MONSANTO RESEARCH CORPORATION

MOUND LABORATORY — MIAMISBURG, OHIO

U. S. GOVERNMENT CONTRACT NO. AT-33-1-GEN-53

August 19, 1963

UNDERHILL 6-8811

Mr. W. B. Creamer, Manager
Dayton Area Office
U. S. Atomic Energy Commission
Post Office Box 66
Miamisburg, Ohio

Dear Mr. Creamer:

Enclosed are three copies of the "Summary of the Division of Reactor Development Program at Mound Laboratory for July 1963."

Please arrange the transmittal of two copies to the Division of Reactor Development, Attention Mr. J. M. Simmons, Chief Fuels and Development Branch, U. S. Atomic Energy Commission, Washington 25, D. C.

Very truly yours,

David L. Scott
Vice President,
Plant Manager

DLS:la

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SUMMARY OF THE DIVISION OF REACTOR DEVELOPMENT PROGRAMS AT MOUND LABORATORY FOR JULY 1963

Submitted by: Dr. G. Richard Grove
Prepared by: Dr. L. J. Wittenberg

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MONSANTO RESEARCH CORPORATION

A SUBSIDIARY OF MONSANTO CHEMICAL COMPANY

MOUND LABORATORY

MIAMISBURG, OHIO

OPERATED FOR

UNITED STATES ATOMIC ENERGY COMMISSION

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The equilibrium liquidus temperatures of several molten plutonium alloys were measured during viscosity determinations in the oscillating cup viscosimeter. When the period of the oscillating cup viscosimeter was related to the temperature, the abrupt change in period of oscillation caused by the appearance of a solid precipitate made a precise measurement of the liquidus temperature possible. The liquidus temperatures of the plutonium-five atom per cent iron alloy at 549°C and of the plutonium-one atom per cent iron alloy at 628°C were determined by this method. A smooth curve is produced on the plutonium-iron phase diagram when a line is drawn through the liquidus points of the one and five atom per cent iron alloys from the melting point of plutonium (640°C) to the plutonium-9.5 atom per cent iron eutectic point (411°C). When the logarithms of the plutonium concentrations as a function of reciprocal liquidus temperatures were plotted, the molten plutonium-iron alloys constituted non-ideal solutions in this region of the phase diagram.

The study of the plutonium-cerium-nickel ternary system was continued by differential thermal analysis. These alloys ranged in composition from 20 to 30 atom per cent nickel and from 15 to 60 atom per cent plutonium. At the present time the liquidus data support the location of a valley extending from the binary eutectic at 87.5 atom per cent plutonium - 12.5 atom per cent nickel to the binary eutectic at 65 atom per cent cerium - 35 atom per cent nickel. The

valley is broad (about 5 atom per cent wide). Data below the liquidus temperatures indicate a phase transformation at 435°C in some compositions. This temperature may be the melting point of a ternary eutectic.

Samples in the plutonium-yttrium binary system were annealed at 635°C and 425°C and analyzed using the electron probe x-ray analyzer. The compositions of the yttrium solid solution were 18.5 and 19.0 atom per cent plutonium, respectively. These data indicate that the solid solubility increased with decreasing temperature in the solid phase. Since this phenomenon is unusual in phase systems, a third sample is being annealed at 300°C and will be analyzed to further investigate this trend.

The effects of small quantities of impurities in the plutonium-gallium binary system are being determined by differential thermal analysis. The individual additions of 0.1 atom per cent iron, nickel, cobalt, silicon and aluminum have been investigated. The presence of iron and cobalt caused a small phase transformation at 405°C which was not present in the plutonium-gallium alloy. The only effect caused by the presence of the aluminum was a five-degree increase in the melting point of the alloy. Nickel and silicon at this concentration had no apparent effect. The quaternary alloy containing 0.05 atom per cent of iron and nickel showed the same small transformation as with the iron but at a lower temperature, 395°C.

A study has been initiated to determine the effect upon the microstructure of alloy powders which are spheroidized in the plasma torch. A 50 atom per cent plutonium-50 atom per cent yttrium alloy subjected to the treatment produced unusually shaped particles. The microstructure of these particles showed an extremely fine grain size. The crystal structure of this material is being determined by x-ray diffraction analysis.

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Development Program — August 19, 1963

The effect of the addition of five atom per cent (1.25 weight per cent) iron upon the viscosity of molten plutonium has been determined. In the temperature range measured from 550° to 850°C, the presence of the iron caused a 25 per cent increase in the viscosity. This large effect caused by a relatively small amount of iron is unusual.

The stage for the electron microprobe x-ray analyzer has been modified so that larger specimens can be accepted for analysis. This modification will make the instrument more useful since a greater variety of specimens can be accepted.

The article, "Plutonium-Bearing Glass for Nuclear Applications", by L. V. Jones, K. D. Phipps, P. A. Tucker and L. J. Wittenberg has been accepted for publication in the BULLETIN OF THE AMERICAN CERAMIC SOCIETY.