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COMMENTS ON METAL REDUCTION

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- 2. [REDACTED]
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COMMENTS ON METAL REDUCTION

It has been reported that Y-12 is firing reduction charges by means of a chemical initiator. This technique has been reported in the literature. The following is quoted from "Uranium Production Technology", by Harrington and Ruehle of the Mallinckrodt Chemical Works:

"- - - - Under adiabatic conditions, the uranium and slag completely fuse even when the charge is ignited at 0°C if calcium is used as the reductant. - - - - However, with fractional kilogram quantities, heat losses upon firing become too great, and therefore the charges must be preheated.

"Open vessels are generally employed for large-scale calcium reductions. The reaction may be started electrically⁽¹⁾ by a magnesium ribbon burned in a suitable primer, such as a mixture of magnesium and sodium peroxide chips, or by dropping in an ignited pellet of potassium nitrate and lactose mixture.⁽²⁾ The reaction is self-sustaining and rapid. It is accompanied by an evolution of gas and small particles; therefore, it is conducted in a shielded firing chamber. The uranium is protected from oxidation, first by a blanket of calcium vapor in the early stage of the reduction, and later by molten calcium fluoride. When the reaction is complete, the products are allowed to cool under an argon atmosphere.

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COMMENTS ON METAL REDUCTION (Continued)

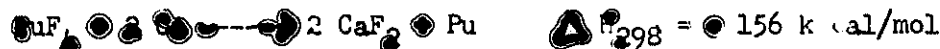
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Small-scale reductions are conducted in sealed bombs.

Residual air is first removed from the system by an inert gas purge. Then the bomb and its contents are heated at a predetermined rate until ignition takes place. Iodine may be added to the charge to increase the heat available during ignition and to yield a lower melting and more fluid slag. In fractional kilogram reductions, 0.15 mols I_2 per mol of uranium are sufficient to obtain good metal yields.

The pros and cons of chemical ignition vs temperature ignition

are discussed. Thermodynamics



indicate the reactions to be very similar, with somewhat higher heat evolution in the Pu reaction. This latter fact might result in a more critical effect from iodine added to the uranium reaction mixture.



Currently we are using 0.1 mol I_2 per mol of Pu. We have tested reduction with no I_2 added, Process Test 99-25-F. Ninety-six charges fired with no I_2 resulted in no significant difference in yield. The buttons were of good quality, with no difference in appearance from those of charges with I_2 . Although it was concluded that reduction without I_2 was satisfactory, operator opinion was that buttons with I_2 were removed from the slag and crucible more easily.

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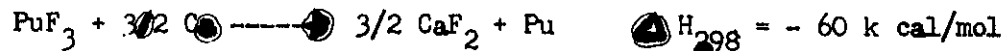
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COMMENTS ON METAL REDUCTION (Continued)

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SRP, using the reaction:



used 0.6 mols I_2 per mol Pu. More recently, the PuF_3 is being oxidized to $3/4 \text{PuF}_4 + 1/4 \text{PuO}_2$. SRP reports this mixture is being fired without I_2 , with yields of about 96 percent, and that the buttons are removed more easily than when I_2 is used. The above reaction with high PuO_2 is reasonable, since



(equivalent ΔH_{298} per mol of Pu in the mixture is 132 k cal), and the CaF_2 CaO eutectic occurs at 25 percent CaO at temperature of 3362°C for CaF_2 is 3386°C .

It has been reported that Rocky Flats uses no I_2 in their reduction charges, however, I have no first hand information. No data are available from other sites to allow comparison of quality of product rate. It has been reported, third hand, that average HAPO-shipped quality is high.

It is reasonable to conclude, since elimination of I_2 does not appear to have any advantage at HAPO, and since elimination of I_2 has been demonstrated should such advantage materialize, that the addition of chemical igniters is not advantageous and could result in lower quality due to the introduction of foreign material into the charge. It is possible that the use of a chemical igniter could result in shorter time cycle due to ignition at lower temperatures. Lower

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COMMENTS ON METAL REDUCTION (Continued)

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temperatures, however, should again result in buttons of lesser quality and lower yields. The heat evolved from the igniter may be sufficient to maintain the higher temperatures.

The data collected during the neodymium runs is being re-examined, and it is likely that the test will be repeated in the process of EVOR testing.

References:

B. Goldschmidt and J. Vetter, "The Preparation of Pure Uranium Metal, Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Volume 8, New York: United Nations, 1956 (P/341) pages 152-155."

L. Grainger, "Production of Uranium Metal", Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Volume 8, New York: United Nations, 1956 (P/407) page 149-151."

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