REFERENCE 67

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6. Critical Lattices of U(4.89) Rods in Water and in Aqueous Boron Solution, *E. G. Johnson (UCC-Y12)*

Earlier measurements[1] of critical water-moderated and -reflected lattices of 4.89% ^{235}U-enriched uranium [U(4.89)] rods 1.31, 2.07, and 2.49 cm in diameter, which provided reference for calculation of the criticality of heterogeneous assemblies of uranium of this enrichment, have been extended to rods 0.76 cm in diameter. The influence of the lattice pitch on the critical dimensions was determined by constructing several lattices in both square and triangular patterns. The data were then transformed, by equating bucklings using an extrapolation distance of 6 cm, to equivalent spheres for comparison with Clark's[2] calculations. The results are shown in Fig. 1 where critical masses are plotted as a function of the ^{235}U concentration. Shown for comparison are the earlier data for the 1.31-cm-diam rods. It is noted that the calculated masses of the 0.76-cm-diam rods are less than the experimental values at all concentrations.

Clark[2] predicted that the smallest critical mass of zero-diameter rods would contain 1.77 kg of ^{235}U at a concentration of 49.7 g/liter. This point was experimentally investigated with an aqueous $U(4.98)O_2F_2$ solution containing 45.3 g/liter enclosed in a sphere of 0.05-cm-thick stainless steel, 44 cm in diameter, based on Monte Carlo calculations by Webster.[3] In the experiment, the water-reflected critical volume, at a temperature of 24°C, filled the container to 99% of its capacity. Consideration of the reactivity of this void and of structural materials, evaluated by substitution experiments, shows that k_{eff} of the solution sphere was 1.006. The mass of ^{235}U in the sphere was 2.01 kg, to be compared with 1.78 kg from Clark's calculations for the concentration of the experiment.

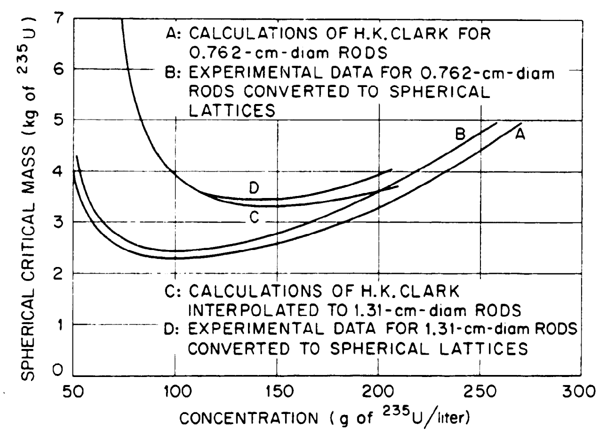

Fig. 1. Comparison of calculated and experimental critical spherical lattices of U(4.89) rods in water.

To provide guidance for the dissolution of rods of this ^{235}U enrichment in chemical processes, a limited number of experiments was performed with an aqueous solution containing 0.140 g of boron per liter as the moderator and reflector. A lattice of rods of each of the above diameters was constructed in the boron solution at the pitch that had resulted in the minimum measured critical mass in the water-moderated and -reflected experiments. Typical results are compared in Table I with those from water-moderated and -reflected lattices.

TABLE I

Criticality of Rods Latticed in Water and in an Aqueous Boron Solution

Boron Concentration: 0.140 g/liter

Description of Lattice[a]				Critical Mass of ^{235}U (kg)	
Diameter (cm)	Pitch (cm)	Concentration (g/liter)	Lattice Height (cm)	Water	Boron Solution[b]
2.49	4.72	234.0	30	6.16	7.58
			60	8.42	10.02
2.07	4.45	180.6	30	5.15	6.87
			60	6.97	8.91
1.31	3.21	140.6	30	3.58	4.59
			60	4.89	6.02
0.76	2.20	103.8	30	2.53	3.30
			60	3.47	4.33

[a]Each Lattice was in a triangular pattern.
[b]The ^{10}B content of the boron was 19.81 at.%.

1. E.B. JOHNSON, *Trans. Am. Nucl. Soc.*, **10**, 190 (1967).
2. H. K. CLARK, "Critical and Safe Masses and Dimensions of Lattices of U and UO_2 Rods in Water," DP-1014, Savannah River Laboratory (1966).
3. J. WALLACE WEBSTER, Personal Communication (1968).