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For The Atomic Energy Commission

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The writers visited the FMPC on May 5, 1955 to present the ORNL results in the moving-bed production of UF_4 from UO_3 by simultaneous reduction-hydrofluorination with starch and HF , to assist in planning similar tests for the FMPC moving-bed pilot plant, and to arrange for further ORNL assistance in the program. Also, the promising results of ORNL tests in the moving-bed production of $ThCl_4$ from the oxalate with Cl_2 , CCl_4 , and starch were reviewed. Messrs. Arnold, Burkhardt, Davis, Manser, Sisson, and other NLO personnel participated in the discussions.

Since the ORNL tests have demonstrated that the production of metal-grade (over 97%) UF_4 can be sustained in the adiabatically-controlled 4-in.-dia. reactor, with starch as the reductant, the NLO people are planning a 15,000-lb test in the 15-in.-dia. FMPC moving-bed hydrofluorination reactor. The writers outlined the following criteria, based on the ORNL tests:

(A) Pelleting

- (1) Use 1 ± 0.05 lb of starch per 12 lbs UO_3 (88% of the stoichiometric amount of carbon to convert the available oxygen to CO).
- (2) Use finely-pulverized UO_3 and starch, in order to permit intimate mixing.
- (3) Dry-mix the starch and UO_3 thoroughly.
- (4) Add about 15% by weight of H_2O , mix, extrude, dry, mill, and screen. The addition of starch to the UO_3-H_2O mixture improves its extrudability and should make operation of the FMPC extruder feasible.
- (5) Use 1/4-in. or larger pellets in order to reduce the possibility of caking and to favor simultaneous endothermic and exothermic reactions.

(B) Moving-Bed Reactor Tests

- (1) Ideally, the hydrofluorination reactor (see Figure 1) should be modified to permit adiabatic control in order to confirm ORNL scale-up data. Since this cannot be accomplished without re-building the reactor, the unit should be insulated as thoroughly as possible, and the lower half should be heated externally to at least $600^\circ C$ to promote complete conversion to UF_4 .
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- (2) Provide for maximum uniformity of solids flow. Perforated plates are preferred; however, the tripod device now installed might give satisfactory bed support.
- (3) Provide for maximum uniformity of gas distribution across the bed at the bottom and at intermediate points up the reactor. Hollow, perforated plates are preferred. Otherwise, extend the existing nozzles to the center of or across the reactor, using perforated inserts. The existing HF distributor valves (1/2-in.) probably are too large to permit the flow control needed.
- (4) Provide HF gas at room temperature to cool the reactor at the intermediate injection points.
- (5) Supply HF at 600°C or higher to the bottom distributor. Forced heating at the lower part of the bed has been necessary to obtain complete conversion in the ORNL reactor.
- (6) Provide for the injection of HF at 200°C into the upper 10% of the reactor, as an aid in initiating the reaction. Preheating of the pellets should not be necessary, however.
- (7) Control the bed temperature gradient by the distribution and temperature of the HF, with the lower half of the bed held at 600°C or more. A high off-gas temperature (about 300°C) appears to be of benefit in reducing excess carbon deposition on the pellets.
- (8) Withdraw the solids continuously at a rate calculated to provide a 2- to 3-hr retention period in the reactor. Feed HF continuously at a rate calculated to be 10 to 25% in excess of the stoichiometric requirement.

The FMPC hydrofluorination reactor, as presently constructed, probably will not be capable of supplying the desired operating conditions for the test, and it is doubtful that ideal conditions can be obtained even after the contemplated modifications are made. However, improved operability and conversion efficiencies should result from the proposed techniques.

Arrangements were completed for two bomb-reduction tests with a 300-lb lot of UF_4 from the ORNL reactor. This material, averaging about 98% UF_4 , was shipped to FMPC on May 6, 1955. In the event that the carbon content of the

metal exceeds specifications, tests will be made in the ORNL reactor to reduce the carbon content of the UF_4 product. This carbon can be burned out at 500°C with oxygen (K-25 experience), or its inclusion in the UF_4 might be prevented by using a deficiency of starch and introducing a small amount of NH_3 with the HF to finish off the reduction.

It was agreed that a representative lot of the UO_3 -starch pellets that are to be prepared at FMPC would be shipped to ORNL and evaluated in the 4-in.-dia. reactor prior to the FMPC test. FMPC personnel will be present during the ORNL test. ORNL personnel will continue assistance in planning, carrying out, and evaluating the FMPC test.

W. K. Fister

J. E. Moore

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Figure 1
Proposed Operating
Conditions for
FMPC Moving-Bed
Reactor Test