| COMPONENTS: | EVALUATOR: |
|---|---|
| (1) Mercury; Hg; [7439-97-6]<br><br>(2) Oxybisalkanes or Ethers | H. Lawrence Clever<br>Chemistry Department<br>Emory University<br>Atlanta, Georgia 30322 USA<br><br>1985, August |

CRITICAL EVALUATION:

An Evaluation of the Solubility of Mercury in Oxybisalkanes.

Spencer and Voigt (ref. 1) have measured the solubility of mercury in the two ethers, 2,2'-oxybispropane and 1,1'-oxybisbutane at six temperatures between 273.15 and 308.15 K by a radioactive tracer method. We know of no other data on the solubility of mercury in ethers.

Mercury + 2,2'-Oxybispropane; $C_6H_{14}O$; [108-20-3]
+ 1,1'-Oxybisbutane; $C_8H_{18}O$; [142-96-1]

The data of the two systems are classified as tentative. Both data set were treated by a linear regression to obtain a two constant equation in the units of concentration, mole fraction and molality in the form:

$$\ln(\text{soly}) = A(1) + A(2)/(T/100\ \text{K})$$

Tentative values of smoothed data and thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the hypothetical unit concentration solution were obtained from the equation.

Tables 1 and 2 contain information on the 2,2'-oxybispropane and Tables 3 and 4 on the 1,1'-oxybisbutane system.

Table 1. Mercury + 2,2'-Oxybispropane. Linear regression for the equation $\ln(\text{soly}) = A(1) + A(2)/(T/100\ \text{K})$.

| Solubility | A(1) ± Error | A(2) ± Error | Std. Error about the Regression Line |
|---|---|---|---|
| $c_1$/mol dm$^{-3}$ | 2.5672 ± 0.4717 | -44.1825 ± 1.3840 | $2.2 \times 10^{-7}$ |
| $x_1$ | 1.2221 ± 0.4690 | -45.9941 ± 1.3761 | $3.1 \times 10^{-8}$ |
| $m_1$/mol kg$^{-1}$ | 3.4006 ± 0.4416 | -45.6728 ± 1.2955 | $3.0 \times 10^{-7}$ |

Table 2. The solubility of mercury in 2,2'-oxybispropane. Tentative values of the solubility in concentration, mole fraction and molality as a function of temperature at 0.1 MPa and thermodynamic changes.

| Temperature | | Mercury Solubility | | |
|---|---|---|---|---|
| | | Concentration | Mole Fraction | Molality |
| $t$/°C | $T$/K | $10^6 c_1$/mol dm$^{-3}$ | $10^7 x_1$ | $10^6 m_1$/mol kg$^{-1}$ |
| 0 | 273.15 | 1.2 | 1.7 | 1.6 |
| 5 | 278.15 | 1.6 | 2.2 | 2.2 |
| 10 | 283.15 | 2.2 | 3.0 | 3.0 |
| 15 | 288.15 | 2.9 | 4.1 | 4.0 |
| 20 | 293.15 | 3.7 | 5.2 | 5.1 |
| 25 | 298.15 | 4.8 | 6.8 | 6.7 |
| 30 | 303.15 | 6.1 | 8.7 | 8.6 |
| 35 | 308.15 | 7.7 | 11.2 | 11.0 |
| $\Delta H_1$[a] | | 36.7 ± 1.2 | 38.2 ± 1.1 | 38.0 ± 1.1 |
| $\Delta S_1$[b] | | 21.3 ± 3.9 | 10.2 ± 3.9 | 28.3 ± 3.7 |

[a] units kJ mol$^{-1}$
[b] units J K$^{-1}$ mol$^{-1}$

Table 3. Mercury + 1,1'-Oxybisbutane. Linear regression constants for the equation ln(soly) = A(1) + A(2)/(*T*/100 K).

| Solubility | A(1) ± Error | A(2) ± Error | Std. Error about the Regression Line |
|---|---|---|---|
| $c_1$/mol dm$^{-3}$ | 3.0686 ± 0.5316 | -44.5568 ± 1.5597 | 4.4 x 10$^{-7}$ |
| $x_1$ | 1.6691 ± 0.5356 | -45.6601 ± 1.5715 | 7.6 x 10$^{-8}$ |
| $m_1$/mol kg$^{-1}$ | 3.5306 ± 0.4980 | -45.1263 ± 1.4610 | 5.5 x 10$^{-7}$ |

Table 4. The solubility of mercury in 1,1'-oxybisbutane. Tentative values of the solubility in concentration, mole fraction, and molality as a function of temperature at 0.1 MPa and thermodynamic changes.

| Temperature | | Mercury Solubility | | |
|---|---|---|---|---|
| $t$/°C | $T$/K | Concentration $10^6 c_1$/mol dm$^{-3}$ | Mole Fraction $10^7 x_1$ | Molality $10^6 m_1$/mol kg$^{-1}$ |
| 0 | 273.15 | 1.8 | 2.9 | 2.3 |
| 5 | 278.15 | 2.4 | 3.9 | 3.1 |
| 10 | 283.15 | 3.2 | 5.3 | 4.1 |
| 15 | 288.15 | 4.1 | 7.0 | 5.4 |
| 20 | 293.15 | 5.4 | 9.1 | 7.0 |
| 25 | 298.15 | 7.0 | 11.9 | 9.1 |
| 30 | 303.15 | 8.9 | 15.3 | 11.7 |
| 35 | 308.15 | 11.3 | 19.5 | 14.9 |
| $\Delta H_1$[a] | | 37.0 ± 1.3 | 38.0 ± 1.3 | 37.5 ± 1.2 |
| $\Delta S_1$[b] | | 25.5 ± 4.4 | 13.9 ± 4.5 | 29.4 ± 4.1 |

[a] units kJ mol$^{-1}$
[b] units J K$^{-1}$ mol$^{-1}$

REFERENCES:

1. Spencer, J. N.; Voigt, A. F. *J. Phys. Chem.* 1968, *72*, 464; Spencer, J. N. Dissertation, Iowa State University, 1968.

| COMPONENTS: | ORIGINAL MEASUREMENTS: |
|---|---|
| (1) Mercury; Hg; [7439-97-6]; Mercury-203; $^{203}$Hg; [13982-78-0] | Spencer, J. N.; Voigt, A. F. *J. Phys. Chem.* 1968, *72*, 464 - 470. |
| (2) 2,2'-Oxybispropane or *Iso*propyl ether; $C_6H_{14}O$; [108-20-3] | Spencer, J. N. Dissertation, Iowa State University, 1967. |
| VARIABLES: | PREPARED BY: |
| $T$/K = 273.15 - 308.15 | S. H. Johnson<br>M. Iwamoto<br>H. L. Clever |

EXPERIMENTAL VALUES:

| Temperature | | Mercury Solubility | | |
|---|---|---|---|---|
| $t$/°C | $T$/K[a] | Concentration $10^6 c_1$/mol dm$^{-3}$ | Mole Fraction[a] $10^7 x_1$ | Molality[a] $10^6 m_1$/mol kg$^{-1}$ |
| 0 | 273.15 | 1.2 ± 0.1 | 1.6 | 1.6 |
| 15.5 | 288.65 | 2.9 ± 0.1 | 4.1 | 4.0 |
| 20 | 293.15 | 4.0 ± 0.2 | 5.6 | 5.5 |
| 25 | 298.15 | 4.8 ± 0.1 | 6.8 | 6.7 |
| 30 | 303.15 | 6.1 ± 0.1 | 8.7 | 8.6 |
| 35 | 308.15 | 7.4 ± 0.1 | 10.7 | 10.5 |

[a]Calculated by compilers.

The authors smoothed their data according to the equation:

$$\log x_1 = (15.633 \pm .578)\log(T/K) - 44.855$$

for the 273.15 to 308.15 temperature interval.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A radioactive tracer method was used. A high activity sample of mercury-203 nitrate was added to mercury(II) nitrate, reduced to metallic mercury by hypophosphorous acid, coagulated into a drop, washed and dried.

The mercury and solvent were shaken continuously in 25 ml glass stoppered flasks in a thermostat for 24 hours. Aliquots of the equilibrated solution were counted by a conventional single channel scintillation counter. The window width was set to count only the photopeak at 279 kev. The solubility values were the average of at least six determinations over a three day period.

The measured mercury concentrations were larger than expected, not reproducible, and increased with time unless the hypophosphorous acid was added. The solubility was not affected by small variations in the acid.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury and Mercury-203. The isotope decays by emission of a beta particle at an energy of 210 kev, accompanied by a gamma ray of 279 kev. The isotope half-life is 47 days.

(2) *Iso*propylether. Matheson, Coleman and Bell. Stated to be no better than 99 mol %. Degassed, 0.1 % hypophosphorous acid added.

ESTIMATED ERROR:

$\delta T$/K = ±0.1; See random error reported by authors with concentration values above.

REFERENCES:

| COMPONENTS: | ORIGINAL MEASUREMENTS: |
|---|---|
| (1) Mercury; Hg; [7439-97-6]; Mercury-203; $^{203}$Hg; [13982-78-0]<br><br>(2) 1,1'-Oxybisbutane or Dibutyl ether; $C_8H_{18}O$; [142-96-1] | Spencer, J. N.; Voigt, A. F. *J. Phys. Chem.* 1968, *72*, 464 - 470.<br><br>Spencer, J. N. Dissertation, Iowa State University, 1967. |
| VARIABLES:<br><br>$T$/K = 273.15 - 308.15 | PREPARED BY:<br>S. H. Johnson<br>M. Iwamoto<br>H. L. Clever |

EXPERIMENTAL VALUES:

| Temperature | | Mercury Solubility | | |
|---|---|---|---|---|
| $t$/°C | $T$/K[a] | Concentration $10^6 c_1$/mol dm$^{-3}$ | Mole Fraction[a] $10^7 x_1$ | Molality[a] $10^6 m_1$/mol kg$^{-1}$ |
| 0 | 273.15 | 1.7 ± 0.1 | 2.8 | 2.2 |
| 15.5 | 288.65 | 4.4 ± 0.3 | 7.4 | 5.7 |
| 20 | 293.15 | 5.6 ± 0.1 | 9.5 | 7.3 |
| 25 | 298.15 | 7.1 ± 0.2 | 12.1 | 9.3 |
| 30 | 303.15 | 9.1 ± 0.5 | 15.6 | 12.0 |
| 35 | 308.15 | 10.5 ± 0.2 | 18.1 | 13.9 |

[a]Calculated by compilers.

The authors smoothed their data according to the equation:

$$\log x_1 = (15.666 \pm .650)\log(T/K) - 44.696$$

for the 273.15 to 308.15 temperature interval.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A radioactive tracer method was used. A high activity sample of mercury-203 nitrate was added to mercury(II) nitrate, reduced to metallic mercury by hypophosphorous acid, coagulated into a drop, washed and dried.

The mercury and solvent were shaken continuously in 25 ml glass stoppered flasks in a thermostat for 24 hours. Aliquots of the equilibrated solution were counted by a conventional single channel scintillation counter. The window width was set to count only the photopeak at 279 kev. The solubility values were the average of at least six determinations over a three day period.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury and Mercury-203. The isotope decays by emission of a beta particle at an energy of 210 kev, accompanied by a gamma ray of 279 kev. The isotope half-life is 47 days.

(2) Dibutyl ether. Matheson, Coleman and Bell. Stated to be better than 99 mol %. Washed with acidified solution of $FeSO_4$, dried and distilled. Hydroquinone (10 ppm) added to pervent peroxide formation.

ESTIMATED ERROR:

$\delta T$/K = ±0.1; See random error reported by authors with concentration values above.