

COMPONENTS:	EVALUATOR:
(1) Carbon dioxide; CO <sub>2</sub> ; [124-38-9]	Pirketta Scharlin
(2) Water-d <sub>2</sub> ; D <sub>2</sub> O; [7789-20-0]	Department of Chemistry
(3) Water; H <sub>2</sub> O; [7732-18-5]	University of Turku
	FIN-20500, Turku, Finland
	August 1995

## CRITICAL EVALUATION:

### The Solubility of Carbon Dioxide in D<sub>2</sub>O and in Mixtures of D<sub>2</sub>O and H<sub>2</sub>O.

The system CO<sub>2</sub>-D<sub>2</sub>O has not been studied by many workers. The first solubility measurements were made by Curry and Hazelton (1) in 1938, a few years after the discovery of deuterium. Since then only three research groups have reported solubility data for CO<sub>2</sub> in heavy water. Salomaa *et al.* (3) measured the solubility of CO<sub>2</sub> in pure H<sub>2</sub>O, pure D<sub>2</sub>O and in mixtures of H<sub>2</sub>O and D<sub>2</sub>O at 298.15 K and atmospheric pressure using the same method as Curry and Hazelton. Kratochvil *et al.* (5) report solubility values in pure D<sub>2</sub>O at three temperatures (303.15, 323.15, and 353.15 K) and partial pressures of CO<sub>2</sub> between 55 and 3972 kPa. The data from references (1), (3) and (5) are used in this evaluation. At high temperatures and pressures there exists one set of measurements by Kapitanov *et al.* (6). Unfortunately, there is not enough information in Kapitanov's paper for the calculation of mole fraction solubilities, and these data will not be handled further in this evaluation.

To represent the temperature dependence of the mole fraction solubility of CO<sub>2</sub> in D<sub>2</sub>O at 101.325 kPa partial pressure of gas the data from references (1), (3) and (5) were fitted to equation 1.

$$\ln x_1 = A + B / (T/100 \text{ K}) + C \ln(T/100 \text{ K}) \quad (1)$$

The best fit for the five points in the temperature range 298 - 353 K gave equation 2,

$$\ln x_1 = -34.0577 + 49.6909 / (T/100 \text{ K}) + 9.1455 \ln(T/100 \text{ K}) \quad (2)$$

where  $x_1$  is the mole fraction solubility of CO<sub>2</sub> at 101.325 kPa partial pressure of gas. The fit in  $\ln x_1$  gave a standard deviation of 1.1 %. Smoothed values of the mole fraction solubility and changes in the thermodynamic functions on solution are shown in Table 1 at 5 K intervals. The thermodynamic properties were calculated from the smoothing equation according to the following equations:

$$\Delta S_1^\circ = R [A + C \ln(T/100 \text{ K}) + C] \quad (3)$$

$$\Delta H_1^\circ = R (-100B + CT) \quad (4)$$

Table 1. Smoothed values of the solubility of carbon dioxide in water-d<sub>2</sub>, and thermodynamic functions<sup>a</sup> at 5 K intervals using equation 2 at 101.325 kPa partial pressure of gas.

T/K	10 <sup>3</sup> x <sub>1</sub>	ΔH <sub>1</sub> <sup>o</sup> /kJ mol <sup>-1</sup>	ΔS <sub>1</sub> <sup>o</sup> /J K <sup>-1</sup> mol <sup>-1</sup>
298.15	0.611	-18.6	124
303.15	0.540	-18.3	123
308.15	0.481	-17.9	122
313.15	0.431	-17.5	120
318.15	0.388	-17.1	119
323.15	0.351	-16.7	118
328.15	0.320	-16.4	117
333.15	0.293	-16.0	116
338.15	0.269	-15.6	114
343.15	0.248	-15.2	113
348.15	0.230	-14.8	112
353.15	0.214	-14.5	111

<sup>a</sup> For the calculation of ΔC<sub>p,1</sub><sup>o</sup> an equation ΔC<sub>p,1</sub><sup>o</sup> = RC can be derived from equation 1. This gives a value of 76 J K<sup>-1</sup> mol<sup>-1</sup> for ΔC<sub>p,1</sub><sup>o</sup>.

Figure 1 shows the temperature dependence of the mole fraction solubility for carbon dioxide in  $D_2O$  at 101.325 kPa partial pressure of gas. The curve was obtained from the smoothing equation 2. For comparison, the temperature dependence of the mole fraction solubility for  $CO_2$  in  $H_2O$  is presented in the same figure as a dotted curve which was obtained from the smoothing equation given by Carroll and Mather in the  $CO_2$ - $H_2O$  section of this volume ("The Solubility of Carbon Dioxide in Water at Low Pressure", Eq. (1)).

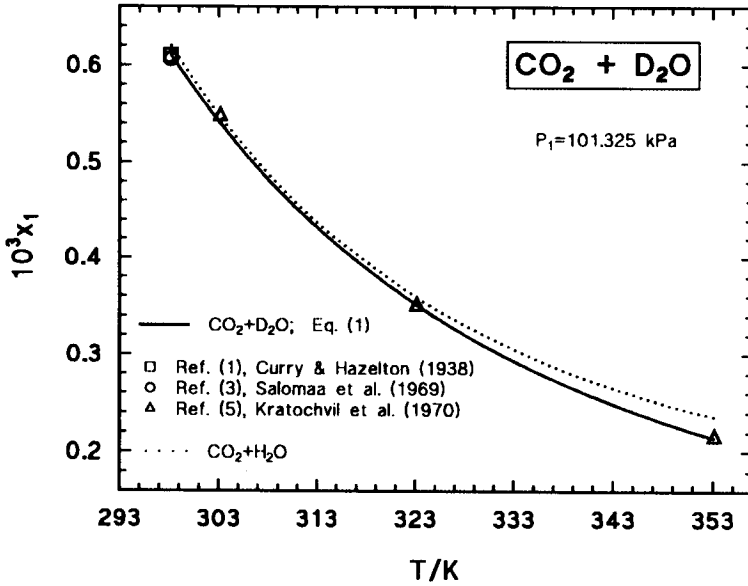


Figure 1. Mole fraction solubility of carbon dioxide in  $D_2O$  at 298.15 to 353.15 K and 101.325 kPa partial pressure of gas. For comparison, the mole fraction solubility of  $CO_2$  in  $H_2O$  in the same temperature interval is presented as the dotted curve.

In Figure 2 the pressure dependence of the mole fraction solubility of carbon dioxide in  $D_2O$  at three different temperatures is presented.

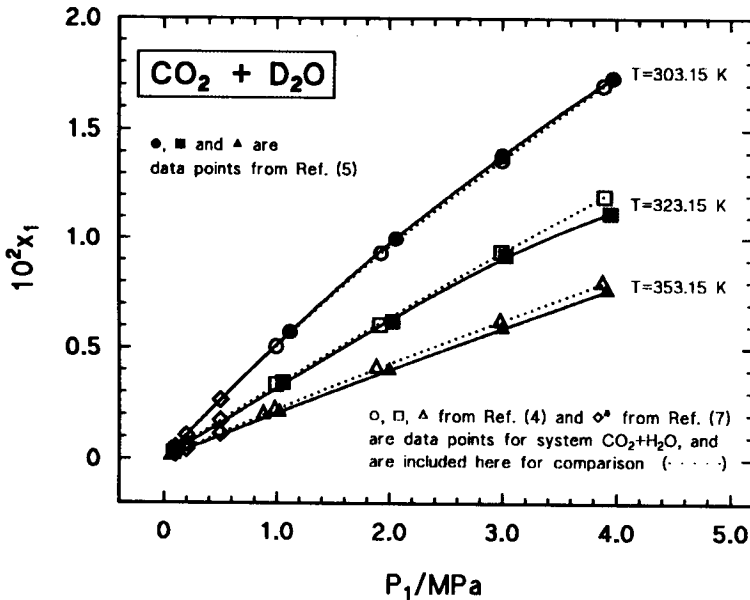


Figure 2. Mole fraction solubility of  $CO_2$  vs. partial pressure of  $CO_2$  at different temperatures. \* Data points  $\diamond$  are from calculated values obtained using the model outlined in Ref. (7).

The only reported data for the solubility of CO<sub>2</sub> in mixtures of D<sub>2</sub>O and H<sub>2</sub>O are the data of Salomaa *et al.* (3). In the original paper the Ostwald coefficients are given. To calculate the molality of CO<sub>2</sub> in mixed solutions the H<sub>2</sub>O-D<sub>2</sub>O density data are needed. Salomaa has unpublished density data which are worth publishing in this connection. In his measurements, Salomaa used the procedure described by Kirshenbaum (2). The values for the density of L<sub>2</sub>O (L = H,D) at 298.15 K are listed in Table 2.

Table 2. Density of H<sub>2</sub>O-D<sub>2</sub>O mixtures at 298.15 K.

$x(\text{D};\text{L}_2\text{O})^a$	$\rho(\text{L}_2\text{O})/\text{g cm}^3$ (L = H,D)
0.4524	1.045974
0.4695	1.048081
0.6156	1.063921
0.9373	1.098754
0.9399	1.099030
0.9881	1.104246
0.9980	1.105312

<sup>a</sup>  $x(\text{D};\text{L}_2\text{O})$  = deuterium isotope mole fraction of water, (L = H,D)

By the method of least squares equation (5) is obtained from the data of Table 2. The linear correlation between  $\rho(\text{L}_2\text{O})$  and  $x(\text{D};\text{L}_2\text{O})$  is excellent (correlation coefficient  $r = 0.999995$ ), and at  $x(\text{D};\text{L}_2\text{O}) = 0$  the density values extrapolate well to the density of pure H<sub>2</sub>O at 298.15 K, as they should.

$$\rho(\text{L}_2\text{O})/\text{g cm}^3 = (0.10852 \pm 0.00015) \times x(\text{D};\text{L}_2\text{O}) + (0.99704 \pm 0.00012) \quad (5)$$

Using a real gas molar volume of 24.34 dm<sup>3</sup> mol<sup>-1</sup> and the L<sub>2</sub>O densities obtained from equation (5), the evaluator calculated the molalities of CO<sub>2</sub> in the mixtures of H<sub>2</sub>O and D<sub>2</sub>O from the Ostwald coefficients given in (3). In Figure 3 the molality of CO<sub>2</sub> at 298.15 K and 101.325 kPa partial pressure of CO<sub>2</sub> is presented as a function of the deuterium isotope mole fraction  $x(\text{D};\text{L}_2\text{O})$  in the solvent water.

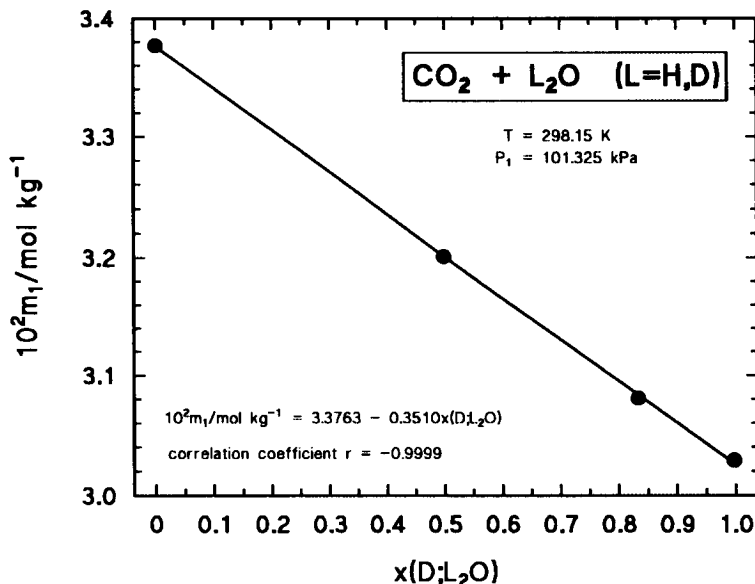


Figure 3. Molality of CO<sub>2</sub> vs. the deuterium isotope mole fraction of solvent water.

Comparison of the smoothed mole fraction solubilities of CO<sub>2</sub> in D<sub>2</sub>O (from Table 1) with corresponding solubilities of CO<sub>2</sub> in H<sub>2</sub>O (Carroll & Mather, CO<sub>2</sub>-H<sub>2</sub>O section, "The Solubility of Carbon Dioxide in Water at Low Pressure", Table 1, Equation (1)) shows that between 298.15 and 323.15 K the solubility of CO<sub>2</sub> in D<sub>2</sub>O is 1.5 - 2 % lower than the solubility of CO<sub>2</sub> in H<sub>2</sub>O. The difference increases with increasing temperature, and at 353.15 K the mole fraction solubility of CO<sub>2</sub> in D<sub>2</sub>O is about 9 % lower than in H<sub>2</sub>O (see also Fig. 1). This differs from most simple nonpolar gases for which the mole fraction solubility in D<sub>2</sub>O is higher than in H<sub>2</sub>O by about 5 - 15 % at 288.15 to 318.15 K and 101.325 kPa partial pressure of gas (8, 9).

The experimental values of Kratochvil *et al.* (5) predict a higher value for the solubility of CO<sub>2</sub> in D<sub>2</sub>O at 298.15 K and 101.325 kPa than the value for the solubility of CO<sub>2</sub> in H<sub>2</sub>O. However, the two independent measurements (1, 3) at 298.15 K and 101.325 kPa, which are in good agreement with each other, support the value of  $x_1 = 0.611 \cdot 10^{-3}$  for the solubility of CO<sub>2</sub> in D<sub>2</sub>O, which is 1.6 % lower than the solubility in H<sub>2</sub>O. The systematic solubility measurements of Salomaa *et al.* (3) in both isotopically pure waters and in their mixtures show that the solubility of CO<sub>2</sub> decreases with increasing deuterium content of water (Fig. 3) supporting the result that CO<sub>2</sub> is more soluble in H<sub>2</sub>O than in D<sub>2</sub>O at 298.15 K and 101.325 kPa. The measurements of Kratochvil *et al.* (5) at 323.15 and 353.15 K and at higher pressures also indicate a higher solubility of CO<sub>2</sub> in H<sub>2</sub>O than in D<sub>2</sub>O.

Because of the rather small number of measurements on the solubility of carbon dioxide in D<sub>2</sub>O, the results are classed as tentative until confirmed by additional measurements.

#### References:

1. Curry, J.; Hazelton, C. L. *J. Am. Chem. Soc.* **1938**, *60*, 2271.
2. Kirshenbaum, I. *Physical Properties and Analysis of Heavy Water*, McGraw-Hill Book Company, Inc., New York, **1951**, pp- 2-17 and pp. 249-251.
3. Salomaa, P.; Vesala, A.; Vesala, S. *Acta Chem. Scand.* **1969**, *23*, 2107.
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5. Kratochvil, J.; Šobr, J.; Matouš, J.; Pick, J. *Collect. Czech. Chem. Commun.* **1970**, *35*, 3761.
6. Kapitanov, V. F.; Shcherbakova, O. M. *Zh. Fiz. Khim.* **1983**, *57*, 1785; *Russ. J. Phys. Chem.* (Engl. Transl.) **1983**, *57*(7), 1080.
7. Carroll, J. J.; Slupsky, J. D.; Mather, A. E. *J. Phys. Chem. Ref. Data* **1991**, *20*, 1201.
8. Scharlin, P.; Battino, R. *J. Solution Chem.* **1992**, *21*, 67.
9. Scharlin, P.; Battino, R. *Fluid Phase Equil.* **1994**, *94*, 137.

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<b>VARIABLES:</b> $T/K = 298.15$ K $P_1/kPa = 94.62 - 97.49$	<b>PREPARED BY:</b> H. L. Clever																																						
<b>EXPERIMENTAL VALUES:</b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;"><math>t/^\circ\text{C}</math></th> <th style="text-align: center;"><math>T/K</math> <sup>a</sup></th> <th style="text-align: center;"><math>P/\text{mmHg}</math></th> <th style="text-align: center;"><math>P_1/\text{mmHg}</math></th> <th style="text-align: center;"><math>10^4 x_1</math> <sup>b</sup></th> <th style="text-align: center;"><math>L/\text{cm}^3 \text{ cm}^{-3}</math> <sup>c</sup></th> </tr> </thead> <tbody> <tr> <td rowspan="6" style="text-align: center; vertical-align: top;">25.00</td> <td rowspan="6" style="text-align: center; vertical-align: top;">298.15</td> <td style="text-align: center;">741.2</td> <td style="text-align: center;">718.6</td> <td></td> <td style="text-align: center;">0.817</td> </tr> <tr> <td style="text-align: center;">743.7</td> <td style="text-align: center;">720.4</td> <td></td> <td style="text-align: center;">0.818</td> </tr> <tr> <td style="text-align: center;">749.9</td> <td style="text-align: center;">726.6</td> <td></td> <td style="text-align: center;">0.817</td> </tr> <tr> <td style="text-align: center;">732.8</td> <td style="text-align: center;">709.7</td> <td></td> <td style="text-align: center;">0.831</td> </tr> <tr> <td style="text-align: center;">735.9</td> <td style="text-align: center;">712.6</td> <td></td> <td style="text-align: center;">0.823</td> </tr> <tr> <td style="text-align: center;">754.5</td> <td style="text-align: center;">731.2</td> <td></td> <td style="text-align: center;">0.810</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td style="text-align: center;">6.10</td> <td style="text-align: center;">Av. 0.819 ± 0.005</td> </tr> </tbody> </table> <p><sup>a</sup> Added by the compiler.</p> <p><sup>b</sup> The mole fraction solubility at a carbon dioxide partial pressure of 101.325 kPa (760 mmHg) was calculated by the compiler using a real gas molar volume of 24.34 dm<sup>3</sup> mol<sup>-1</sup> and a heavy water density of 1.1042 g cm<sup>-3</sup> at 298.15 K.</p> <p><sup>c</sup> L = Ostwald coefficient.</p> <p>According to the authors the Ostwald coefficient corresponds to a molality of 0.0304 mol kg<sup>-1</sup> at a CO<sub>2</sub> partial pressure of 101.325 kPa.</p>		$t/^\circ\text{C}$	$T/K$ <sup>a</sup>	$P/\text{mmHg}$	$P_1/\text{mmHg}$	$10^4 x_1$ <sup>b</sup>	$L/\text{cm}^3 \text{ cm}^{-3}$ <sup>c</sup>	25.00	298.15	741.2	718.6		0.817	743.7	720.4		0.818	749.9	726.6		0.817	732.8	709.7		0.831	735.9	712.6		0.823	754.5	731.2		0.810					6.10	Av. 0.819 ± 0.005
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<b>METHOD/APPARATUS/PROCEDURE:</b> <p>The apparatus was an Ostwald type using the "dry method" as described by Just (Ref. 1).</p> <p>The apparatus was of small size because of a small sample of heavy water available. The buret was 10 cm<sup>3</sup> graduated to 0.05 cm<sup>3</sup>. The sample bulb had a volume of 6.811 cm<sup>3</sup>.</p> <p>The six water samples ranged in weight from 2.6003 to 4.0429 g.</p> <p>The physical properties of water-d<sub>2</sub> at 298.15 K were estimated from data of Wahl and Urey (Ref. 2). The authors used a vapor pressure of 20.7 mmHg and a density of 1.1042 g cm<sup>-3</sup> for the 99.8 percent water-d<sub>2</sub>.</p>	<b>SOURCE AND PURITY OF MATERIALS:</b> (1) Commercial tank. Analyzed by reaction with KOH and found to be 99.8 % pure. (2) Commercial source. Distilled from alkaline permanganate, then from phosphoric anhydride, then without reagents. Average composition for the solubility measurements was 99.8 %. <b>ESTIMATED ERROR:</b> $\delta T/K = \pm 0.01$ $\delta L/L = \pm 0.01$ <b>REFERENCES:</b> 1. Just, G. <i>Z. physik. Chem.</i> (Leipzig) <u>1901</u> , <i>37</i> , 342. 2. Wahl, M.H.; Urey, H.C. <i>J. Chem. Phys.</i> <u>1935</u> , <i>3</i> , 411.																																						

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<b>VARIABLES:</b> $T/K = 298.15$ $P/kPa = 101.325$ $x(D;L_2O) = 0.000 - 0.997$	<b>PREPARED BY:</b> Pirketta Scharlin																						
<b>EXPERIMENTAL VALUES:</b> <table border="1" data-bbox="54 483 1089 685"> <thead> <tr> <th><math>T/K</math> <sup>a</sup></th> <th><math>x(D;L_2O)</math> <sup>b</sup></th> <th><math>L/cm^3</math> <math>cm^{-3}</math> <sup>c</sup></th> <th><math>\rho(L_2O)/g</math> <math>cm^{-3}</math> <sup>d</sup></th> <th><math>10^2 m_1/mol</math> <math>kg^{-1}</math> <sup>a,e</sup></th> </tr> </thead> <tbody> <tr> <td rowspan="4">298.15</td> <td>0.000</td> <td>0.8196 (20)</td> <td>0.99705 <sup>f</sup></td> <td>3.377</td> </tr> <tr> <td>0.498<sub>5</sub></td> <td>0.8189 (20)</td> <td>1.05113</td> <td>3.201</td> </tr> <tr> <td>0.833</td> <td>0.8154 (23)</td> <td>1.08743</td> <td>3.081</td> </tr> <tr> <td>0.997</td> <td>0.8149 (18)</td> <td>1.10523</td> <td>3.029</td> </tr> </tbody> </table> <p data-bbox="66 724 1137 1120"> <sup>a</sup> Calculated by the compiler.  <sup>b</sup> <math>x(D;L_2O)</math> is the deuterium mole fraction of solvent water (L = H, D).  <sup>c</sup> L = Ostwald coefficient.            The figure in the parentheses after each L is the number of measurements made in the corresponding solvent composition.  <sup>d</sup> <math>\rho(L_2O)</math> = density of solvent water (L = H, D). Densities were calculated by the compiler using equation (5) in the evaluation section.  <sup>e</sup> <math>m_1</math> = molality of carbon dioxide  <sup>f</sup> Density for pure H<sub>2</sub>O at 298.15 K was taken from <i>Recommended Reference Materials for the Realization of Physicochemical Properties</i>, Edited by K.N. Marsh, Blackwell, <u>1987</u>, p. 27.         </p>		$T/K$ <sup>a</sup>	$x(D;L_2O)$ <sup>b</sup>	$L/cm^3$ $cm^{-3}$ <sup>c</sup>	$\rho(L_2O)/g$ $cm^{-3}$ <sup>d</sup>	$10^2 m_1/mol$ $kg^{-1}$ <sup>a,e</sup>	298.15	0.000	0.8196 (20)	0.99705 <sup>f</sup>	3.377	0.498 <sub>5</sub>	0.8189 (20)	1.05113	3.201	0.833	0.8154 (23)	1.08743	3.081	0.997	0.8149 (18)	1.10523	3.029
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<b>METHOD/APPARATUS/PROCEDURE:</b> The equipment employed for the solubility measurements on CO <sub>2</sub> was of the Ostwald type. <sup>1,2</sup> Before each measurement, the water was freed from dissolved air by boiling under reflux. The CO <sub>2</sub> which was passed into the absorption apparatus was purified by passing it subsequently through acidic ferric sulfate, iodine, potassium permanganate, and water. The gas was finally dried carefully with magnesium perchlorate.	<b>SOURCE AND PURITY OF MATERIALS:</b> (1) From commercial tank. (2) Norsk Hydro-Elektrisk Kvaelstof-aktieselskab, Norway. Analyzed and purified as described in Ref. 3. (3) Distilled, degassed.																						
<b>ESTIMATED ERROR:</b> $\delta L \approx \pm 0.2 \%$ (estimated by compiler)																							
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<b>VARIABLES:</b> $T/K = 303.15 - 353.15$ $P_1/MPa = 0.055 - 3.97$	<b>PREPARED BY:</b> C. L. Young																																				
<b>EXPERIMENTAL VALUES:</b> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;"><u>T/K</u></th> <th style="text-align: center;"><u>P<sub>1</sub>/bar</u></th> <th style="text-align: center;"><u>10<sup>2</sup>x<sub>2</sub></u></th> </tr> </thead> <tbody> <tr> <td rowspan="5" style="text-align: center; vertical-align: middle;">303.15</td> <td style="text-align: center;">0.94</td> <td style="text-align: center;">0.051</td> </tr> <tr> <td style="text-align: center;">11.1</td> <td style="text-align: center;">0.573</td> </tr> <tr> <td style="text-align: center;">20.6</td> <td style="text-align: center;">0.998</td> </tr> <tr> <td style="text-align: center;">30.0</td> <td style="text-align: center;">1.386</td> </tr> <tr> <td style="text-align: center;">39.7</td> <td style="text-align: center;">1.731</td> </tr> <tr> <td rowspan="5" style="text-align: center; vertical-align: middle;">323.15</td> <td style="text-align: center;">0.87</td> <td style="text-align: center;">0.029</td> </tr> <tr> <td style="text-align: center;">10.5</td> <td style="text-align: center;">0.344</td> </tr> <tr> <td style="text-align: center;">20.3</td> <td style="text-align: center;">0.621</td> </tr> <tr> <td style="text-align: center;">30.3</td> <td style="text-align: center;">0.922</td> </tr> <tr> <td style="text-align: center;">39.5</td> <td style="text-align: center;">1.118</td> </tr> <tr> <td rowspan="5" style="text-align: center; vertical-align: middle;">353.15</td> <td style="text-align: center;">0.55</td> <td style="text-align: center;">0.012</td> </tr> <tr> <td style="text-align: center;">10.2</td> <td style="text-align: center;">0.210</td> </tr> <tr> <td style="text-align: center;">20.0</td> <td style="text-align: center;">0.400</td> </tr> <tr> <td style="text-align: center;">30.0</td> <td style="text-align: center;">0.589</td> </tr> <tr> <td style="text-align: center;">39.2</td> <td style="text-align: center;">0.761</td> </tr> </tbody> </table>		<u>T/K</u>	<u>P<sub>1</sub>/bar</u>	<u>10<sup>2</sup>x<sub>2</sub></u>	303.15	0.94	0.051	11.1	0.573	20.6	0.998	30.0	1.386	39.7	1.731	323.15	0.87	0.029	10.5	0.344	20.3	0.621	30.3	0.922	39.5	1.118	353.15	0.55	0.012	10.2	0.210	20.0	0.400	30.0	0.589	39.2	0.761
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<b>AUXILIARY INFORMATION</b>																																					
<b>METHOD/APPARATUS/PROCEDURE:</b> Cell charged with components, equilibrated and pressure measured with Bourdon gauge. Liquid sampled and analysed by stripping with nitrogen and absorbing dried carbon dioxide on absorbent containing sodium hydroxide.	<b>SOURCE AND PURITY OF MATERIALS:</b> (1) Lachema, Novy Bohumin sample purity better than 99.8 mole %. (2) Redistilled sample, purity probably better than 99 mole %. (compiler)																																				
	<b>ESTIMATED ERROR:</b> $\delta T/K = \pm 0.1$ ; $\delta P_1/\text{bar} = \pm 0.5$ $\delta x_1 = \pm 0.2 \times 10^{-4}$ (estimated by compiler)																																				
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<b>COMPONENTS:</b> (1) Carbon dioxide; CO <sub>2</sub> ; [124-38-9] (2) Water-d <sub>2</sub> ; (deuterium oxide); D <sub>2</sub> O; [7789-20-0]	<b>ORIGINAL MEASUREMENTS:</b> Kapitanov, V. F.; Shcherbakova, O. M. <i>Zh. Fiz. Khim.</i> 1983, 57, 1785-7; <i>*Russ. J. Phys. Chem.</i> (Engl. Transl.) 1983, 57(7), 1080-1.
<b>VARIABLES:</b> T/K = 303 -473 P/MPa = 1 - 20	<b>PREPARED BY:</b> Pirketta Scharlin

**EXPERIMENTAL VALUES:**

The solubility (g dm<sup>-3</sup>) of CO<sub>2</sub> in D<sub>2</sub>O as a function of P and T.

P/MPa	303 K	313 K	323 K	333 K	343 K	353 K
1	14.5	10.5	7.5	5.5	4.9	3.5
2	22.8	18.0	14.5	12.1	10.4	9.2
3	31.7	25.5	21.0	17.8	15.4	13.7
4	38.9	31.0	26.5	22.7	19.9	17.9
5	44.9	37.0	31.2	27.0	23.9	21.6
6	50.0	41.6	35.4	30.9	27.5	25.0
7	54.6	45.7	39.2	34.5	30.9	28.3
8		49.5	42.8	37.8	34.1	31.4
9		53.0	46.0	40.9	37.1	34.3
10		57.0	49.2	43.9	40.0	37.1
11		60.0	53.0	46.8	43.0	39.3
12		63.5	55.4	49.7	45.5	42.5
13		66.0	58.5	52.5	48.0	45.0
14		69.0	61.6	56.0	51.5	48.0
15		72.1	63.5	58.5	54.0	50.3
16		75.3	66.5	60.5	56.5	53.0
17		78.4	70.0	63.0	59.0	55.5
18		80.5	73.0	66.5	62.3	57.5
19		83.2	76.2	70.5	66.2	62.1
20		86.0	78.5	73.5	69.0	65.3

(continued on the next page)

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

The solubility was studied by a static method (1) in an autoclave thermostatted at the required temperature. The autoclave was filled with D<sub>2</sub>O, constant specified temperature and pressure were attained, and the autoclave was bubbled with carbon dioxide.

The CO<sub>2</sub> dissolved in D<sub>2</sub>O was absorbed by baryta water and the excess of the latter was then titrated with a solution of oxalic acid (2). The CO<sub>2</sub> which remained dissolved in water was titrated with a solution of alkali using phenolphthalein as an indicator (3).

**SOURCE AND PURITY OF MATERIALS:**

(1) Carbon dioxide. Alimentary grade (GOST 8050-64) freed beforehand from moisture and oil with the aid of ultrafine glass fibre filters, NaA zeolites, and BAU activated charcoal.

(2) Water-d<sub>2</sub>. 99.78 %

**ESTIMATED ERROR:**

According to the authors the error of the determination of the composition of the phases is 5 %.

**REFERENCES:**

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2. Blazhenova, A.N.; Il'inskaya, A.A.; Rapoport, F.M. "Analiz Gazov v Khimicheskoi Promyshlennosti", Goskhimizdat, Moscow, 1964, pp. 118-22.
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## COMPONENTS:

- (1) Carbon dioxide; CO<sub>2</sub>; [124-38-9]  
 (2) Water-d<sub>2</sub>; (deuterium oxide); D<sub>2</sub>O;  
 [7789-20-0]

## ORIGINAL MEASUREMENTS:

Kapitanov, V. F.; Shcherbakova, O. M.  
*Zh. Fiz. Khim.* 1983, 57, 1785-7;  
 \**Russ. J. Phys. Chem.* (Engl. Transl.)  
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## EXPERIMENTAL VALUES: (continued)

The solubility (g dm<sup>-3</sup>) of CO<sub>2</sub> in D<sub>2</sub>O as a function of P and T.

P/MPa	363 K	373 K	383 K	393 K	403 K	413 K
1	2.5	2.2	2.0	1.9	1.8	1.7
2	8.4	7.7	5.5	4.9	4.7	4.5
3	12.5	11.6	10.3	9.9	9.0	8.5
4	16.4	15.3	14.9	13.3	12.8	12.0
5	19.9	18.7	17.5	14.8	16.0	15.0
6	23.2	21.9	20.0	19.0	18.5	18.0
7	26.4	24.9	23.5	22.3	21.5	20.5
8	29.4	27.8	26.5	25.5	24.0	23.5
9	32.2	30.7	28.7	27.6	27.0	26.0
10	35.0	33.7	31.2	30.0	29.0	28.5
11	37.0	35.0	33.5	32.5	31.0	30.0
12	39.5	37.5	36.1	34.3	33.5	32.0
13	42.3	39.5	38.3	36.5	35.0	34.0
14	44.9	41.8	40.0	38.2	37.0	36.1
15	47.0	44.0	42.9	40.7	39.0	38.0
16	49.5	46.5	44.3	42.5	41.0	39.5
17	51.9	49.0	46.5	44.9	43.0	41.3
18	54.7	51.5	48.5	47.0	45.0	43.5
19	57.5	54.0	51.5	49.0	47.0	45.8
20	60.5	56.5	54.3	51.2	49.5	48.0

P/MPa	423 K	433 K	443 K	453 K	463 K	473 K
1	1.5	1.3	0.9	0.7	0.5	0.3
2	4.2	4.0	3.7	3.5	3.4	3.2
3	8.1	7.5	7.2	7.0	6.8	6.7
4	11.6	11.0	10.5	10.2	9.8	9.6
5	14.5	14.0	13.8	13.6	13.4	13.0
6	17.5	17.0	16.5	16.0	15.5	15.0
7	19.5	18.6	18.0	17.5	18.0	17.5
8	22.5	21.5	21.0	20.5	20.0	19.0
9	25.0	24.0	23.0	22.5	22.0	21.5
10	27.2	26.5	25.7	25.0	24.0	24.0
11	29.2	28.0	27.5	27.0	26.5	26.0
12	31.5	30.5	29.7	29.2	28.5	27.7
13	33.5	32.5	32.0	31.0	30.5	30.0
14	35.5	34.0	33.0	32.5	32.0	31.0
15	37.0	36.0	35.5	35.0	34.8	34.0
16	38.5	37.5	37.0	36.5	36.0	35.5
17	40.0	39.0	38.5	38.0	37.5	36.0
18	42.0	41.5	40.8	40.0	39.6	39.4
19	44.3	43.0	42.0	41.5	41.0	40.6
20	46.5	45.0	44.0	43.5	43.0	42.5