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Fission Product Recoil Separation in Suspension Reactors

The interesting paper of Wolfgang (*1*) on the use of fission product recoil separation in power reactors prompts us to comment on the use of this principle in the slurry reactor at present being developed in the Netherlands.

The use of the recoil principle has been described some years ago (*2*). Our remarks will be restricted to a slurry of uranium oxide, in water of pH about 7 as measured at room temperature.

According to their chemical behavior the fission products can be divided into four groups:

1. the gases, which will be swept out by decomposition gases (in case water decomposition is low, additional sparging can be provided);
2. ions which are not adsorbed; e.g., I^-, are to be removed by treatment of the liquid from which the fuel particles are separated;
3. ions which show a normal adsorption behavior, e.g., Cs^+;
4. ions which show an adsorption behavior of the "radiocolloidal type," e.g., the lanthanides.

The latter elements only will be discussed more extensively. The adsorption of the lanthanides at room temperature begins at pH about 3 and is virtually complete from pH = 5 upward.

Sequestering agents are effective in removing adsorbed material or preventing adsorption. This is true only at low temperature however. At high temperatures the lanthanides are extremely strongly bound to such surfaces as uranium oxide and stainless steel so that rough treatments, as boiling with 6 *N* hydrochloric acid, are then necessary for their removal. This phenomenon alone would suffice to rule out the use of sequestering agents in reactors at high temperature, decomposition in the radiation field and thermal instability being other arguments.

With respect to these difficulties we have found it useful to apply a second solid phase in the slurry, as is also suggested by Wolfgang. Active charcoal is our preferred choice here. It has been shown that about 90% of lanthanides can be removed from the slurry system with charcoal at concentrations of the latter as low as 2 g/kg uranium oxide. Patents are

[4] Operated for the U. S. Atomic Energy Commission by the General Electric Company under Contract W-31-109-52.

pending for this and related preferred processes. Other adsorbents may also be used, e.g., some suitable inorganic materials.

Apart from the usual requirements for a material that is to be used in a reactor core, we require of our competitive adsorbent that it does not disturb the colloid-chemical stability of the suspension: it should not flocculate the oxide suspension, nor should flocculation of the adsorbent occur that would hinder its distribution around the oxide particles.

By periodically removing the adsorbent from the system the fission products whose behavior is the same as that of the lanthanides (and that is by far the major part of the elements formed in fission) can be removed.

A word may be added on the use of the recoil principle itself. If two particles of fissile material are close enough together, there is the possibility that fission products, recoiling from one particle enter the other. Thus the percentage of fission products found outside

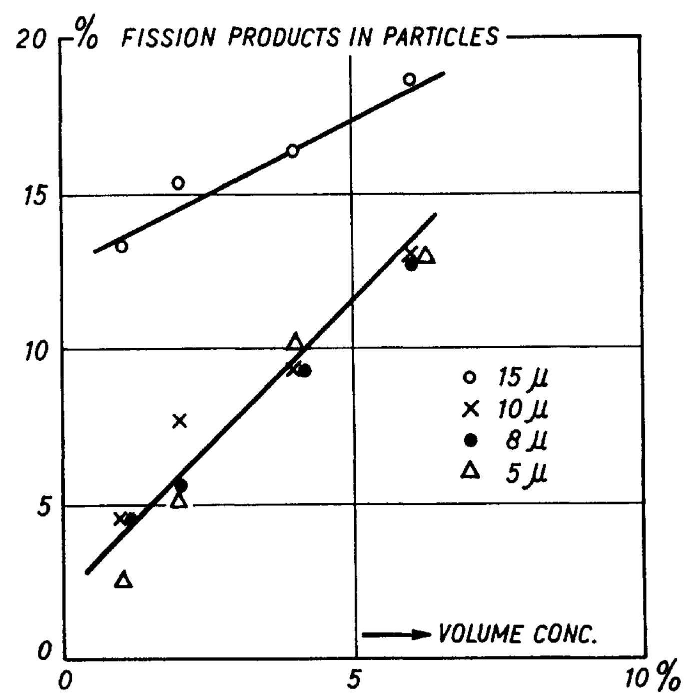

Fig. 1. The percentage of fission products left in the solid as a function of the volume concentration of uranium dioxide suspensions of different particle sizes.

the particles will decrease with increase of concentration. The useful range of concentration however is determined by physical considerations. Fortunately the required concentrations are such that a useful recoil effect can be obtained. This effect is seen in Fig. 1.

Considerations as the above show that also in the dilute suspensions in which only the recoil effect is useful, a distribution of particles that is as homogeneous as possible, with minimum fluctuations of concentration, should be achieved. For, while increase of the distance between two particles does not increase appreciably the already large recoil effect, decrease of this distance causes a rapid decrease of the effect.

It can be seen, we hope, that in this way the difficulties of a liquid suspension can in principle be overcome, although at the cost, it is true, of introducing a rather complicated separation system.

Calculations have shown that it should be possible to obtain a poisoning level due to poison in the liquid comparable to that due to poison products still remaining in the solid fuel. The poisoning level due to the latter cause evidently presents us with the lower limit which can be obtained in a system of this kind.

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Announcement

THIRD ANNUAL MEETING OF THE AMERICAN NUCLEAR SOCIETY

Date: June 10–12, 1957
Place: Hotel Penn-Sheraton, Pittsburgh, Pennsylvania
Deadline for Authors and Titles: April 1, 1957
Deadline for Abstracts: May 1, 1957
Titles and Abstracts to be sent to:

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