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Y-409

DIRECT REDUCTION OF
URANIUM HEXAFLUORIDE
TO METALLIC URANIUM

By

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Y-12 PLANT

CARBIDE AND CARBON CHEMICALS CORPORATION

OAK RIDGE, TENNESSEE

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Abstract

Exploratory tests are reported which indicate the feasibility of a one-step reduction process for the preparation of uranium metal from the hexafluoride by the action of calcium metal and iodine.

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Oak Ridge, Tennessee
the May 16, 1949

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TO METALLIC URANIUM

The reduction of uranium tetrafluoride by reaction with metallic calcium to produce metallic uranium and calcium fluoride has been known for some time, and accepted as standard procedure in the preparation of metallic uranium.

In case that it is desired to prepare uranium metal from uranium hexafluoride, as the raw material, the usual procedure is to first convert the uranium hexafluoride to uranium tetrafluoride by one of several established methods, followed by calcium reduction to metallic uranium.

The purpose of the experiments reported here was to explore the possibilities of a direct method of conversion from UF_6 to metallic uranium, by reduction with metallic calcium, thus eliminating the usual step of converting the UF_6 to UF_4 .

Two runs were carried out in which UF_6 was reacted with metallic calcium to form metallic uranium, the experiments being carried out in a similar method and equipment to that ordinarily used in the preparation of metallic uranium from UF_4 .

In the first run, 19 grams of UF_6 , sealed in a glass bulb, along with a considerable excess of reducing reactants, 30 grams of calcium and 3 grams of iodine were placed in an iron, cylindrical, bomb-type reactor, fitted with a ceramic liner of magnesia. The liner was covered with a magnesia lid and the space between the liner and bomb walls filled with sand. The bomb lid was then placed in position and securely fastened to the main body of the apparatus, using a copper gasket to make a tight seal. Next, the bomb was evacuated through a removable screw plug in the bomb lid,

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followed by the filling of the apparatus with argon gas, the process being repeated four times to insure exclusion of air from the system. The apparatus was again sealed, and heated by means of an induction furnace, the temperature being raised about 12 - 15°C per minute. At an estimated temperature of 700°C, the occurrence of a reaction was evidenced by a sudden rise in temperature. The bomb was then cooled to room temperature and opened for examination of the reaction products. Small pellets of metallic uranium of the order of 0.5 - 1 mm. diameter were found to be dispersed throughout the slag which was formed during the reaction, with the major portion of the product being located at the bottom of the melt.

A second experiment was carried out with 86 grams of UF_6 as charge material along with 107 grams of calcium and 13 grams of iodine. The apparatus used in this test was larger than that used in the first experiment, due to the volume required to satisfy the charge container and reactants, otherwise the two runs were carried out in like manner. In this case, reaction occurred at 330°C (bomb wall temperature), as evidenced by a rapid rise in temperature. After cooling the apparatus and contents, the bomb was opened and the contents removed. On examining the reaction products, a button of uranium, weighing approximately 42 grams, was found at the bottom of the melt, with other small pellets about 1 mm. or less in diameter dispersed throughout the melt, with a few pellets being located on the walls of the liner and the liner lid above the melt. It should be mentioned that in this run a sudden pressure development within the bomb was believed to have occurred, as the bomb jumped about one inch in an upward direction off of the base of the furnace when the reaction was initiated.

Evidence was found in each experiment to show that a slight

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