Thermotransport of Cobalt in Liquid Silver*

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In a thermotransport experiment where a column of liquid binary alloy is held in a temperature gradient, migration of solute either to the hotter region or to the colder region is often observed. If the alloy is held in the temperature gradient until the stationary state is reached, the resulting segregation is related to the temperature gradient (in the absence of convection) through a quantity called the heat of transport, denoted by Q^* . The meaning of Q^* is explained in an earlier paper⁽¹⁾ (referred to as Paper I). The heat of transport is of considerable theoretical interest.

In the case of a very dilute liquid binary alloy in the form of a narrow capillary, the heat of transport may be obtained from the expression⁽¹⁾

$$\text{grad} (\ln C) = \frac{Q^*}{R} \text{grad} \left(\frac{1}{T} \right) \quad (1)$$

where C, T = concentration of solute and temperature respectively

along the length of the capillary

R = gas constant

The results for a study of thermotransport of the solutes Au, Sb and S in liquid silver were reported in Paper I. It was found that the values of the heats of transport Q^* so obtained for gold, antimony and sulfur were

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+ 1690, - 6770 and - 29,000 cal/gm-atom respectively. In this study results for thermotransport of a transition metal, cobalt, are presented.

The experimental technique employed in this study was the same as described in Paper I. The experimental results are summarized in Table I. Fig. 1 shows the plot of the logarithm of the relative concentration of cobalt versus reciprocal temperature for one experiment and the heat of transport obtained from the data is

$$(Q^*)_{Co} = -8,400 \pm 720 \text{ cal/gm-atom} \quad (2)$$

According to one approach the heat of transport may be considered to consist of two different contributions.

$$Q^* = Q_e^* + Q_i^* \quad (3)$$

Table I

Expt. No.	Capillary diameter (mm)	Temperature difference between hot and cold ends (°C)	Heat of Transport Q^* (cal/gm-atom)	Standard error %	Average heat of transport (cal/gm-atom)
1	0.75	100	-8,240	7.23	
2	1.00	100	-9,610	7.43	
3	1.00	125	-7,800	3.67	-8,400 ± 720
4	0.80	100	-7,940	2.76	

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This expression is valid for dilute binary mixtures only, and can be employed if the ions in liquid metals are considered to behave like the atoms in a gas. (The details of this model may be found in the ref. 5.) The constant K is estimated empirically by fitting the experimental results of thermotransport in isotopic liquid mixtures of different metals, ⁽⁵⁾ and its average value is found to be 2.2. Assuming a valence of two for cobalt in liquid silver, one obtains

$$Q_i^* = -2,370 \text{ cal/gm-atom} \quad (5)$$

By difference, $Q_e^* = -6,030 \text{ cal/gm-atom}$ for cobalt which is comparable to that for antimony in liquid silver. ⁽¹⁾

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