COMPONENTS:	EVALUATOR:
(1) Mercury; Hg; [7439-97-6] (2) Alkanes	H. Lawrence Clever Chemistry Department Emory University Atlanta, Georgia 30322 USA 1985, June

CRITICAL EVALUATION:

An Evaluation of the Solubility of Mercury in Alkanes.

The solubility of mercury in alkanes is reported in seven papers. Three of the papers are from the laboratory of A. F. Voigt. The other papers report independent measurements. The solvents include five normal alkanes and five branched alkanes. The solubility measurements were made over the 273 to 336 K range of temperature. Several of the papers report only smoothed data. Two authors, A. F. Voigt, Iowa State University, and S. Okouchi, Hosei University, kindly provided us with a full set of their experimental measurements to supplement the published values. The solubility of mercury in normal and branched alkanes is evaluated in separate sections.

I. Mercury + Normal Alkanes

When preparing the mercury + normal alkane molal solubility values for evaluation, it was observed that the solubility values at 298.15 K were independent of the solvent. The thirteen solubility values in pentane, hexane, heptane, octane and decane averaged 9.4 ± 0.6 mol kg^{-1}, or omitting the one outlaying value, the remaining twelve values averaged 9.6 ± 0.1 mol kg^{-1}. Further inspection of the data showed a similar constancy of the molal solubility at other temperatures although there were not as many data points to be as convincing as the data at 298.15 K.

Figure 1 shows $\ln(m_1/\text{mol kg}^{-1})$ vs. $1000/(T/\text{K})$. Five solubility values deviated significantly from the line and were not used. They are Reichardt and Bonhoeffer's value in hexane at 336.15 K, Spencer and Voigt's value in octane at 313.15 K, Klehr and Voigt's values in decane at 308.15 and 318.15 K, and Kuntz and Mains's value in decane at 298.15 K.

Fifty-two of the fifty-seven mercury molal solubility values were combined in a linear regression to obtain the equation

$$\ln(m_1/\text{mol kg}^{-1}) = (5.105848 \pm 0.157626) - (49.70898 \pm 0.46401)/(T/100\ \text{K})$$

with a standard error about the regression line of 4.0 x 10^{-7}.

The constants of the equation give thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the hypothetical one molal solution of

$$\Delta H_1/\text{kJ mol}^{-1} = 41.33 \pm 0.39 \text{ and } \Delta S_1/\text{J K}^{-1}\text{ mol}^{-1} = 42.45 \pm 1.31.$$

Table 1 summarizes the experimental molal solubility values, the average molal solubility at each temperature for all of the data for the five solvents, an average value omitting the doubtful value at each temperature, and the value from the smoothing equation. The smoothed values agree well with the experimental value averages. We believe the equation can be used with caution to predict the solubility in other normal hydrocarbons at temperatures beyond the experimental range.

The saturation concentration fits a similar pattern but with a little larger uncertainty. For the saturation concentration, the equation is

$$\ln(c_1/\text{mol dm}^{-3}) = (4.239037 \pm 0.247227) - (48.30896 \pm 0.72777)/(T/100\ \text{K}).$$

The smoothed values from the equation at selected temperatures are also in Table 1.

Each system is discussed separately with respect to the mole fraction solubility.

Mercury + Pentane; C_5H_{12}; [109-66-0]

Kuntz and Mains (ref. 4) report one solubility value at 298.15 K. Okouchi and Sasaki (ref. 7) report values at six temperatures between 278.15 and 313.15 K. The values at 298.15 K agree within 1.5 percent. All values were combined in a linear regression to obtain the equation for the 278 to 313 K temperature interval

Table 1. The solubility of mercury in normal alkanes.

Alkane	Molal solubility, $10^6 m_1$/mol kg^{-1}, at temperatures of											Ref.
	273.15	278.15	283.15	288.15	293.15	298.15	303.15	308.15	313.15	318.15	336.15	
Pentane	-	2.6	3.7	-	6.4	9.4	12.8	-	22.	-	-	(7)
	-	-	-	-	-	9.3	-	-	-	-	-	(4)
Hexane	-	2.8	3.9	-	6.8	9.6	13.	-	22.	-	-	(7)
	-	-	-	-	-	9.8	-	-	-	-	-	(4)
	2.1	-	-	5.6	7.3	9.6	12.6	16.1	-	-	-	(5)
	-	-	-	-	-	9.5	-	-	-	-	-	(2)
	-	-	-	-	-	-	-	-	21.	-	82.8	(1)
Heptane	-	2.9	3.7	-	7.1	9.6	12.0	-	22.	-	-	(7)
	2.0	-	-	5.4	7.0	9.7	12.6	16.2	-	-	-	(5)
Octane	-	2.9	4.1	-	6.9	9.6	12.0	-	20.	-	-	(7)
	2.2	-	-	5.4	-	9.6	12.4	15.5	18.2	-	-	(5)
	-	-	-	-	-	9.6	-	-	-	-	-	(6)
Nonane	-	-	-	-	-	-	-	-	-	-	-	
Decane	2.8	-	4.1	6.1	6.7	9.6	11.9	13.4	-	18.7	-	(3)
	-	-	-	-	-	7.6	-	-	-	-	-	(4)
Av. all	2.3	2.8	3.9	5.6	6.9	9.4	12.4	15.3	20.9	18.7	82.8	
	±0.4	±0.2	±0.2	±0.3	±0.3	±0.6	±0.4	±1.3	±1.5			
omit one	2.1 ±0.1					9.6 ±0.1		15.9 ±0.4	21.4 ±0.9			
Equation molal (*m*)	2.06	2.86	3.92	5.31	7.13	9.48	12.48	16.28	21.06	27.03	62.4	
concentration (*c*)	1.45	1.99	2.70	3.63	4.83	6.37	8.32	10.78	13.84	17.64	39.8	

COMPONENTS:	EVALUATOR:
(1) Mercury; Hg; [7439-97-6] (2) Alkanes	H. Lawrence Clever Chemistry Department Emory University Atlanta, Georgia 30322 USA 1985, June

CRITICAL EVALUATION:

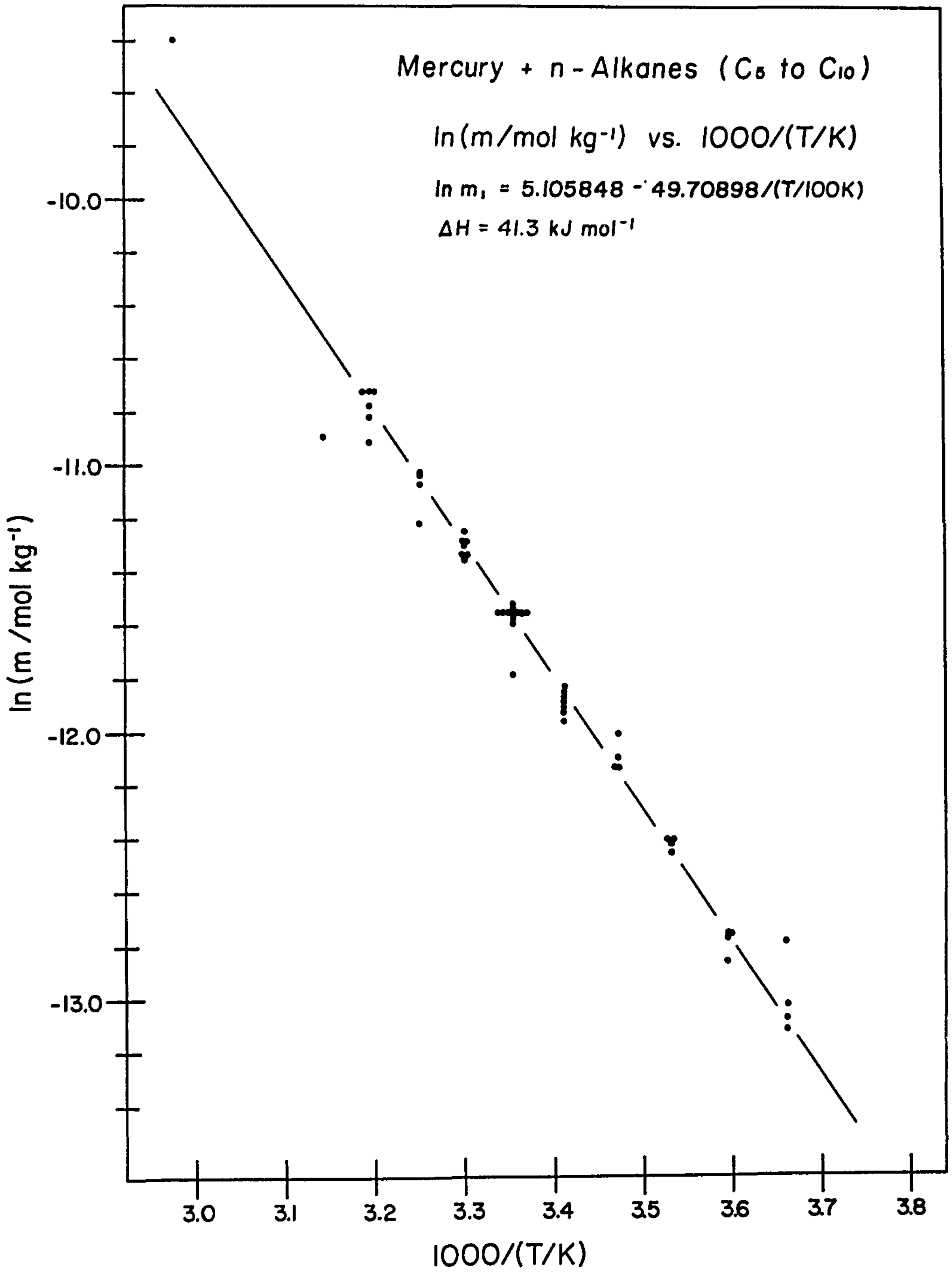

Figure 1. The solubility of mercury in normal alkanes. ln(m/mol kg $^{-1}$) vs. 1000/(T/K)

Horizontal cluster of points indicate the number of independent data points of one value. Vertical clusters are independent values at a given temperature.

$$\ln x_1 = (3.58822 \pm 0.40979) - (53.06278 \pm 1.20755)/(T/100\ \mathrm{K})$$

with a standard error about the regression line of 2.2 x 10^{-8}. The thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the infinitely dilute solution are

$$\Delta H_1/\mathrm{kJ\ mol^{-1}} = 44.1 \pm 1.0 \text{ and } \Delta S_1/\mathrm{J\ K^{-1}\ mol^{-1}} = 29.8 \pm 3.4.$$

Smoothed values of the mole fraction solubility are in Table 2.

Mercury + Hexane; C_6H_{14}; [110-54-3]

Reichardt and Bonhoeffer (ref. 1) report solubility values at 313.15 and 336.15 K, Moser and Voigt (ref. 2) report distribution data from which we estimated one solubility value at 298.15 K, Kuntz and Mains (ref. 4) report one value at 298.15 K, Spencer and Voigt (ref. 5) report six solubility values between 273.15 and 308.15 K and Okouchi and Sasaki (ref. 7) report six values between 278.15 and 313.15 K. At least three quite different methods were used. The only value that appears doubtful is the 336.15 K value of Reichardt and Bonhoeffer which appears to be about 15 percent too large. All except the 336.15 K value were treated by a linear regression to obtain the equation

$$\ln x_1 = (2.76226 \pm 0.16258) - (49.9972 \pm 0.4804)/(T/100\ \mathrm{K})$$

with a standard error about the regression line of 2.5 x 10^{-8}.

The thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the infinitely dilute solution are

$$\Delta H_1/\mathrm{kJ\ mol^{-1}} = 41.6 \pm 0.4 \text{ and } \Delta S_1/\mathrm{J\ K^{-1}\ mol^{-1}} = 23.0 \pm 1.4.$$

Smoothed values of the mole fraction solubility are in Table 2.

Mercury + Heptane; C_7H_{16}; [142-82-5]

Spencer and Voigt (ref. 5) report six solubility values between 273.15 and 308.15 K; Okouchi and Sasaki (ref. 7) report six solubility values between 278.15 and 313.15 K.

The two data sets were combined in a linear regression to obtain the equation

$$\ln x_1 = (3.10124 \pm 0.19810) - (50.5916 \pm 0.58183)/(T/100\ \mathrm{K})$$

with a standard error about the regression line of 2.9 x 10^{-8}.

The thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the infinitely dilute solution are

$$\Delta H_1/\mathrm{kJ\ mol^{-1}} = 42.1 \pm 0.5 \text{ and } \Delta S_1/\mathrm{J\ K^{-1}\ mol^{-1}} = 25.8 \pm 1.6.$$

The mole fraction solubility values have an average deviation from the regression line of 2.2 percent and a maximum deviation of 5.4 percent. The Okouchi and Sasaki data show more scatter (Av. dev. 2.9%) than the Spencer and Voigt data (Av. dev. 1.4%). Smoothed mole fraction solubility values are in Table 2.

Mercury + Octane; C_8H_{18}; [111-65-9]

As for the heptane, both Spencer and Voigt (ref. 5) and Okouchi and Sasaki (ref. 7) report six solubility values. Vogel and Gjaldbaek (ref. 6) report one value at 298.15 K. All three papers report a mole fraction solubility of 11.0 x 10^{-7} at 298.15 K. All data were combined in a linear regression to obtain the equation

$$\ln x_1 = (2.03628 \pm 0.23584) - (47.07542 \pm 0.69681)/(T/100\ \mathrm{K})$$

with a standard error about the regression line of 6.2 x 10^{-8}.

The thermodynamic changes for the transfer at one mole of mercury from the liquid metal to the infinitely dilute solution are

$$\Delta H_1/\mathrm{kJ\ mol^{-1}} = 39.1 \pm 0.6 \text{ and } \Delta S_1/\mathrm{J\ K^{-1}\ mol^{-1}} = 16.9 \pm 2.0.$$

Smoothed values of the mole fraction solubility are in Table 2.

COMPONENTS:	EVALUATOR:
(1) Mercury; Hg; [7439-97-6] (2) Alkanes	H. Lawrence Clever Chemistry Department Emory University Atlanta, Georgia 30322 USA 1985, June

CRITICAL EVALUATION:

Mercury + Decane; $C_{10}H_{22}$; [124-18-5]

Klehr and Voigt (ref. 3) report eight solubility values between 273.15 and 318.15 K. Kuntz and Mains (ref. 4) report one value at 298.15 K. The Kuntz and Mains value is one of the few values that does not fit the molality plot well (fig. 1). Thus, we consider it doubtful. The Klehr and Voigt paper is the first attempt of measuring mercury solubility in a hydrocarbon from that laboratory. Although the evidence is not as strong as we would like, we feel the Klehr and Voigt values at 308.15 and 318.15 K are also doubtful. The three doubtful values were omitted and the other values treated by a linear regression to obtain the equation

$$\ln x_1 = (0.05995 \pm 0.94229) - (40.5530 \pm 2.7261)/(T/100\ \mathrm{K})$$

with a standard error about the regression line of 6.8×10^{-8}.

The thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the infinitely dilute solution are

$$\Delta H_1/\mathrm{kJ\ mol^{-1}} = 33.7 \pm 2.3 \text{ and } \Delta S_1/\mathrm{J\ K^{-1}\ mol^{-1}} = 0.5 \pm 7.8$$

smoothed solubility values are in Table 2.

We are concerned that the thermodynamic properties for decane differ so much from the values for the other normal alkanes.

Table 2. The solubility of mercury in normal alkanes. Tentative values of the mole fraction solubility as a function of temperature.

T/K	Mole Fraction solubility, $10^7 x_1$, in the normal alkanes Pentane	Hexane	Heptane	Octane	Decane
273.15	-	1.8	2.0	2.5	3.8
278.15	1.9	2.5	2.8	3.4	4.9
283.15	2.6	3.4	3.9	4.6	6.4
288.15	3.6	4.6	5.3	6.2	8.2
293.15	5.0	6.2	7.1	8.1	10.4
298.15	6.7	8.3	9.5	10.6	13.2
303.15	9.0	10.9	12.6	13.8	16.5
308.15	12.0	14.2	16.5	17.8	20.4
313.15	15.8	18.4	21.4	22.7	25.2
318.15	-	23.8	-	-	30.9
323.15	-	30.3	-	-	-
328.15	-	38.4	-	-	-
333.15	-	48.3	-	-	-
338.15	-	60.3	-	-	-
$\Delta H_1{}^a$	44.1 ± 1.0	41.6 ± 0.4	42.1 ± 0.5	39.1 ± 0.6	33.7 ± 2.3
$\Delta S_1{}^b$	29.8 ± 3.4	26.0 ± 1.4	25.8 ± 1.6	16.9 ± 2.0	0.5 ± 7.8

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

II. Mercury + Branched Alkanes.

Although there are solubility data on five branched alkanes, there are many fewer values than there were for the five normal alkanes. The molality correlation for the normal alkanes does not hold true for the branched alkanes. The mole fraction solubilities at 298.15 K fall in a narrow range of values, but there are not enough data to support a generalization. The solubility of mercury is less in the branched alkane than in the corresponding normal alkane at a given temperature. This is expected because the branched hydrocarbons are of smaller cohesive energy density than the corresponding normal alkane. Thus, the cohesive energy difference between mercury and branched alkanes is larger that between mercury and normal alkanes, and the branched alkane solvent is less ideal. Each system is discussed below.

Mercury + 2-Methylbutane; C_5H_{12}; [78-78-4]

The only measurement is that of Kuntz and Mains (ref. 4) at 298.15 K. It is classed as tentative. The value appears in the Tables 3, 4 and 5.

Mercury + 3-Methylpentane; C_6H_{14}; [96-14-0]

The only measurement is that of Kuntz and Mains (ref. 4) at 298.15 K. It is classed as tentative. The value appears in the Tables 3, 4 and 5.

Mercury + 2,2-Dimethylbutane; C_6H_{14}; [75-83-2]

Kuntz and Mains (ref. 4) report one measurement at 298.15 K and Spencer and Voigt (ref. 5) report six values between temperatures of 273.15 and 308.15 K. All of the data were combined in a linear regression to obtain the equations

$$\ln(c_1/\text{mol dm}^{-3}) = (1.89608 \pm 0.31898) - (42.21314 \pm 0.93774)/(T/100\text{ K})$$

$$\ln(m_1/\text{mol kg}^{-1}) = (2.93988 \pm 0.32646) - (44.0108 \pm 0.9597)/(T/100\text{ K})$$

$$\ln x_1 = (0.23496 \pm 0.43775) - (43.2397 \pm 1.2869)/(T/100\text{ K})$$

with standard errors about the regression line of 1.5×10^{-7}, 2.6×10^{-7}, and 2.8×10^{-8}, respectively.

The thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the solution and smoothed solubility values are in Tables 3, 4 and 5.

Mercury + 2,3-Dimethylbutane; C_6H_{14}; [79-29-8]

The only measurement is that of Kuntz and Mains (ref. 4) at 298.15 K. It is classed as tentative. The value appears in Tables 3, 4 and 5.

Mercury + 2,2,4-Trimethylpentane; C_8H_{18}; [540-84-1]

Kuntz and Mains (ref. 4) and Vogel and Gjaldbaek (ref. 6) each report one value at 298.15 K. Spencer and Voigt (ref. 5) report seven values between 273.15 and 308.15 K. At 298.15 K, the Vogel and Gjaldbaek and the Spencer and Voigt values agree within three percent while the Kuntz and Mains value is about 10 percent larger that the average of the other two. We classify all three data sets tentative, but we have used only the Vogel and Gjaldbaek and Spencer and Voigt data in the linear regression to obtain the equations

$$\ln(c_1/\text{mol dm}^{-3}) = (3.19617 \pm 0.44480) - (46.5373 \pm 1.3034)/(T/100\text{ K})$$

$$\ln(m_1/\text{mol kg}^{-1}) = (3.97728 \pm 0.43080) - (47.7399 \pm 1.2624)/(T/100\text{ K})$$

$$\ln x_1 = (1.84306 \pm 0.44990) - (47.8583 \pm 1.3184)/(T/100\text{ K})$$

with standard errors about the regression line of 1.3×10^{-7}, 2.1×10^{-6}, and 2.3×10^{-8}, respectively.

Smoothed solubility data and thermodynamic changes for the transfer of one mole of mercury from the liquid metal to the solution are in Tables 3, 4 and 5.

The solubility values in Tables 3, 4 and 5 are classed as tentative. The enthalpy and entropy changes on solution are smaller for the branched than for the normal alkanes. Since there are only limited data on two branched alkane solvents, it is not possible to judge whether or not the smaller values are significant.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Alkanes

EVALUATOR:

H. Lawrence Clever
Chemistry Department
Emory University
Atlanta, Georgia 30322 USA

1985, June

CRITICAL EVALUATION:

Table 3. Solubility of mercury in branched alkanes. Tentative values of the saturation concentration as a function of temperature.

T/K	Saturation concentration, $10^6 c_1$/mol dm^{-3}, in the branched alkanes 2-Methyl butane	3-Methyl pentane	2,2-dimethyl butane	2,3-dimethyl butane	2,2,4-trimethyl pentane
273.15			1.3		0.97
278.15			1.7		1.3
283.15			2.2		1.8
288.15			2.9		2.4
293.15			3.7		3.1
298.15	5.5	5.1	4.7	6.0	4.1
303.15			6.0		5.3
308.15			7.5		6.7
ΔH_1[a]			35.1 ± 0.8		38.7 ± 1.1
ΔS_1[b]			15.8 ± 2.7		26.6 ± 3.7

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

Table 4. Solubility of mercury in branched alkanes. Tentative values of the saturation molality solubility as a function of temperature.

T/K	Saturation molality, $10^6 m_1$/mol kg^{-1}, in the branched alkanes 2-Methyl butane	3-Methyl pentane	2,2-dimethyl butane	2,3-dimethyl butane	2,2,4-trimethyl pentane
273.15			1.9		1.4
278.15			2.5		1.9
283.15			3.4		2.5
288.15			4.4		3.4
293.15			5.7		4.5
298.15	8.9	7.7	7.3	9.1	5.9
303.15			9.4		7.7
308.15			11.9		10.0
ΔH_1[a]			36.6 ± 0.8		39.7 ± 1.0
ΔS_1[b]			24.4 ± 2.7		33.1 ± 3.6

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

Table 5. Solubility of mercury in branched alkanes. Tentative values of the mole fraction solubility as a function of temperature.

T/K	Mole fraction solubility, 10^7x_1, in the branched alkanes 2-Methyl butane	3-Methyl pentane	2,2-dimethyl butane	2,3-dimethyl butane	2,2,4-trimethyl pentane
273.15			1.7		1.5
278.15			2.2		2.1
283.15			2.95		2.9
288.15			3.8		3.9
293.15			5.0		5.1
298.15	6.5	6.7	6.4	7.9	6.7
303.15			8.1		8.8
308.15			10.2		11.4
ΔH_1[a]			36.0 ± 1.1		39.8 ± 1.1
ΔS_1[b]			2.0 ± 3.7		15.3 ± 3.7

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

REFERENCES:

1. Reichardt, H.; Bonhoeffer, K. F. *Z. Phys.* 1931, *67*, 780-9.

2. Moser, H. C.; Voigt, A. F. *J. Am. Chem. Soc.* 1957, *79*, 1837-9.

3. Klehr, E. H.; Voigt, A. F. *Radioisotopes Phys. Sci. Ind., Proc. Conf. Use, Copenhagen* 1960, *1*, 517-29 (Pub. 1962).

4. Kuntz, R. R.; Mains, G. J. *J. Phys. Chem.* 1964, *68*, 408-10.

5. Spencer, J. N.; Voigt, A. F. *J. Phys. Chem.* 1968, *72*, 464-70; Spencer, J. N. Dissertation, Iowa State University, 1967.

6. Vogel, A.; Gjaldbaek, J. C. *Arch. Pharm. Chem. Sci. Ed.* 1974, *2*, 25-9.

7. Okouchi, S.; Sasaki, S. *Bull. Chem. Soc. Jpn.* 1981, *54*, 2513-4; Report of the College of Engineering of Hosei University 1983, (No. 22), 55-106.

8. Moser, H. C.; Voigt, A. F. USAEC Report 1957, ISC-892.

ADDED NOTE:

All of the solubility values reported by Kuntz and Mains (ref. 4) are based on the hexane solubility value at 298.15 K reported by Moser and Voigt (ref. 8). See the Moser and Voigt data sheet, p. 114. Thus, there is a relationship between the Kuntz and Mains solubility values and the Moser and Voigt data.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Pentane; C_5H_{12}; [109-66-0]

ORIGINAL MEASUREMENTS:

Kuntz, R. R.; Mains, G. J.

J. Phys. Chem. 1964, *68*, 408 - 10.

VARIABLES:

$T/K = 298.15$

PREPARED BY:

S. H. Johnson
M. Iwamoto
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}
25	298.15	5.8	6.7	9.3

^{a}Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Spectrophotometric method. It was assumed that the optical density at 2560 A is a reliable measure of the solubility. It was further assumed that the extinction coefficient of mercury was the same in all hydrocarbon solvents. The optical density of a saturated solution of Hg in hexane was measured and, when combined with the solubility measured by Moser and Voigt (ref. 1), gives an extinction coefficient $\varepsilon_{2560} = 7.35 \times 10^3$ dm^3 mol^{-1} cm^{-1} at 25°C. The value was used to calculate the solubility in the other solvents.

The Hg and solvent were equilibrated for 20 minutes and the optical density was measured by a Beckman DU Spectrophotometer.

The reliability of the results depends on the Moser and Voigt solubility value in hexane.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. No information given.

(2) Pentane. Phillips "pure grade" hydrocarbon solvents; purified by passage through silica gel until optically pure, degassed and distilled.

ESTIMATED ERROR:

REFERENCES:

1. Moser, H. C.; Voigt, A. F. USAEC Report 1957, ISC-892.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Pentane; C_5H_{12}; [109-66-0]

ORIGINAL MEASUREMENTS:

Okouchi, S.; Sasaki, S.

Bull. Chem. Soc. Jpn. <u>1981</u>, *54*, 2513 - 4.
Report of the College of Engineering of Hosei University <u>1983</u>, (No. 22), 55 - 106.

VARIABLES:

$T/K = 278.15 - 313.15$

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
$t/°C$	T/K^a	Concentration^a $10^6c_1/\text{mol dm}^{-3}$	Mole Fraction 10^7x_1	Molality^a $10^6m_1/\text{mol kg}^{-1}$
5	278.15	1.7	1.9	2.6
10	283.15	2.4	2.7	3.7
20	293.15	4.0	4.6	6.4
25	298.15	5.9	6.8	9.4
30	303.15	7.9	9.3	12.8
40	313.15	13	16	22

^{a}Calculated by compilers.

Dr. S. Okouchi kindly provided the experimental mole fraction solubility values which did not appear in the original papers.

The authors fitted the data to two equations. The second is preferred.

$$\log x_1 = (17.375)\log(T/K) - 49.169$$
$$\log x_1 = 1.3840 - 2256.1/(T/K)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility experiments were conducted by shaking the solvent with a drop of mercury for 24 hours in a thermostat. Separate experiments showed the mercury concentration remained constant after 24 hours of shaking.

A 0.5 cm³ sample of the equilibrated solution was analyzed by the cold-vapor atomic absorption method. Steps in the procedure included tin(II) chloride reduction, nitrogen bubbling and passage through magnesium perchlorate to dry the Hg vapor.

The mercury was determined from the area under the atomic absorption peak at 253.7 nm compared to a calibration curve.

In experiments with water, phosphinic acid (0.001 mol) was added to prevent mercury oxidation. Water-hydrocarbon distribution constants of Hg were also directly determined.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. Purified as did Glew and Hames (ref. 1).

(2) Pentane. Analytical reagent grade. Passed through activated alumina and distilled.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$
$\delta x_1/x_1 = \pm(0.03 - 0.05)$ (compilers)

REFERENCES:

1. Glew, D. N.; Hames, D. A.
Can. J. Chem. <u>1971</u>, *49*, 3114.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) 2-Methylbutane or *Iso*pentane; C_5H_{12}; [78-78-4]

ORIGINAL MEASUREMENTS:

Kuntz, R. R.; Mains, G. J.

J. Phys. Chem. 1964, *68*, 408 - 10.

VARIABLES:

T/K = 298.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
$t/°C$	T/K^a	Concentration 10^6c_1/mol dm^{-3}	Mole Fraction^a 10^7x_1	Molality^a 10^6m_1/mol kg^{-1}
25	298.15	5.5	6.5	8.9

^{a}Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Spectrophotometric method. It was assumed that the optical density at 2560 A is a reliable measure of the solubility. It was further assumed that the extinction coefficient of mercury was the same in all hydrocarbon solvents. The optical density of a saturated solution of Hg in hexane was measured and, when combined with the solubility measured by Moser and Voigt (ref. 1), gives an extinction coefficient ε_{2560} = 7.35 x 10^3 dm^3 mol^{-1} cm^{-1} at 25°C. The value was used to calculate the solubility in the other solvents.

The Hg and solvent were equilibrated for 20 minutes and the optical density was measured by a Beckman DU Spectrophotometer.

The reliability of the results depends on the Moser and Voigt solubility value in hexane.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. No information given.

(2) *Iso*pentane. Phillips "pure grade" hydrocarbon solvents; purified by passage through silica gel until optically pure, degassed and distilled.

ESTIMATED ERROR:

REFERENCES:

1. Moser, H. C.; Voigt, A. F.
USAEC Report 1957, ISC-892.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Reichardt, H.; Bonhoeffer, K. F.

Z. Phys. 1931, *67*, 780 - 9.

VARIABLES:

T/K = 313.15 - 336.15

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility			
t/°C	T/K^a	c_1/mg dm^{-3}	Concentration^a 10^5c_1/mol dm^{-3}	Mole Fraction^a 10^6x_1	Molality^a 10^5m_1/mol kg^{-1}
40	313.15	2.7	1.3	1.8	2.1
63	336.15	10.3	5.13	7.14	8.28

^{a}Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Some of these results are mentioned in two earlier papers (ref. 1 and 2), but the present paper discusses the solubility work in the most detail.

The solution is analyzed by weighing a gold foil before and after amalgamation with the mercury of the saturated solution.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury.

(2) Hexane.

ESTIMATED ERROR:

δc_1/mg dm^{-3} = ±(0.1 - 0.2)

REFERENCES:

1. Bonhoeffer, K. F.; Reichardt, H. *Naturwissenshaften* 1929, *17*, 933.

2. Reichardt, H.; Bonhoeffer, K. F. *Z. Electrochem.* 1930, *36*, 753.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]
Mercury-203; ^{203}Hg; [13982-78-0]

(2) Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Moser, H. C.; Voigt, A. F.

USAEC Report <u>1957</u>, ISC-892.
Chem. Abstr. <u>1958</u>, *52*, 10691h.

VARIABLES:

T/K = 298.15

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
t/°C	T/K^a	Concentration 10^6c_1/mol dm^{-3}	Mole Fraction^a 10^7x_1	Molality^a 10^6m_1/mol kg^{-1}
25	298.15	6.1 - 6.7	8.0 - 8.8	9.3 - 10.2

^{a}Calculated by compilers.

Note: All of the results of Kuntz and Mains (ref. 1) are based on the hexane solubility value of Moser and Voigt. Apparently Kuntz and Mains averaged the values from the range above and referenced all of their values to 6.4 x 10^{-6} mol dm^{-3} value in hexane at 298.15K.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A globule of Hg metal prepared from radioactive mercury(II) nitrate by reduction with hypophosphorous acid was equilibrated with 5 - 10 ml of liquid by shaking in a thermostat. Aliquotes of the liquid were withdrawn periodically for up to two weeks and the Hg concentration determined radiochemically.

The aliquot was diluted with acetone and equilibrated with $Hg(NO_3)_2$ carrier to exchange the radioactive mercury. The mercury was precipitated as HgS, mounted on a stainless steel planchet and counted with a Geiger-Mueller tube.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury and Mercury-203. Oak Ridge National Lab; recieved as 0.31 M $Hg(NO_3)_2$ in 1.56 M HNO_3 solution. Initial activity 50 millicuries g^{-1}; half-life 48 days. Reduced to Hg by hypophosphorous acid; coagulated to a Hg droplet by addition of concentrated HI.

(2) Hexane. Phillips Petroleum Co. "pure grade"; shaken with concentrated H_2SO_4 and alkaline $KMnO_4$, passed through a column of dry activated Al_2O_3, and redistilled.

ESTIMATED ERROR:

δT/K = $\pm$0.1

REFERENCES:

1. Kuntz, R. R.; Mains, G. J. *J. Phys. Chem.* <u>1964</u>, *68*, 408.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]
Mercury-203; ^{203}Hg; [13982-78-0]

(2) Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Moser, H. C.; Voigt, A. F.

J. Am. Chem. Soc. 1957, *79*, 1837 - 9.

VARIABLES:

$T/K = 298.15$

PREPARED BY:

H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Distribution Constant	Mercury Solubility		
$t/°C$	T/K^a	$E° = c_1\text{aq}/c_1\text{org}$	Concentration^a $10^8 c_1$/mol dm^{-3}	Mole Fraction^a $10^7 x_1$	Molality^a $10^8 m_1$/mol kg^{-1}
25.0	298.15	0.048	6.2_5	8.2	9.5

^{a}Calculated by compiler.

The above mercury solubility value was calculated using the free mercury solubility in water of 3.0×10^{-7} mol dm^{-3}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The distribution of mercury-203 between aqueous and organic phases was measured. Dilute solutions of 0.01 molar HNO_3 containing a known amount of pure mercurous nitrate were shaken with an equal volume of organic liquid for about 12 hours. Both phases were analyzed for total mercury by first converting to Hg^{2+}, precipitation as HgS, and counting in a thin window Geiger counter.

In the aqueous phase the disproportionation

$$Hg_2^{2+}(aq) = Hg^{2+}(aq) + Hg(aq)$$

and possibly the dissociation

$$Hg_2^{2+}(aq) = 2\ Hg^+(aq)$$

take place. It is assumed that only metallic Hg is extracted into the organic phase.

The distribution of total Hg in the aqueous phase to total Hg in the organic phase is determined as a function of total Hg in the organic phase. From the slope and intercept, the authors obtain values of the metallic Hg distribution ratio.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury and Mercury-203. Oak Ridge National Lab; obtained as a high specific activity solution of mercury(II) nitrate containing isotope 203. In the 0.01 molar HNO_3 solution of mercury(I) nitrate, the authors estimate 96% mercury(II) is Hg^{2+} and 99% of the mercury(I) is Hg_2^{2+}. At this acidity, there is no minimum hydrolysis and nitrato complex formation.

(2) Hexane. Phillips "pure grade".

REFERENCES:

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Kuntz, R. R.; Mains, G. J.

J. Phys. Chem. 1964, *68*, 408 - 10.

VARIABLES:

$T/K = 298.15$

PREPARED BY:

S. H. Johnson
M. Iwamoto
H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
$t/°C$	T/K^a	Concentration $10^6 c_1/\mathrm{mol\ dm^{-3}}$	Mole Fraction^a $10^7 x_1$	Molality^a $10^6 m_1/\mathrm{mol\ kg^{-1}}$
25	298.15	6.4	8.4	9.8

^{a}Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Spectrophotometric method. It was assumed that the optical density at 2560 A is a reliable measure of the solubility. It was further assumed that the extinction coefficient of mercury was the same in all hydrocarbon solvents. The optical density of a saturated solution of Hg in hexane was measured and, when combined with the solubility measured by Moser and Voigt (ref. 1), gives an extinction coefficient $\varepsilon_{2560} = 7.35 \times 10^3\ \mathrm{dm^3\ mol^{-1}\ cm^{-1}}$ at 25°C. The value was used to calculate the solubility in the other solvents.

The Hg and solvent were equilibrated for 20 minutes and the optical density was measured by a Beckman DU Spectrophotometer.

The reliability of the results depends on the Moser and Voigt solubility value in hexane.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. No information given.

(2) Hexane. Phillips "pure grade" hydrocarbon solvents; purified by passage through silica gel until optically pure, degassed and distilled.

ESTIMATED ERROR:

REFERENCES:

1. Moser, H. C.; Voigt, A. F. USAEC Report 1957, ISC-892.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6];
Mercury-203; ^{203}Hg; [13982-78-0]

(2) Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Spencer, J. N.; Voigt, A. F.
J. Phys. Chem. 1968, *72*, 464 - 470.

Spencer, J. N.
Dissertation, Iowa State University, 1967.

VARIABLES:

T/K = 273.15 - 308.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
t/°C	T/K^a	Concentration 10^6c_1/mol dm^{-3}	Mole Fraction^a 10^7x_1	Molality^a 10^6m_1/mol kg^{-1}
0	273.15	1.4 ± .1	1.8	2.1
15	288.15	3.7 ± .1	4.8	5.6
20	293.15	4.8 ± .1	6.3	7.3
25	298.15	6.3 ± .3	8.3	9.6
30	303.15	8.2 ± .3	10.9	12.6
35	308.15	10.4 ± .2	13.9	16.1

^{a}Calculated by compilers.

The authors smoothed their data according to the equation:

$$\log x_1 = (17.084 \pm .420)\log(T/K) - 48.366$$

for the 273.15 to 308.15 temperature interval.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A radioactive tracer method using mercury-203 was used.

The mercury and solvent were shaken continuously for 24 hours in 25 ml glass stoppered volumetric flasks in a thermostat. Aliquots of the equilibrated solution were counted by a conventional single channel scintilation counter. The window width was set to count only the photopeak at 279 kev.

Solvents were treated to remove traces of peroxides. If peroxides were not removed a black coating formed on the mercury.

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) Hexane. Research grade obtained from Phillips; used without further purification.

ESTIMATED ERROR:

δT/K = ±0.1; See random error reported by authors with concentration values above.

REFERENCES:

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Hexane; C_6H_{14}; [110-54-3]

ORIGINAL MEASUREMENTS:

Okouchi, S.; Sasaki, S.

Bull. Chem. Soc. Jpn. 1981, *54*, 2513 - 4.
Report of the College of Engineering of Hosei University 1983, (No. 22), 55 - 106.

VARIABLES:

$T/K = 278.15 - 313.15$

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
$t/°C$	T/K^a	Concentration[a] $10^6 c_1$/mol dm^{-3}	Mole Fraction $10^7 x_1$	Molality[a] $10^6 m_1$/mol kg^{-1}
5	278.15	1.9	2.4	2.8
10	283.15	2.6	3.4	3.9
20	293.15	4.5	5.9	6.8
25	298.15	6.3	8.3	9.6
30	303.15	8.3	11	13
40	313.15	14	19	22

[a] Calculated by compilers.

Dr. S. Okouchi kindly provided the experimental mole fraction solubility values which did not appear in the original papers.

The authors fitted the data to two equations. The second is preferred.

$$\log x_1 = (17.111)\log(T/K) - 48.432$$
$$\log x_1 = 1.3441 - 2215.2/(T/K)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility experiments were conducted by shaking the solvent with a drop of mercury for 24 hours in a thermostat. Separate experiments showed the mercury concentration remained constant after 24 hours of shaking.

A 0.5 cm³ sample of the equilibrated solution was analyzed by the cold-vapor atomic absorption method. Steps in the procedure included tin(II) chloride reduction, nitrogen bubbling and passage through magnesium perchlorate to dry the Hg vapor.

The mercury was determined from the area under the atomic absorption peak at 253.7 nm compared to a calibration curve.

In experiments with water, phosphinic acid (0.001 mol) was added to prevent mercury oxidation. Water-hydrocarbon distribution constants of Hg were also directly determined.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. Purified as did Glew and Hames (ref. 1).

(2) Hexane. Analytical reagent grade. Passed through activated alumina and distilled.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$
$\delta x_1/x_1 = \pm(0.03 - 0.05)$ (compilers)

REFERENCES:

1. Glew, D. N.; Hames, D. A. *Can. J. Chem.* 1971, *49*, 3114.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) 3-Methylpentane; C_6H_{14};
[96-14-0]

ORIGINAL MEASUREMENTS:

Kuntz, R. R.; Mains, G. J.

J. Phys. Chem. 1964, *68*, 408 - 10.

VARIABLES:

$T/K = 298.15$

PREPARED BY:

S. H. Johnson
M. Iwamoto
H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
$t/°C$	T/K^a	Concentration $10^6 c_1/\text{mol dm}^{-3}$	Mole Fraction^a $10^7 x_1$	Molality^a $10^6 m_1/\text{mol kg}^{-1}$
25	298.15	5.1	6.7	7.7

^{a}Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Spectrophotometric method. It was assumed that the optical density at 2560 A is a reliable measure of the solubility. It was further assumed that the extinction coefficient of mercury was the same in all hydrocarbon solvents. The optical density of a saturated solution of Hg in hexane was measured and, when combined with the solubility measured by Moser and Voigt (ref. 1), gives an extinction coefficient $\varepsilon_{2560} = 7.35 \times 10^3 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$ at 25°C. The value was used to calculate the solubility in the other solvents.

The Hg and solvent were equilibrated for 20 minutes and the optical density was measured by a Beckman DU Spectrophotometer.

The reliability of the results depends on the Moser and Voigt solubility value in hexane.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. No information given.

(2) 3-Methylpentane. Phillips "pure grade" hydrocarbon solvents; purified by passage through silica gel until optically pure, degassed and distilled.

ESTIMATED ERROR:

REFERENCES:

1. Moser, H. C.; Voigt, A. F.
USAEC Report 1957, ISC-892.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) 2,2-Dimethylbutane; C_6H_{14}; [75-83-2]

ORIGINAL MEASUREMENTS:

Kuntz, R. R.; Mains, G. J.

J. Phys. Chem. 1964, *68*, 408 - 10.

VARIABLES:

T/K = 298.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
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}
25	298.15	5.0	6.7	7.8

[a] Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Spectrophotometric method. It was assumed that the optical density at 2560 Å is a reliable measure of the solubility. It was further assumed that the extinction coefficient of mercury was the same in all hydrocarbon solvents. The optical density of a saturated solution of Hg in hexane was measured and, when combined with the solubility measured by Moser and Voigt (ref. 1), gives an extinction coefficient ε_{2560} = 7.35 x 10^3 dm^3 mol^{-1} cm^{-1} at 25°C. The value was used to calculate the solubility in the other solvents.

The Hg and solvent were equilibrated for 20 minutes and the optical density was measured by a Beckman DU Spectrophotometer.

The reliability of the results depends on the Moser and Voigt solubility value in hexane.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. No information given.

(2) 2,2-Dimethylbutane. Phillips "pure grade" hydrocarbon solvents; purified by passage through silica gel until optically pure, degassed and distilled.

ESTIMATED ERROR:

REFERENCES:

1. Moser, H. C.; Voigt, A. F. USAEC Report 1957, ISC-892.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6];
Mercury-203; ^{203}Hg; [13982-78-0]

(2) 2,2-Dimethylbutane; C_6H_{14};
[75-83-2]

ORIGINAL MEASUREMENTS:

Spencer, J. N.; Voigt, A. F.
J. Phys. Chem. 1968, *72*, 464 - 470.

Spencer, J. N.
Dissertation, Iowa State University, 1967.

VARIABLES:

$T/K = 273.15 - 308.15$

PREPARED BY:

S. H. Johnson
M. Iwamoto
H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
$t/°C$	T/K^a	Concentration $10^6c_1/mol\ dm^{-3}$	Mole Fraction^a 10^7x_1	Molality^a $10^6m_1/mol\ kg^{-1}$
0	273.15	1.3 ± .1	1.7	1.9
15	288.15	2.8 ± .2	3.7	4.3
20	293.15	3.7 ± .1	4.9	5.7
25	298.15	4.7 ± .3	6.3	7.3
30	303.15	6.0 ± .1	8.1	9.4
35	308.15	7.3 ± .7	9.9	11.5

^{a}Calculated by compilers.

The authors smoothed their data according to the equation:

$$\log x_1 = (14.905 \pm .380)\log(T/K) - 43.089$$

for the 273.15 to 308.15 temperature interval.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A radioactive tracer method using mercury-203 was used.

The mercury and solvent were shaken continuously for 24 hours in 25 ml glass stoppered volumetric flasks in a thermostat. Aliquots of the equilibrated solution were counted by a conventional single channel scintilation counter. The window width was set to count only the photopeak at 279 kev.

Solvents were treated to remove traces of peroxides. If peroxides were not removed a black coating formed on the mercury.

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) 2,2-Dimethylbutane. Research grade obtained from Phillips; used without further purification.

ESTIMATED ERROR:

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

REFERENCES:

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) 2,3-Dimethylbutane; C_6H_{14}; [79-29-8]

ORIGINAL MEASUREMENTS:

Kuntz, R. R.; Mains, G. J.

J. Phys. Chem. 1964, *68*, 408 - 10.

VARIABLES:

T/K = 298.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
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}
25	298.15	6.0	7.9	9.1

[a] Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Spectrophotometric method. It was assumed that the optical density at 2560 A is a reliable measure of the solubility. It was further assumed that the extinction coefficient of mercury was the same in all hydrocarbon solvents. The optical density of a saturated solution of Hg in hexane was measured and, when combined with the solubility measured by Moser and Voigt (ref. 1), gives an extinction coefficient ε_{2560} = 7.35 x 10^3 dm^3 mol^{-1} cm^{-1} at 25°C. The value was used to calculate the solubility in the other solvents.

The Hg and solvent were equilibrated for 20 minutes and the optical density was measured by a Beckman DU Spectrophotometer.

The reliability of the results depends on the Moser and Voigt solubility value in hexane.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. No information given.

(2) 2,3-Dimethylbutane. Phillips "pure grade" hydrocarbon solvents; purified by passage through silica gel until optically pure, degassed and distilled.

ESTIMATED ERROR:

REFERENCES:

1. Moser, H. C.; Voigt, A. F. USAEC Report 1957, ISC-892.

COMPONENTS:

(1) Mercury-203; ^{203}Hg; [13982-78-0]

(2) Heptane; C_7H_{16}; [142-82-5]

ORIGINAL MEASUREMENTS:

Spencer, J. N.; Voigt, A. F.
J. Phys. Chem. 1968, *72*, 464 - 470.

Spencer, J. N.
Dissertation, Iowa State University, 1967.

VARIABLES:

T/K = 273.15 - 308.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
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	1.4 $\pm$ .1	2.0	2.0
15	288.15	3.7 $\pm$ .1	5.4	5.4
20	293.15	4.8 $\pm$ .1	7.0	7.0
25	298.15	6.6 $\pm$ .2	9.7	9.7
30	303.15	8.5 $\pm$ .4	12.6	12.6
35	308.15	10.9 $\pm$ .8	16.3	16.2

^{a}Calculated by compilers.

The authors smoothed their data according to the equation:

$$\log x_1 = (17.462 \pm .301)\log(T/\mathrm{K}) - 49.234$$

for the 273.15 to 308.15 temperature interval.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A radioactive tracer method using mercury-203 was used.

The mercury and solvent were shaken continuously for 24 hours in 25 ml glass stoppered volumetric flasks in a thermostat. Aliquots of the equilibrated solution were counted by a conventional single channel scintilation counter. The window width was set to count only the photopeak at 279 kev.

Solvents were treated to remove traces of peroxides. If peroxides were not removed a black coating formed on the mercury.

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) Heptane. Research grade obtained from Phillips; used without further purification.

ESTIMATED ERROR:

δT/K = $\pm$0.1; See random error reported by authors with concentration values above.

REFERENCES:

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Heptane; C_7H_{16}; [142-82-5]

ORIGINAL MEASUREMENTS:

Okouchi, S.; Sasaki, S.

Bull. Chem. Soc. Jpn. <u>1981</u>, *54*, 2513 - 4.
Report of the College of Engineering of Hosei University <u>1983</u>, (No. 22), 55 - 106.

VARIABLES:

T/K = 278.15 - 313.15

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
t/°C	T/K^a	Concentration^a $10^6 c_1$/mol dm^{-3}	Mole Fraction $10^7 x_1$	Molality^a $10^6 m_1$/mol kg^{-1}
5	278.15	2.0	2.9	2.9
10	283.15	2.6	3.7	3.7
20	293.15	4.8	7.1	7.1
25	298.15	6.5	9.6	9.6
30	303.15	8.1	12	12
40	313.15	15	22	22

^{a}Calculated by compilers.

Dr. S. Okouchi kindly provided the experimental mole fraction solubility values which did not appear in the original papers.

The authors fitted the data to two equations. The second is preferred.

$$\log x_1 = (17.250)\log(T/K) - 48.705$$
$$\log x_1 = 1.3461 - 2195.1/(T/K)$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility experiments were conducted by shaking the solvent with a drop of mercury for 24 hours in a thermostat. Separate experiments showed the mercury concentration remained constant after 24 hours of shaking.

A 0.5 cm³ sample of the equilibrated solution was analyzed by the cold-vapor atomic absorption method. Steps in the procedure included tin(II) chloride reduction, nitrogen bubbling and passage through magnesium perchlorate to dry the Hg vapor.

The mercury was determined from the area under the atomic absorption peak at 253.7 nm compared to a calibration curve.

In experiments with water, phosphinic acid (0.001 mol) was added to prevent mercury oxidation. Water-hydrocarbon distribution constants of Hg were also directly determined.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. Purified as did Glew and Hames (ref. 1).

(2) Heptane. Analytical reagent grade. Passed through activated alumina and distilled.

ESTIMATED ERROR:

$\delta T/K = \pm 0.1$
$\delta x_1/x_1 = \pm(0.03 - 0.05)$ (compilers)

REFERENCES:

1. Glew, D. N.; Hames, D. A. *Can. J. Chem.* <u>1971</u>, *49*, 3114.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6];
Mercury-203; ^{203}Hg; [13982-78-0]

(2) Octane; C_8H_{18}; [111-65-9]

ORIGINAL MEASUREMENTS:

Spencer, J. N.; Voigt, A. F.
J. Phys. Chem. 1968, *72*, 464 - 470.

Spencer, J. N.
Dissertation, Iowa State University, 1967.

VARIABLES:

T/K = 273.15 - 313.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
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	1.6 ± .1	2.5	2.2
15	288.15	3.8 ± .1	6.1	5.4
25	298.15	6.7 ± .1	10.9	9.5
30	303.15	8.7 ± .3	14.2	12.4
35	308.15	10.8 ± .3	17.8	15.5
40	313.15	12.6 ± 1.0	20.8	18.2

^{a}Calculated by compilers.

The authors smoothed their data according to the equation:

$$\log x_1 = (16.583 \pm .228)\log(T/K) - 47.003$$

for the 273.15 to 313.15 temperature interval.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A radioactive tracer method using mercury-203 was used.

The mercury and solvent were shaken continuously for 24 hours in 25 ml glass stoppered volumetric flasks in a thermostat. Aliquots of the equilibrated solution were counted by a conventional single channel scintilation counter. The window width was set to count only the photopeak at 279 kev.

Solvents were treated to remove traces of peroxides. If peroxides were not removed a black coating formed on the mercury.

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) Octane. Research grade obtained from Phillips; used without further purification.

ESTIMATED ERROR:

δT/K = ±0.1; See random error reported by authors with concentration values above.

REFERENCES:

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Octane; C_8H_{18}; [111-65-9]

ORIGINAL MEASUREMENTS:

Vogel, A.; Gjaldbaek, J. Chr.

Arch. Pharm. Chem. Sci. Ed.
1974, *2*, 25 - 9.

VARIABLES:

T/K = 298.15

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility			
t/°C	T/K^a	No. of Exps.	Concentration $10^6 c_1$/mol dm^{-3}	Mole Fraction^a $10^7 x_1$	Molality^a $10^6 m_1$/mol kg^{-1}
25	298.15	6	6.7 ± .5	11	9.6

^{a}Calculated by compilers.

The error is the standard deviation of an individual measurement.

ADDITIONAL COMMENTS:

The authors state that they found the same solubility after shaking mercury + solvent for 48 hours as for shaking times of up to one month.

The authors also found the same solubility within experimental error when the solvent was saturated with oxygen and with nitrogen.

The authors took special care to see that the glassware surface of the sampling pipet was equilibrated with the saturated solution of mercury. Special care was taken to see that colloidal mercury did not form in the solution.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The mercury was analyzed by cold vapor atomic absorption spectroscopy (ref. 1).

The solvent was saturated with Hg in a special glass container in which a few grams of mercury was kept in a cellulose extraction thimble. The container was shaken at least 48 hours at 25°C.

A 10.00 cm^3 sample of the saturated solution was taken. It was treated to convert the Hg to Hg^{2+} and extracted into an aqueous phase.

An aliquot of the aqueous phase was diluted, treated with tin(II) chloride to reduce the mercury, and the solution analyzed by cold vapor atomic absorption spectroscopy. The apparatus allowed measurements down to one part per billion of Hg.

Similtaneous measurements were made under the same conditions of samples containing a known amount of mercury.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. Source not given, purified by distillation.

(2) Octane. British Drug House; spectroscopic quality, used without further purification.

ESTIMATED ERROR:

$\delta c_1/c_1 = \pm 0.07$
See standard deviation above.

REFERENCES:

1. Hatch, W. R.; Ott, W. L. *Anal. Chem.* 1968, *10*, 2085.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Octane; C_8H_{18}; [111-65-9]

ORIGINAL MEASUREMENTS:

Okouchi, S.; Sasaki, S.

Bull. Chem. Soc. Jpn. 1981, *54*, 2513 - 4.
Report of the College of Engineering of Hosei University 1983, (No. 22), 55 - 106.

VARIABLES:

T/K = 278.15 - 313.15

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
t/°C	T/K[a]	Concentration[a] $10^6 c_1$/mol dm^{-3}	Mole Fraction $10^7 x_1$	Molality[a] $10^6 m_1$/mol kg^{-1}
5	278.15	2.1	3.3	2.9
10	283.15	2.9	4.7	4.1
20	293.15	4.9	7.9	6.9
25	298.15	6.7	11	9.6
30	303.15	8.5	14	12
40	313.15	14	23	20

[a] Calculated by compilers.

Dr. S. Okouchi kindly provided the experimental mole fraction solubility values which did not appear in the original papers.

The authors fitted the data to two equations. The second is preferred.

$$\log x_1 = (16.500)\log(T/\mathrm{K}) - 46.800$$
$$\log x_1 = 1.1542 - 2122.0/(T/\mathrm{K})$$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility experiments were conducted by shaking the solvent with a drop of mercury for 24 hours in a thermostat. Separate experiments showed the mercury concentration remained constant after 24 hours of shaking.

A 0.5 cm³ sample of the equilibrated solution was analyzed by the cold-vapor atomic absorption method. Steps in the procedure included tin(II) chloride reduction, nitrogen bubbling and passage through magnesium perchlorate to dry the Hg vapor.

The mercury was determined from the area under the atomic absorption peak at 253.7 nm compared to a calibration curve.

In experiments with water, phosphinic acid (0.001 mol) was added to prevent mercury oxidation. Water-hydrocarbon distribution constants of Hg were also directly determined.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. Purified as did Glew and Hames (ref. 1).

(2) Octane. Analytical reagent grade. Passed through activated alumina and distilled.

ESTIMATED ERROR:

δT/K = ±0.1
$\delta x_1/x_1$ = ±(0.03 - 0.05) (compilers)

REFERENCES:

1. Glew, D. N.; Hames, D. A. *Can. J. Chem.* 1971, *49*, 3114.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6];
Mercury-203; ^{203}Hg; [13982-78-0]

(2) 2,2,4-Trimethylpentane or *Iso*octane; C_8H_{18}; [540-84-1]

ORIGINAL MEASUREMENTS:

Klehr, E. H.; Voigt, A. F.

Radioisotopes Phys. Sci. Ind., Proc. Conf. Use, Copenhagen 1960, *1*, 517 - 29 (Pub. 1962).

VARIABLES:

T/K = 298.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
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}
25	298.15	4.6 ± .1	7.6	6.7

^{a}Calculated by compilers.

The value above is from the direct measurement technique. The indirect measurement result is 4.7 x 10^{-6} mol dm^{-3} at 25°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Direct Method. A globule of mercury containing 203-Hg was placed in 50 ml of solvent in a 100 ml flask and agitated in a thermostated bath. Samples were taken until the solution appeared to be at equilibruim. Analysis were made by GM-counting by one of two techniques:

(i) Solid precipitate counting. The Hg in a 0.5 ml aliquote was exchanged and reprecipitated on a stainless steel panchet as the sulfide was dried and counted. Details in Moser an Voigt (ref. 1).

(ii) Liquid aliquote scintillation-counting. A 0.5 ml aliquote of the saturated solution was diluted and transferred to the counting tube with a known volume of benzene.

The 0.28 MeV gamma radiation was counted. Error due to radiation adsorbed by the benzene and water was shown to be less than one percent.

Indirect Method. The distribution coefficient between solvent and water was measured.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury and Mercury-203. Reduced from a mercury nitrate sample. Half-life is 47 days.

(2) *Iso*octane. Pure grade, used without futher repurification.

ESTIMATED ERROR:

See random error reported by authors with concentration values above.

REFERENCES:

1. Moser, H. C.; Voigt, A. F. *Radiochemical Studies of Mercury and its Ions in Dilute Solutions* US AEC Report ISC-892, March 1957.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6];
Mercury-203; ^{203}Hg; [13982-78-0]

(2) 2,2,4-Trimethylpentane or
*Iso*octane; C_8H_{18}; [540-84-1]

ORIGINAL MEASUREMENTS:

Spencer, J. N.; Voigt, A. F.
J. Phys. Chem. 1968, *72*, 464 - 470.

Spencer, J. N.
Dissertation, Iowa State University, 1967.

VARIABLES:

T/K = 273.15 - 308.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
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	1.0 ± .1	1.6	1.4
13.5	286.65	2.1 ± .1	3.4	3.0
15	288.15	2.2 ± .1	3.6	3.2
20	293.15	3.3 ± .1	5.4	4.8
25	298.15	4.2 ± .2	7.0	6.1
30	303.15	5.3 ± .1	8.9	7.8
35	308.15	6.6 ± .3	11.1	9.7

^{a}Calculated by compilers.

The authors smoothed their data according to the equation:

$$\log x_1 = (16.583 \pm .228)\log(T/K) - 47.003$$

for the 273.15 to 308.15 temperature interval.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A radioactive tracer method using mercury-203 was used.

The mercury and solvent were shaken continuously for 24 hours in 25 ml glass stoppered volumetric flasks in a thermostat. Aliquots of the equilibrated solution were counted by a conventional single channel scintilation counter. The window width was set to count only the photopeak at 279 kev.

Solvents were treated to remove traces of peroxides. If peroxides were not removed a black coating formed on the mercury.

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*octane. Research grade obtained from Phillips; used without further purification.

ESTIMATED ERROR:

δT/K = ±0.1; See random error reported by authors with molar solubility values above.

REFERENCES:

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) 2,2,4-Trimethylpentane or *Iso*octane; C_8H_{18}; [540-84-1]

ORIGINAL MEASUREMENTS:

Vogel, A.; Gjaldbaek, J. Chr.

Arch. Pharm. Chem. Sci. Ed. 1974, *2*, 25 - 9.

VARIABLES:

$T/K = 298.15$

PREPARED BY:

H. L. Clever
M. Iwamoto

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility			
$t/°C$	T/K^a	No. of Exps.	Concentration $10^6 c_1$/mol dm^{-3}	Mole Fraction^a $10^7 x_1$	Molality^a $10^6 m_1$/mol kg^{-1}
25	298.15	27	4.1 ± .25	6.8	6.0

^{a}Calculated by compilers.

The error is the standard deviation of an individual measurement.

ADDITIONAL COMMENTS:

The authors state that they found the same solubility after shaking mercury + solvent for 48 hours as for shaking times of up to one month.

The authors also found the same solubility within experimental error when the solvent was saturated with oxygen and with nitrogen.

The authors took special care to see that the glassware surface of the sampling pipet was equilibrated with the saturated solution of mercury. Special care was taken to see that colloidal mercury did not form in the solution.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The mercury was analyzed by cold vapor atomic absorption spectroscopy (ref. 1).

The solvent was saturated with Hg in a special glass container in which a few grams of mercury was kept in a cellulose extraction thimble. The container was shaken at least 48 hours at 25°C.

A 10.00 cm^3 sample of the saturated solution was taken. It was treated to convert the Hg to Hg^2 and extracted into an aqueous phase.

An aliquot of the aqueous phase was diluted, treated with tin(II) chloride to reduce the mercury, and the solution analyzed by cold vapor atomic absorption spectroscopy. The apparatus allowed measurements down to one part per billion of Hg.

Similtaneous measurements were made under the same conditions of samples containing a known amount of mercury.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. Source not given, purified by distillation.

(2) *Iso*octane. British Drug House; spectroscopic quality, used without further purification.

ESTIMATED ERROR:

$\delta c_1/c_1 = \pm 0.07$
See standard deviation above.

REFERENCES:

1. Hatch, W. R.; Ott, W. L.
Anal. Chem. 1968, *10*, 2085.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6];
Mercury-203; ^{203}Hg; [13982-78-0]

(2) Decane; $C_{10}H_{22}$; [124-18-5]

ORIGINAL MEASUREMENTS:

Klehr, E. H.; Voigt, A. F.

Radioisotopes Phys. Sci. Ind., Proc. Conf. Use, Copenhagen 1960, *1*, 517 - 29 (Pub. 1962).

VARIABLES:

T/K = 273.15 - 318.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
t/°C	T/K^a	Concentration 10^6c_1/mol dm^{-3}	Mole Fraction^a 10^7x_1	Molality^a 10^6m_1/mol kg^{-1}
0	273.15	2.1 ± .1	4.0	2.8
10	283.15	3.0 ± .1	5.8	4.1
15	288.15	4.5 ± .1	8.7	6.1
20	293.15	4.9 ± .1	9.6	6.7
25	298.15	7.0 ± .1	13.7	9.6
30	303.15	8.6 ± .1	16.9	11.9
35	308.15	9.6 ± .1	19.0	13.4
45	318.15	13.3 ± .1	26.6	18.7

^{a}Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Direct Method. A globule of mercury containing 203-Hg was placed in 50 ml of solvent in a 100 ml flask and agitated in a thermostated bath. Samples were taken until the solution appeared to be at equilibruim. Analysis were made by GM-counting by one of two techniques:

(i) Solid precipitate counting. The Hg in a 0.5 ml aliquote was exchanged and reprecipitated on a stainless steel panchet as the sulfide was dried and counted. Details in Moser an Voigt (ref. 1).

(ii) Liquid aliquote scintillation-counting. A 0.5 ml aliquote of the saturated solution was diluted and transferred to the counting tube with a known volume of benzene.

The 0.28 MeV gamma radiation was counted. Error due to radiation adsorbed by the benzene and water was shown to be less than one percent.

Indirect Method. The distribution coefficient between solvent and water was measured.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury and Mercury-203. Reduced from a mercury nitrate sample. Half-life is 47 days.

(2) Decane. Pure grade, used without futher repurification.

ESTIMATED ERROR:

See random error reported by authors with concentration values above.

REFERENCES:

1. Moser, H. C.; Voigt, A. F. *Radiochemical Studies of Mercury and its Ions in Dilute Solutions* US AEC Report ISC-892, March 1957.

COMPONENTS:

(1) Mercury; Hg; [7439-97-6]

(2) Decane; $C_{10}H_{22}$; [124-18-5]

ORIGINAL MEASUREMENTS:

Kuntz, R. R.; Mains, G. J.

J. Phys. Chem. <u>1964</u>, *68*, 408 - 10.

VARIABLES:

T/K = 298.15

PREPARED BY:

S. H. Johnson
M. Iwamoto
H. L. Clever

EXPERIMENTAL VALUES:

Temperature		Mercury Solubility		
t/°C	T/K[a]	Concentration $10^6 c_1$/mol dm^{-3}	Mole Fraction[a] $10^6 x_1$	Molality[a] $10^6 m_1$/mol kg^{-1}
25	298.15	5.5	1.1	7.6

[a] Calculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Spectrophotometric method. It was assumed that the optical density at 2560 A is a reliable measure of the solubility. It was further assumed that the extinction coefficient of mercury was the same in all hydrocarbon solvents. The optical density of a saturated solution of Hg in hexane was measured and, when combined with the solubility measured by Moser and Voigt (ref. 1), gives an extinction coefficient $\varepsilon_{2560} = 7.35 \times 10^3$ dm^3 mol^{-1} cm^{-1} at 25°C. The value was used to calculate the solubility in the other solvents.

The Hg and solvent were equilibrated for 20 minutes and the optical density was measured by a Beckman DU Spectrophotometer.

The reliability of the results depends on the Moser and Voigt solubility value in hexane.

SOURCE AND PURITY OF MATERIALS:

(1) Mercury. No information given.

(2) Decane. Phillips "pure grade" hydrocarbon solvents; purified by passage through silica gel until optically pure, degassed and distilled.

ESTIMATED ERROR:

REFERENCES:

1. Moser, H. C.; Voigt, A. F. USAEC Report <u>1957</u>, ISC-892.