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CALCULATION OF RESONANCE SELF SHIELDING IN Pu^{239}

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The 2000 group TART code⁽¹⁾ and the ENDL⁽⁴⁾ cross section library were used to calculate the fissions as a function of depth in the Czirr and Bramblett⁽²⁾ flat plutonium plate experiment. The current disagreement between calculation and experiment can stem from either an insufficient number of groups to represent the cross sections or problems with the evaluated data itself (due to the lack of experimental data) or both. The necessary calculations have been completed to allow us to point out the areas of difficulty. In the current version of ENDL the Pu^{239} and Pu^{240} fission, capture and elastic cross sections were replaced by Doppler broadened (293°K) cross sections from ENDF/B-III⁽³⁾ below 1.0 keV and 4.0 keV respectively. The new Pu^{239} has considerably more detail between thermal and 300 eV than was in the previous library (see Fig. 11).

The Czirr-Bramblett experiment gives the ratio of the number of fissions with the Pu target in to the number with the target out. The secondary fissions in the target do not contribute to experimental results (see Fig. 1 for simulated experimental configuration). As pointed out by Czirr, the experimental configuration allows only the uncollided flux to reach the detector; hence the number of fissions from the uncollided flux as a function of depth can be calculated from

$$\int_{E_f}^{2.15 E_f} \frac{\Sigma_f(E)}{E} e^{-\Sigma_t(E)x} dE \quad (1)$$

where Σ_t and Σ_f are respectively the total and fission microscopic cross sections, and E_f is energy of lower group bound.

Results of calculations using Eq. (1) agreed with the 2000 group TART calculations over all energy ranges and target thicknesses. Table I gives the results of experiment and the Monte Carlo calculations. Figs. 2 through 10 give the experimental and the results from Eq. (1). Figure 11 is a plot of the Pu^{239} cross section data for fission and total cross sections.

Conclusions

Comparison of TART calculations to exact uncollided calculations indicate that the TART 2000 group structure is adequate since vastly increasing the number of groups does not change the results. Where the total and fission cross section data are well-known the calculations and experiment are in reasonably good agreement. The only region of disagreement is in the unresolved resonance region above 300 eV.

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Table I.

g/cm ²	% Error			% Error			% Error		
	Exp	Calc	Error	Exp	Calc	Error	Exp	Calc	Error
THICKNESS	GROUP ENERGY			GROUP ENERGY			GROUP ENERGY		
	2.15 to 4.64 eV			4.64 to 10.0 eV			10.0 to 21.5 eV		
.06	.989	.997	+ .809	.884	.901	+ 1.92	.850	.900	+ 5.88
.1217	.933	.993	+ 6.43	.695	.825	+18.7	.746	.826	+10.7
.2170	--	.987	--	.683	.713	+ 4.39	.694	.713	+ 2.73
.4117	.902	.975	+ 8.09	.562	.554	- 1.42	.507	.546	+ 7.69
.7818	.932	.954	+ 2.36	.416	.417	+ .24	.378	.383	+ 1.31
1.626	.880	.910	+ 3.41	.290	.293	+ 1.03	.242	.228	- 5.79
3.130	.813	.832	+ 2.34	.192	.227	+18.2	.143	.136	- 4.89
	21.5 to 46.4 eV			46.4 to 100 eV			100 to 215 eV		
.06	.851	.934	+ 9.8	.863	.967	+12.0	.909	.981	+ 7.92
.1217	.756	.859	+13.6	.810	.905	+11.7	.884	.956	+ 8.14
.2170	.728	.778	+ 6.87	.710	.834	+17.5	.770	.927	+20.4
.4117	.567	.626	+10.4	.687	.729	+ 6.11	.773	.867	+12.2
.7818	.441	.464	+ 5.21	.577	.601	+ 4.16	.730	.775	+ 6.16
1.626	.318	.308	- 3.14	.443	.436	- 1.58	.631	.635	+ .63
3.130	.215	.213	- .93	.334	.303	- 9.28	.524	.482	- 8.01
	215 to 464 eV			464 to 1000 eV			1000 to 10000 eV		
.06	.947	.987	+ 4.22	--	.995	--	.886	--	
.1217	.811	.977	+20.5	.864	.991	+14.7	.918	--	
.2170	.865	.958	+10.8	.861	.982	+14.1	.936	--	
.4117	.783	.924	+18.0	.949	.967	+ 1.90	.911	.977	+ 7.2
.7818	.783	.871	+11.2	.962	.937	- 2.60	.938	.957	+ 2.02
1.626	.678	.777	+14.6	.736	.874	+18.8	.870	.915	+ 5.17
3.130	.558	.652	+16.8	.637	.769	+20.7	.847	.846	- .12

Fig 1

Figure 2

Figure 3

Figure 4

Fig. 5

Fig. 7

Fig. 8

Fig. 6

Fig. 9.

Fig. 10

Figure 11

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