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Magnesium–Zinc Reduction Is Effective in Preparation of Metals

The preparation of metals by magnesium–zinc reduction has been studied, using uranium oxides, thorium dioxide, and plutonium dioxide as starting materials. The effects of flux composition, temperature, agitation, magnesium oxide loading in the flux, and starting material particle size on the rate and extent of reduction were investigated.

In the laboratory procedure for preparation of uranium, uranium oxide was suspended in a flux composed of alkali and alkaline earth halides. It was then reduced by vigorous mixing with Zn/5Mg alloy at temperatures between 650° and 800°C. The reductions were conducted in an alumina crucible in air. As the uranium metal was produced, it dissolved in the liquid-metal alloy, and was later recovered by vacuum distillation. Laboratory-scale (4 g of uranium) reduction of U_3O_8 was more than 99% complete in periods as short as 10 minutes. Uranium losses in the process were well below 1%.

In the preparation of thorium, the reduction rates of thorium dioxide were slower than those obtained with U_3O_8, but the effects of changes in flux composition were similar. A reduction of more than 99% was obtained in less than 4 hours, and product purities of up to 99.7% were achieved. Thorium tetrafluoride is also readily reduced by the magnesium–zinc alloy.

In the preparation of plutonium, the reduction rate of plutonium dioxide, unlike those of uranium and thorium oxides, was relatively independent of flux composition. The most satisfactory reductions at 800°C were obtained with a magnesium concentration of about 10 wt% in the liquid-metal phase. The use of plutonium dioxide instead of fluorides as the starting material has the advantage of greatly reducing the neutron-emission hazard resulting from (α,n) reactions. Plutonium losses from incomplete reduction were less than 1%.

Notes:

1. The techniques used in these reductions would be useful to organizations performing reduction of metals such as zirconium and titanium.
2. Additional information including experimental procedures, reduction requirements, discussion, and conclusions is available in *Preparation of Metals by Magnesium–Zinc Reduction,* by J. B. Knighton and R. K. Steunenberg, ANL-7057, June 1965, Argonne National Laboratory, Argonne, Illinois. The report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151; $3.00 each (microfiche, $0.65).
3. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B67-10579

Source: J. B. Knighton and R. K. Steunenberg
Chemical Engineering Division
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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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