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ACTIVITIES IN LIQUID AND SOLID METAL SYSTEMS

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Three experimental studies have been completed in 1957 on this program. Technical papers treating the results are now being prepared. In the near future, they will be circulated according to A. E. C. instructions and then they will be submitted for approval for publication in the open literature. Brief summaries of the results of this work and another study are included below. The name of the graduate student associated with each is indicated.

A. Activities in the Mn-Pb-Bi System (Mn. Hal Harman)

The activity of manganese in the liquid region and the liquid-solid region in the boundary binaries and in the ternary field of the Mn-Pb-Bi system has been measured with the following cell:

This cell has functioned quite satisfactorily in the temperature range of 660 to 950°C. Potentials are reasonably steady and reproducible. Manganese is found to have a slightly positive departure from ideal behavior in the Mn-Pb system and a slightly negative departure in the Mn-Bi system. A systematic change in behavior was observed in the ternary field in passing from one side to the other.

From these data, the molar and partial molar entropies, free energies, and heats of mixing for the three components are being calculated for 900°C. Activities for the components are also available.

The data also indicate the location of the liquidus surface for saturation of the Mn-Pb-Bi melt with solid manganese ($a_{\text{Mn}} = 1$) over the temperature interval of 700 - 950°C.

B. The Solubility of Iron-Nickel Alloys in Liquid Lead
(700 - 1300°C). (Mr. Bertram Fleischer)

Strips of iron, nickel and iron-nickel alloys were placed in liquid lead to determine the equilibrium solubility of these solid metals in lead over a considerable temperature range. Preliminary thought and also a mathematical analysis by C. Wagner permitted the calculation of a theoretical estimated time for reaching 99 percent of saturation. Even with the very favorable condition of a high ratio of surface area of solid to liquid metal volume, the theory indicated that the time to reach equilibrium may be very long for the binary Fe-Ni alloys. The reason for this is that the diffusion of nickel through the iron lattice is very slow. It was assumed that the lead preferentially leaches nickel from the surface and the diffusion of nickel from the body of the strip to replenish the surface layer is the slow step.

In actual experiments, the approach to equilibrium from the high-side (Ni doped Pb) was actually very slow in accordance with the theory. The approach to equilibrium from the low side was relatively rapid because of intergranular and non-planar attack of the metal strip by the liquid lead.

The liquidus surface showing the solubility of iron-nickel alloys in lead has been determined from 700 to 1100°C. The results for the nickel content are reasonably good, but those for iron are somewhat discordant because of analytical problems. It is probable that the calculated values based on the Fe-Pb system are more satisfactory than are the experimental results.

The data permit the calculation of the activity curve for nickel in the iron-nickel system at 1100°C. For this, it is necessary to assume that nickel obeys Henry's law in the liquid lead. The activity curve for iron is obtained by the Duhem integration. While the activity curves must be considered only semi-quantitative, they show a rather strong negative departure from Raoultian behavior for nickel ($\gamma_{Ni} = 0.35$ up to $X_{Ni} = 0.5$). Iron is almost ideal down to $X_{Fe} = 0.5$ and then shows a rather pronounced negative behavior also.

C. Phase Distribution in the Fe-Ni-Pb and Fe-Ni-Pb-C (Sat.) Systems (1350 to 1550°C) (Mr. Kenneth Miller)

Experimental work on these two systems is currently just being completed. The experimental procedure is to equilibrate a liquid layer high in nickel and iron with a layer high in lead. The two layers are then sampled for chemical analysis. The ternary melts are held in alumina crucibles, and the carbon saturated melts are contained in graphite crucibles. Difficulties with available methods for iron analysis have handicapped the work inspite of great care by the analytical chemists.

The phase boundaries appear to be reasonably well established by the results except for the monotectic point for the lead-nickel side of the Fe-Ni-Pb ternary system. The data will be collated and reported following the resolution of this problem.

D. Activities in The Al-Ag-Pb System

It appears that a reproducible and reversible electrode

potential cell can be obtained in this system between 660 and 900°C. There are currently inconsistencies in the data which preclude commenting on the results at this time. The inconsistencies apparently result from the contact between the leads and the aluminum electrode. Further work is necessary to resolve this problem.

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