April 25, 1942

Remarks on the Fast Neutron Fission

The first estimate was based on the diffusion equation and values were obtained for R = 4 cm. and R = 8 cm. The mean free path of Uranium was based on a cross section of 4 assumed to be the cross section for spherical symmetrical scattering. Since a 4 cm. sphere is too small to justify the application of the diffusion formulae, it appears of interest to see what an optical formula would give which neglects the scattering. Assuming creation of neutrons at T = .8 R, we assume that half of the neutrons go through R, and half of the neutrons go through .4R. The influence of back-scattering from carbon is then taken into account by calculating from the diffusion formulae the difference in F, in the case of production in the center of the sphere with and without carbon. This is a rather conservative estimate, particularly in the case of larger spheres, since the neutrons which come from the center of the sphere are already slow when they reach the carbon.

$$\Sigma = F \frac{0.5 \times 1.6}{4.2} \text{ for oxide}$$

$$\Sigma = F \cdot \frac{0.5 \times 1.6}{2.7 + 0.5} \text{ for metal}$$

Remarks on the Cross Sections Used in Applying the Diffusion Formulae.

We assumeed for uranium metal a mean free path of 5 cm. corresponding to a cross section of 4. In carbon we assume the mean free path to be 5 cm. for U we took a value of 4 cm.

$$U = 5\sqrt{\frac{4}{3 \times 2.7}} = 3.5 \text{ cm}$$

This is certainly not quite correct. The absorption cross section of uranium ought to include the fission cross section. Assuming that 1 to 2 collisions (1.5 collisions) with carbon atoms kill the fast neutrons we obtain from B

$$B = 5\sqrt{\frac{1.5}{3}} = 3.5$$

$$B = U$$

B = 1.5 x U would correspond to 3.3 collisions in carbon.

In oxide of density 3.1 we based the mean free path for the diffusion formulae on a cross section of 8 per uranium atoms.

<u>Optical Formula for Larger Spheres.</u>

For 8 cm. spheres the optical formula gives a too optimistic value since we must not neglect elastic collisions if the creation is at T = .8 R. For this reason it might be better to take the arithmetic mean of the diffusion result and the optical result which includes back-scattering.