Vapor Pressure of Liquid Metal Solutions: Mercury–Tin

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Experimental measurements of bubble point temperature of a stirred liquid mixture under helium atmosphere at a controlled pressure were made to obtain vapor pressures of binary liquid solutions of mercury and tin. Thermodynamic functions such as liquid-phase activity coefficients and heat of vaporization were calculated and presented.

WITH THE ADVENT of nuclear reactors and high temperature technology, liquid metals have found an increasing number of applications. Also, they represent a unique class of relatively simple solutions of atoms and their agglomerates. Therefore, a study of their vapor pressures and related thermodynamic properties is of interest from both theoretical and practical grounds.

Behavior of metal solutions may be studied by measuring electric potentials between the liquid metal solution of interest and a reference electrode or by measuring vapor pressure of solutions. Usual methods of measuring vapor pressure require an elaborate set-up and are time-consuming. The present work used a simple apparatus (*1*) and shortened the experimentation time (*4*). A slight decrease of precision is therefore expected. Maximum errors in measured temperature and pressure here are respectively 0.5° C. and 2 mm. of Hg. These errors are caused mainly by pressure fluctuations of solution in the neighborhood of its bubble point.

The binary system studied in this work consists of a volatile component (mercury) and a relatively non-volatile component (tin). Vapor pressure data of this system at 324° C. are available (*2*) but that at other temperatures are not. This work presents experimental data at temperatures below 324° C. and shows temperature effect on solution behvavior or deviation from ideality.

EXPERIMENTAL

Materials. Mercury (F.W. Berk and Co.) was triple distilled and had the following maximum impurities:

non-volatile	0.001%
insoluble in HNO_3	0.000
base metal	0.000

Tin (J.T. Baker Chemical Co.) had the following maximum impurities:

As	0.000005%
Cu	0.0005
Fe	0.0005
Pb	0.001
Zn	0.0005

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Equipment. The equilibrium still in Figure 1 is made of 304 stainless steel and contains a thermocouple well and a stainless steel stirring rod which is not shown in Figure 1. The lower end of this rod was bent to a hoop shape to stir liquid and the upper end was welded to a stainless steel tube which contains a soft iron core and is inside the glass adapter. A solenoid slipped on the glass adapter causes the mixing rod to oscillate vertically within a distance less than 1 cm. and thus to agitate liquid. The lower part of the still, about four inches, was heated by an electric furnace.

The use of a magnetic stirrer diminishes liquid phase temperature gradient from about 1° C./mm. (without stirring) to less than 0.1° C./mm. as measured by thermocouple travel. This is essential for an accurate measure-

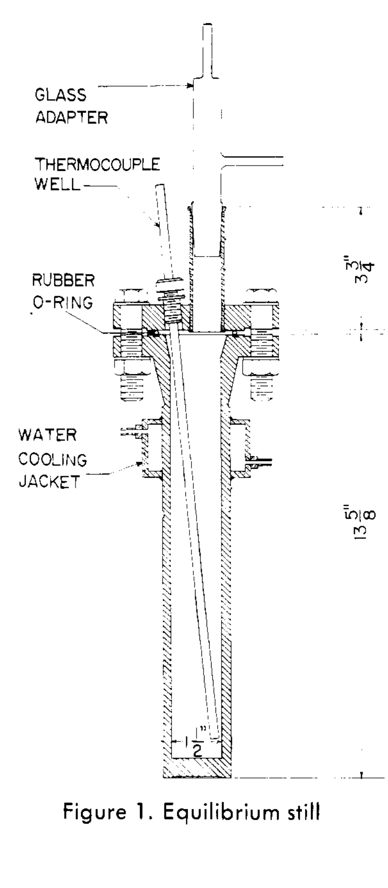

Figure 1. Equilibrium still