]																																																					
293.15	19.4	0.537	0.576																																																		
298.15	19.4	0.532	0.581																																																		
1,4-Dioxane; C ₄ H ₈ O ₂ ; [123-91-1]																																																					
293.15	13.4	0.352	0.378																																																		
298.15	12.9	0.338	0.369																																																		
2,3-Dihydropyran; C ₅ H ₈ O; [25512-65-6]																																																					
293.15	19.4	0.480	0.515																																																		
298.15	19.4	0.478	0.522																																																		
Tetrahydro-2H-pyran; C ₅ H ₁₀ O; [142-68-7]																																																					
293.15	23.2	0.536	0.575																																																		
298.15	23.3	0.536	0.585																																																		
AUXILIARY INFORMATION																																																					
METHOD/APPARATUS/PROCEDURE: The apparatus was a modified Van Slyke-Neill Manometric Apparatus manufactured by the Eimer and Amend Co. The procedure of Van Slyke (1) for pure liquids was modified (2) so that small solvent samples (2 cm ³) could be used with almost 100 per cent recovery of the sample. An improved temperature control system was used.	SOURCE AND PURITY OF MATERIALS: Tetrahydrofuran. Eastman Kodak Co. B.p. (752.7 mmHg) t/°C 65.50 - 65.54. 1,4-Dioxane. Eastman Kodak Co. B.p. (743.7 mmHg) t/°C 100.81-100.82. Dihydro-2H-pyran. Prepared from tetrahydrofurfuryl alcohol. B.p. (743.6 mmHg) t/°C 84.81 - 84.89. Tetrahydro-2H-pyran. Prepared by catalytic reduction of dihydro-2H-pyran. B.p. (750.6 mmHg) t/°C 87.51 - 87.52. All b.p. are corrected.																																																				
SOURCE AND PURITY OF MATERIALS: (1) Methane. Prepared by hydrolysis of crystalline methyl Grignard reagent. Passed through conc. H ₂ SO ₄ , solid KOH, and Dririte. (2) Cyclic ethers. The ethers were fractionally distilled from over Na in a nitrogen atmosphere. In addition to the solubility data the thesis contains measured values of refractive index, density, vapor pressure and b.p.	ESTIMATED ERROR: $\delta T/K = 0.05$ REFERENCES: 1. Van Slyke, D. D. <i>J. Biol. Chem.</i> 1939, 130, 545. 2. Ijams, C. C. Ph.D. thesis, 1941 Vanderbilt University																																																				

COMPONENTS: 1. Methane; CH ₄ ; [74-82-8] 2. Methoxybenzene (<i>Anisole</i>); C ₇ H ₈ O; [100-66-3]	ORIGINAL MEASUREMENTS: Gibanel, F.; Urieta, J. S.; Gutierrez Losz, C. <i>J. Chim. Phys.</i> <u>1981</u> , 78, 171-174.												
VARIABLES:	PREPARED BY: <p style="text-align: center;">C. L. Young</p>												
EXPERIMENTAL VALUES: <p style="text-align: center;">10⁴ Mole fraction of methane at 1 atm partial pressure 10⁴x_{CH₄}</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">T/K</th> <th style="text-align: center;">10⁴x_{CH₄}</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">283.15</td> <td style="text-align: center;">16.51₂</td> </tr> <tr> <td style="text-align: center;">288.15</td> <td style="text-align: center;">16.30₈</td> </tr> <tr> <td style="text-align: center;">293.15</td> <td style="text-align: center;">16.14₉</td> </tr> <tr> <td style="text-align: center;">298.15</td> <td style="text-align: center;">15.97₆</td> </tr> <tr> <td style="text-align: center;">303.15</td> <td style="text-align: center;">15.81₈</td> </tr> </tbody> </table> <p style="text-align: center;">Smoothing equation given in source</p> $\ln x_{\text{CH}_4} = 0.625 \ln(T/K) + 2.876.$		T/K	10 ⁴ x _{CH₄}	283.15	16.51 ₂	288.15	16.30 ₈	293.15	16.14 ₉	298.15	15.97 ₆	303.15	15.81 ₈
T/K	10 ⁴ x _{CH₄}												
283.15	16.51 ₂												
288.15	16.30 ₈												
293.15	16.14 ₉												
298.15	15.97 ₆												
303.15	15.81 ₈												
AUXILIARY INFORMATION													
METHOD/APPARATUS/PROCEDURE: <p>Solubility apparatus was similar to that used by Ben-Naim and Baer (1), consisting essentially of a gas buret, mercury manometer and solution vessel. The solvent was degassed in the solution vessel. Measurements were carried out on the saturated gas. It appears that the mole fraction at a partial pressure of 1 atmosphere was estimated from the raw experimental data by assuming that Henry's law is obeyed and that the partial pressure of solvent in the gas phase is given by Raoult's law.</p>	SOURCE AND PURITY OF MATERIALS: 1. Sociedad Espanola del Oxigeno sample, purity 99.95 mole per cent. 2. Fluka product, purity equal to or better than 99 mole per cent, checked by GC. ESTIMATED ERROR: $\delta T/K = \pm 0.1$; $\delta x_{\text{CH}_4} = \pm 4\%$ (estimated by compiler). REFERENCES: 1. Ben-Naim, A.; Baer, S. <i>Trans. Faraday Soc.</i> <u>1963</u> , 59, 2735.												