MUC KW 61

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Date April 12, 1946

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Subject Re: Change in Laplacian with Change in Temperature in BeO Pile MUC-KW-61

By K. Way

Copy # 5 A. Young

To R. G. Sachs

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MUC-KW-61
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April 12, 1946

Reactor Theory

TO: R. G. Sachs

FROM: K. Way

RE: Change in Laplacian with Change in Temperature in BeO Pile

The Laplacians of homogeneous piles consisting of BeO mixed with different amounts of U_3O_8 (containing 20% $U_3(235)O_8$) have been calculated for neutron temperatures such that kT is equal to .025 ev and .090 ev. When expressed in degrees, these temperatures are 290°A and 1040°A. For a given concentration of the fissionable isotope, the ratio of the Laplacian for the cold pile to that for the hot pile, B_{cold}/B_{hot} is given in the last column of the table.

The calculations were made assuming that the neutrons come to thermal equilibrium in the pile and that the thermal pile equation

$$(1 + L^2B) = ke^{-\tau B}$$

is valid. L is the diffusion length, B the negative Laplacian, k the reproduction factor, and τ the age.

The diffusion length L was calculated from the relation

$$1/L^2 = 3N_{25}\sigma_{a25}N_{BeO}\sigma_{tBeO}\left[1 + N_{28}\sigma_{a28}/N_{25}\sigma_{a25} + N_{BeO}\sigma_{aBeO}\right]$$

where the N's represent the number of atoms per cc, σ_a is the absorption cross section and σ_t is the transport cross section.

The reproduction factor, k, was taken equal to $f\eta p$ where f is the fraction of neutrons absorbed in 25, η the number of new neutrons produced per absorption in 25, and p is the chance that one of these escape resonance capture. For homogeneous piles

$$f = 1/\left[1 + N_{28}\sigma_{a28}/N_{25}\sigma_{a25} + N_{BeO}\sigma_{aBeO}/N_{25}\sigma_{a25}\right]$$

$$\eta = \nu\sigma_{f25}/\sigma_{a25} = 2.10$$

$$p = \exp\left[(N\int\sigma dE/E)_{28}/(N\sigma_s\xi)_{BeO}\right].$$

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unauthorized [redacted] by law.

[redacted]

Values of $\int \sigma dE/E$ were found from the Handbook curve for the appropriate value of the scattering cross section per atom of 28. For infinite dilution $\int \sigma dE/E$ was taken to be 240 barns. σ_s is the scattering cross section and ξ the average change in the logarithm of the energy per collision. The product $\sigma_s \xi$ for BeO was taken to be 1.89 for the cold temperature and 1.72 for the hot.

For BeO of density 2.7, the age τ was taken to be 136 cm^2 at the cold temperature and 130 cm^2 at the hot temperature.

Other constants used are the same as those given in MUC-KW-60.

VALUES OF PILE CONSTANTS FOR HOMOGENEOUS
U_3O_8 - BeO PILE FOR TWO TEMPERATURES

COLD kT = .025 ev

$\frac{\text{gms } U_3(25)O_8}{\text{gms BeO}}$	f	p	$k=f\eta p$	L^2	τ	B	B_{cold}/B_{hot}
.001	.815	.956	1.638	126.8	136	1.98×10^{-3}	
.002	.890	.918	1.714	69.0		2.70	
.003	.920	.888	1.714	47.6		2.98	
.004	.937	.865	1.700	36.4		3.10	
.005	.945	.846	1.680	29.2		3.16	
.006	.953	.828	1.658	24.8		3.165	
				HOT kT = .090 ev			
.001	.810	.951	1.591	282	130	1.25×10^{-3}	1.58
.002	.889	.911	1.682	155		1.963	1.38
.003	.914	.880	1.680	107.5		2.30	1.30
.004	.930	.856	1.661	82.5		2.47	1.26
.005	.940	.834	1.638	67.0		2.56	1.23
.006	.948	.819	1.616	56.5		2.62	1.21

K. Way

KW:jjp

Katharine Way

cc-J.E.Willard
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