Platinum-lined Furnace for the Fluorination of Uranium Compounds

FEATURES OF DESIGN AND CONSTRUCTION

The high temperature stability of platinum and its immunity from attack by hydrogen fluoride gas even at 1000°C have led to its being specified to form the liner material for a furnace recently designed and constructed for use in the fluorination of uranium compounds at the Harwell research establishment of the United Kingdom Atomic Energy Authority. The design, testing, and operation of the furnace are described in report AERE–R4297 by D. N. Fletcher and L. J. White of the Scientific Services Department of the Engineering Division at Harwell.

The high level of radio-activity exhibited by uranium compounds, and eventually by the equipment, necessitated that the furnace should be so designed that all operations could be conducted inside a glove box, yet easy access to the furnace chamber and element housings had still to be retained.

The basic design specification called for a furnace capable of producing a chamber temperature of 1000°C and able to operate at a working pressure of 1 p.s.i. (gauge). A furnace liner was demanded that would be unaffected by hydrogen fluoride gas at 1000°C, would protect the charge from contamination by preventing the formation of corrosion products inside the furnace chamber and would itself be unaffected by contact with uranium compounds. The furnace chamber was required to be approximately $8 \times 8 \times 2$ inches, to accommodate existing platinum trays which were to bear the charges, and there was to be no water cooling of the joint between the lid of the furnace and the chamber in order to avoid any hazard that might arise if water were to come into contact with the charges.

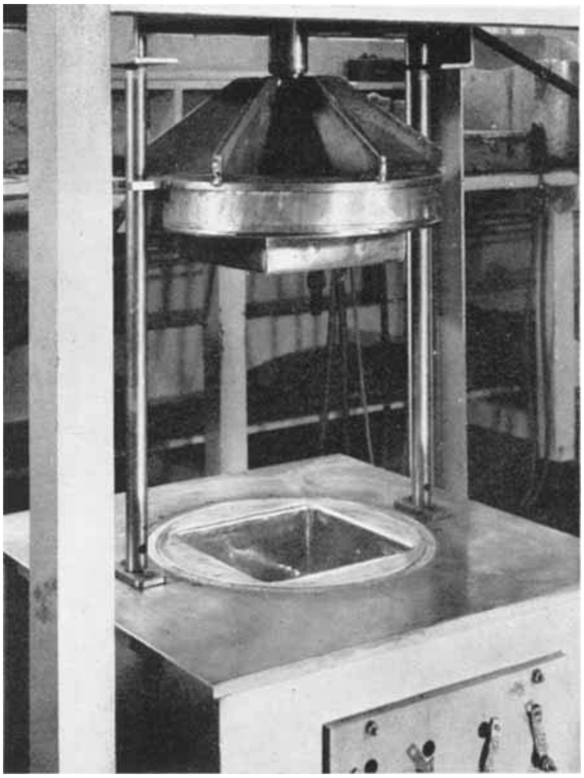
The furnace liner requirements were found to be ideally fulfilled by the use of platinum in the form of 0.010 inch thick sheet, and the furnace chamber, the purge outlet and inlet tubes and the chamber lid are sheathed with the metal.

As pure platinum surfaces readily weld to each other at high temperatures, a $\frac{1}{4}$-inch gap was left between the lid and the sides of the furnace chamber after lining. A water cooled joint ring between the lid and the furnace chamber was not permissible and after many tests a gasket of $\frac{1}{16}$-inch thick white asbestos millboard was used to prevent the platinum surfaces from coming into contact and to provide an effective seal. To avoid the platinum trays from sticking to the chamber lining a separator grid of a rhodium-platinum alloy was placed on the floor of the furnace.

Temperature control is effected by the use of three platinum: rhodium-platinum thermocouples, one sealed into the purge inlet tube and protruding into the furnace chamber, the second fitted into a pocket at the centre of the lid with its hot junction in contact with a flat-headed platinum rivet from the platinum-lining, and the third connected to one of the four silicon carbide heating elements.

In the furnace chamber, on the projecting box section of the lid and in the purge inlet and outlet tubes, the thin platinum liner is supported on $\frac{1}{8}$-inch thick Inconel, which was selected because of its good high temperature properties. At the development stage much investigation was carried out to enable precautions to be taken to prevent contamination of the platinum liner by its close contact with Inconel. When platinum is in contact

The furnace chamber and the box-section lid lined with platinum



at high temperatures with certain base metals, in this case principally chromium, contamination of the platinum can result from the diffusion of these elements into its surface, leading to embrittlement and subsequent failure. To avoid this risk, a barrier was placed in the path of the diffusing elements between the platinum liner and the Inconel support, this taking the form of a thin layer of a proprietary aluminium silicate fibre. This material, which can withstand temperatures in the region of 1000°C, has proved highly successful in protecting the platinum liner and also serves as a soft buffer layer between the metal surfaces.

Once this contamination problem and the difficulty of finding a suitable gasket material were overcome the construction of the furnace was completed. The furnace construction and assembly were carried out by R. M. Catterson-Smith Limited, the platinum lining being manufactured and fitted to the furnace by Johnson Matthey & Co Limited.

J. A. S.

Determination of Thermal Conductivity

PLATINUM AS A REFERENCE STANDARD

The growing demand for materials to operate at high temperatures has brought a need for accurate knowledge of the manner in which they conduct heat. Reliable figures for thermal conductivity are, however, notoriously difficult to determine, and standard reference materials would be invaluable for checking the reliability of testing equipment and as standards in comparative methods.

Platinum has many advantages as a standard for use at high temperatures, but the values previously determined by various authorities for thermal conductivity up to about 1000°C have shown significant differences. A careful redetermination at the National Physical Laboratory over the range 0° to 950°C has now been reported by R. W. Powell and R. P. Tye (*Brit. J. Appl. Phys.*, 1963, **14**, 662), who have for the first time used substantial bars of platinum for the measurements. Two sets of observations were made on bars having diameters of ¼ and ½ inch respectively; with both samples the conductivity was found to remain constant within 0.5 per cent of 0.73 w cm^{-1} deg C^{-1} over the whole range. This result is as much as 20 per cent lower than four out of the five previous determinations, but yields values of Lorenz function in much closer agreement with the theoretical.

J. C. C.