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CALCULATIONS TO COMPARE WITH MEASUREMENTS OF THERMAL NEUTRON SPECTRA IN BORATED WATER

Calculations have been made using APOLLO-1 and JEF thermal scattering data to compare with measurements of neutron spectra, reported in the literature, for borated water. The measurements for borated water were chosen because the absorption cross-section of boron is accurately known at thermal energies and the scattering by the boron is of minor importance. The measurements span a range of different spectra, from the well-thermalised to those with a fairly high mean energy. Also calculated are the spectra measured on one solution at four temperatures. A simple fundamental mode calculation has been made. It is said in the literature that this model should be adequate for all excepting the pure water case.

In this first stage of the analysis the aim has been to see if there are any significant differences, for spectrum averaged values of eta for uranium fuel, between values averaged using the measured and the calculated spectra. Tables 1 and 2 present the results. In Table 1 the percentage differences are presented for the measurements made at about 293K. The differences are very small but there is an indication of a trend with increasing mean energy of the spectrum. This trend is being analysed further. In Table 2 the percentage differences are presented for four temperatures. There is no significant trend. It is concluded that adjustments made to the thermal scattering data would not improve the prediction of moderator temperature coefficients.

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TABLE 1
PERCENTAGE DIFFERENCES BETWEEN THE VALUES OF ETA AVERAGED OVER THE MEASURED AND CALCULATED SPECTRA

Variation with boron density

(averaging range 0.01 to 0.485eV)
(U8/U5 ratio of 200)

b/H value	B*B	Calculated Eta	Percentage Difference
H2O	-0.0242	1.1348	0.04%
1.025	-0.0242	1.1303	0.02%
1.025	-0.0454	1.1305	-0.02%
1.848	-0.0242	1.1253	0.00%
1.848	-0.0454	1.1255	-0.02%
2.99	-0.0454	1.1193	-0.03%
4.075	-0.0454	1.1140	-0.06%
5.2	0	1.1088	-0.06%
5.17	-0.0454	1.1091	-0.06%
6.35	0	1.1039	-0.11%

b/H value is the thermal absorption per atom of H

TABLE 2
PERCENTAGE DIFFERENCES BETWEEN THE VALUES OF ETA AVERAGED OVER THE MEASURED AND CALCULATED SPECTRA

Variation with temperature

(averaging range 0.01 to 0.485eV)
(U8/U5 ratio of 200 and 25)

Temperature ¢C	U8/U5 ratio	Percentage difference 200	25
23		-0.23%	-0.062%
150		-0.18%	-0.047%
232		-0.21%	-0.063%
316		-0.18%	-0.049%
Total variation in ratio		1.4%	0.5%