Glossary

d	density of solution, g/cm^3
d^0	density of pure water, g/cm^3
ϕ_v	apparent molal volume, cm^3/mol
Φ	molal osmotic coefficient
ν	number of ions formed by the dissociation of one molecule of solute
m	molal concentration of the solute, mol/kg
c	molar concentration of the solute, mol/dm^3
$*$	symbols with asterisks refer to KCl or $CaCl_2$ isopiestic standards
B_i	least-squares coefficients of eq 1
A_i	least-squares coefficients of eq 4 and 5
r_i	powers of eq 4 and 5
A	Debye–Hückel constant for 3–1 electrolytes
M_1	molecular mass of water, g/mol
M_2	molecular mass of solute, g/mol
$\beta^{(0)}$, $\beta^{(1)}$, C^{ϕ}	parameters for Pitzer's equations
A^{ϕ}	Debye–Hückel constant for Pitzer's Φ equations (1–1 charge type)
σ	standard deviation of fitting equations
$\gamma_{\pm}$	mean molal activity coefficient
a_1	water activity

Literature Cited

(1) Spedding, F. H.; Atkinson, G. In "The Structure of Electrolytic Solutions"; Hamer, W. J., Ed.; Wiley: New York, 1959.
(2) Spedding, F. H.; Nelson, R. A.; Rard, J. A. *J. Chem. Eng. Data* **1974**, *19*, 379.
(3) Spedding, F. H.; Weber, H. O.; Saeger, V. W.; Petheram, H. H.; Rard, J. A.; Habenschuss, A. *J. Chem. Eng. Data* **1976**, *21*, 341.
(4) Rard, J. A.; Weber, H. O.; Spedding, F. H. *J. Chem. Eng. Data* **1977**, *22*, 187.
(5) Rard, J. A.; Shiers, L. E.; Heiser, D. J.; Spedding, F. H. *J. Chem. Eng. Data* **1977**, *22*, 337.
(6) Rard, J. A.; Miller, D. G.; Spedding, F. H. *J. Chem. Eng. Data* **1979**, *24*, 348.
(7) Rard, J. A.; Spedding, F. H. *J. Chem. Eng. Data* **1981**, *26*, 391.
(8) Spedding, F. H.; Pikal, M. J.; Ayers, B. O. *J. Phys. Chem.* **1966**, *70*, 2440.
(9) Habenschuss, A.; Spedding, F. H. *J. Chem. Phys.* **1980**, *73*, 442.
(10) Spedding, F. H.; DeKock, C. W.; Pepple, G. W.; Habenschuss, A. *J. Chem. Eng. Data* **1977**, *22*, 58.
(11) Spedding, F. H.; Baker, J. L.; Walters, J. P. *J. Chem. Eng. Data* **1975**, *20*, 189.
(12) Spedding, F. H.; Rard, J. A. *J. Phys. Chem.* **1974**, *78*, 1435.
(13) Spedding, F. H.; Witte, D. L.; Shiers, L. E.; Rard, J. A. *J. Chem. Eng. Data* **1974**, *19*, 369.
(14) Rard, J. A.; Miller, D. G. *J. Chem. Eng. Data* **1981**, *26*, 38.
(15) West, P. W.; Sarma, P. L. *Mikrochimica Acta* **1957**, 506.
(16) Duval, C. "Inorganic Thermogravimetric Analysis", 2nd ed. revised (English Translation); Elsevier: Amsterdam, 1963.
(17) Spedding, F. H.; Shiers, L. E.; Brown, M. A.; Baker, J. L.; Gutierrez, L.; McDowell, L. S.; Habenschuss, A. *J. Phys. Chem.* **1975**, *79*, 1087.
(18) Kell, G. S. *J. Chem. Eng. Data* **1975**, *20*, 97.
(19) Spedding, F. H.; Saeger, V. W.; Gray, K. A.; Boneau, P. K.; Brown, M. A.; DeKock, C. W.; Baker, J. L.; Shiers, L. E.; Weber, H. O.; Habenschuss, A. *J. Chem. Eng. Data* **1975**, *20*, 72.
(20) Templeton, D. H.; Dauben, C. H. *J. Am. Chem. Soc.* **1954**, *76*, 5237.
(21) Zachariasen, W. H. In "The Actinide Elements"; Seaborg, G. T., Katz, J. J., Eds.; McGraw-Hill: New York, 1954; Chapter 18.
(22) Hamer, W. J.; Wu, Y. C. *J. Phys. Chem. Ref. Data* **1972**, *1*, 1047.
(23) Rard, J. A.; Habenschuss, A.; Spedding, F. H. *J. Chem. Eng. Data* **1977**, *22*, 180.
(24) Mason, C. M. *J. Am. Chem. Soc.* **1938**, *60*, 1638.
(25) Pitzer, K. S.; Peterson, J. R.; Silvester, L. F. *J. Solution Chem.* **1978**, *7*, 45.
(26) Pitzer, K. S. In "Activity Coefficients in Electrolyte Solutions"; Pytkowicz, R. M., Ed.; CRC Press: Boca Raton, FL, 1979; Vol. 1, Chapter 7.
(27) Spedding, F. H.; Rard, J. A.; Habenschuss, A. *J. Phys. Chem.* **1977**, *81*, 1069.
(28) Spedding, F. H.; Shiers, L. E.; Rard, J. A. *J. Chem. Eng. Data* **1975**, *20*, 66.
(29) Lugina, L. N.; Davidenko, N. K. *Russ. J. Inorg. Chem.* (*Engl. Trans.*) **1980**, *25*, 1322.
(30) Sayre, E. V.; Miller, D. G.; Freed, S. *J. Chem. Phys.* **1957**, *26*, 109.
(31) Choppin, G. R.; Henrie, D. E.; Buijs, K. *Inorg. Chem.* **1966**, *5*, 1743.
(32) Reuben, J.; Fiat, D. *J. Chem. Phys.* **1969**, *51*, 4909.
(33) Marcinkowsky, A. E.; Phillips, H. O. *J. Chem. Soc. A* **1971**, 3556.
(34) Kozachenko, N. N.; Batyaev, I. M. *Russ. J. Inorg. Chem.* (*Engl. Trans.*) **1971**, *16*, 66.
(35) Bünzli, J.-C. G.; Yersin, J.-R. *Inorg. Chem.* **1979**, *18*, 605.
(36) Marcantonatos, M. D.; Deschaux, M.; Vuilleumier, J. J. *Chem. Phys. Lett.* **1981**, *82*, 36.
(37) Abrahamer, I.; Marcus, Y. *Inorg.* Chem. **1967**, *6*, 2103.
(38) Reuben, J. *J. Phys. Chem.* **1975**, *79*, 2154.
(39) Silber, H. B.; Fowler, J. *J. Phys. Chem.* **1976**, *80*, 1451.
(40) Jezowska-Trzebiatowska, B.; Ernst, S.; Legendziewicz, J.; Oczko, G. *Bull. Acad. Pol. Sci., Ser. Sci. Chim.* **1977**, *25*, 649.
(41) Freed, S.; Jacobson, H. F. *J. Chem. Phys.* **1938**, *6*, 654.
(42) Choppin, G. R.; Strazik, W. F. *Inorg. Chem.* **1965**, *4*, 1250.
(43) Peppard, D. F.; Mason, G. W.; Hucher, I. *J. Inorg. Nucl. Chem.* **1962**, *24*, 881.
(44) Rard, J. A.; Spedding, F. H. *J. Phys. Chem.* **1975**, *79*, 257.

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Solubility of Hydrogen in *o*-Nitroanisole, *o*-Nitroanisole–Methanol Mixtures, and *o*-Anisidine[†]

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The solubility of hydrogen in *o*-nitroanisole, *o*-nitroanisole–methanol mixtures, and *o*-anisidine is determined at temperatures between 40 and 80 °C and pressures between 7 and 50 atm. The values of Henry's law constant and heat of solution are reported.

A precise knowledge of solubility of gases in liquids is essential for analyzing gas–liquid and gas–liquid–solid reactions. This paper presents solubility data of hydrogen in *o*-nitroanisole, *o*-nitroanisole–methanol mixtures, and *o*-anisidine under various conditions of temperature and pressure. The data are important in the design of a reactor for *o*-anisidine which is manufactured by catalytic hydrogenation of *o*-nitroanisole. No data have been published for the solubility of hydrogen in *o*-nitroanisole and *o*-anisidine. The solubility of hydrogen in *o*-nitroanisole, *o*-nitroanisole–methanol mixtures, and *o*-anisidine was studied in the range of interest for hydrogenation, namely, 40–80 °C, 7–50 atm, and 3–8 M concentration.

Commercially available *o*-nitroanisole and *o*-nitroanisidine of

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Table I. Solubilities and Henry's Law Constant

compd	molarity	temp, °C	$10^{-4}H$, atm (mole fraction)$^{-1}$	solubility, mole fraction of $H_2 \times 10^3$			
				7.47 atm	21.08 atm	34.68 atm	48.29 atm
o-nitroanisole	8.2	40	0.800	0.805	2.49	4.20	5.91
		50	0.750	1.00	2.80	4.61	6.45
		60	0.678	1.07	3.10	5.10	7.09
		70	0.578	1.20	3.64	5.88	8.30
	5.74	40	0.464	1.44	4.30	7.31	10.20
		50	0.443	1.50	4.60	7.70	10.69
		60	0.425	1.58	4.80	7.95	11.20
		70	0.394	1.60	5.14	8.54	11.98
	3.28	40	0.369	1.82	5.43	9.10	12.89
		50	0.340	1.98	6.05	9.99	14.00
		60	0.321	2.21	6.40	10.72	14.89
		70	0.298	2.30	7.07	11.00	16.20
o-anisidine	7.97	40	0.712	0.90	2.72	4.71	6.60
		50	0.633	1.10	3.20	5.40	7.53
		60	0.593	1.20	3.50	5.79	8.09
		70	0.529	1.34	3.98	6.50	9.07

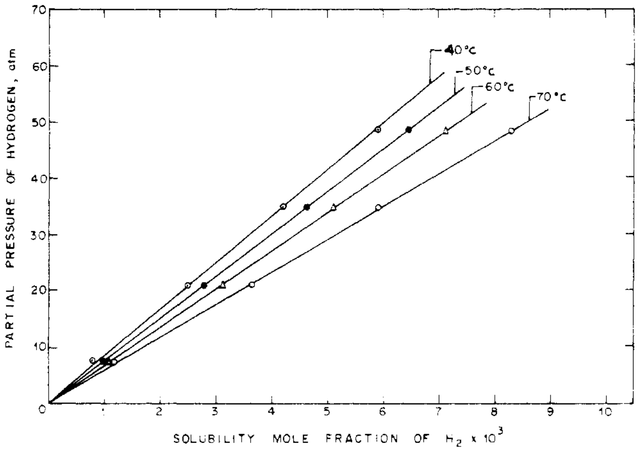

Figure 1. Solubility of hydrogen in *o*-nitroanisole.

99% purity were used in the present work after distillation. The assay of the distilled product was 99.9%. Distilled methanol was used for preparing solutions of desired concentrations. Hydrogen gas over 99.9% purity was used in all the measurements. The solubilities were measured with the same apparatus as described in our earlier paper (1). The maximum experimental error was found to be less than 3%.

The experimental data are presented in Table I, and Figures 1 and 2 show some typical curves of solubility as a function of partial pressure of hydrogen. These figures indicate that the solubility is linearly dependent on pressure, and Table I summarizes the values of Henry's law constant (H, in atm (mole fraction)$^{-1}$). The influence of temperature on the solubility of hydrogen in *o*-nitroanisole and *o*-anisidine is shown in Figure 3 as plots of ln (1/H) vs. 1/*T*. The solubility was found to be a mild function of temperature. The values of *H*, the partial molar enthalpy (cal (g-mol)$^{-1}$) obtained from Figure 3 for hydrogen-*o*-nitroanisole and hydrogen-*o*-anisidine systems, were 1350 and 1314 cal (g-mol)$^{-1}$, respectively.

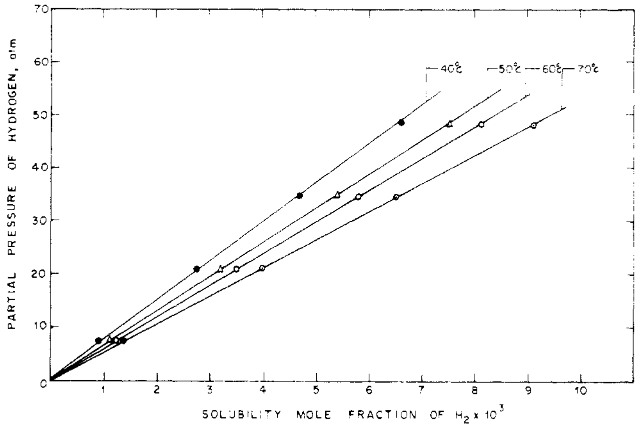

Figure 2. Solubility of hydrogen in *o*-anisidine.

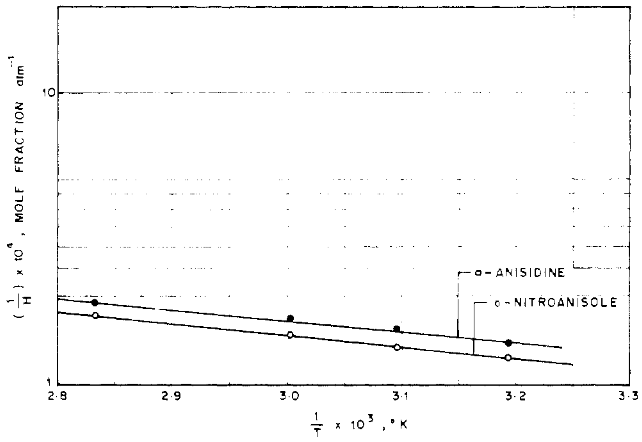

Figure 3. Temperature dependence of Henry's law constant.

Literature Cited

(1) Brahme, P. H.; Vadgaonkar, H. G.; Ozarde, P. S.; Parande, M. G. *J. Chem. Eng. Data* **1981**, *26*, 416.

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