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3.6. SOME STUDIES OF WATER, STYROFOAM, AND PLEXIGLAS REFLECTORS

J. K. Fox   L. W. Gilley

Two sets of critical experiments have been performed with slabs of uranium solutions in order to compare the reflecting properties of Styrofoam[1] and water and to determine the effect of placing various thicknesses of Plexiglas between two unreflected slabs. The fissile material used was an aqueous solution of UO_2F_2 which was enriched to 93.2% in U^{235} and had an $H:U^{235}$ atomic ratio of 293. The solution was contained in slab-shaped aluminum vessels having nominal dimensions of 6 × 48 × 48 in. and wall thicknesses of $\frac{1}{8}$ in.

The first group of experiments consisted in determining the critical height of a single 6-in.-thick slab under the following reflector conditions: (a) no reflector, (b) water reflector on the bottom and on all four sides of slab to the height of the solution, (c) a 3- or 6-in.-thick Styrofoam reflector on each face, that is, on each 48 by 48 in. side of the slab, and (d) a 3- or 6-in.-thick Styrofoam reflector on each face of the slab plus a water reflector on the bottom and all four sides of the slab-Styrofoam assembly to the height of the solution. The results are summarized in Table 3.6.1. It is noted that Styrofoam is significantly less effective as a neutron reflector than is water: a layer of the plastic 6 in. thick, which is nearly effectively infinite, reduced the critical height of the slab by only about 20%, while a water reflector reduced the height by more than a factor of 3. Replacing the first 3 in. of water on the two faces of the slab with Styrofoam increased the critical height about 33%; replacing the first 6 in. of water with Styrofoam increased the height about 53%. Using a 3-in.-thick Styrofoam reflector on each of the two faces of an otherwise unreflected slab is almost as effective as using a 6-in.-thick Styrofoam reflector on the faces.

In some of the experiments two 6-in.-thick parallel slabs were placed 6 and $12\frac{1}{6}$ in. apart, and the critical heights of the two-slab assemblies were determined for several reflector conditions. In one experiment the slabs were both reflected (except on top) and separated by water, and in another experiment they were reflected by water and separated by Styrofoam. In other experiments no water reflector was used, and the effect of placing Styrofoam between the slabs was determined. Comparison of the critical height of two water-reflected slabs separated by water with their critical height when they were separated by Styrofoam shows that replacing the water with the Styrofoam decreased the reactivity of the assembly, since the increased leakage more than compensated for the increased interaction. Placing 6 in. of Styrofoam between two unreflected slabs increased the critical height slightly; however, placing $12\frac{1}{6}$ in. of Styrofoam between two unreflected slabs decreased the critical height.

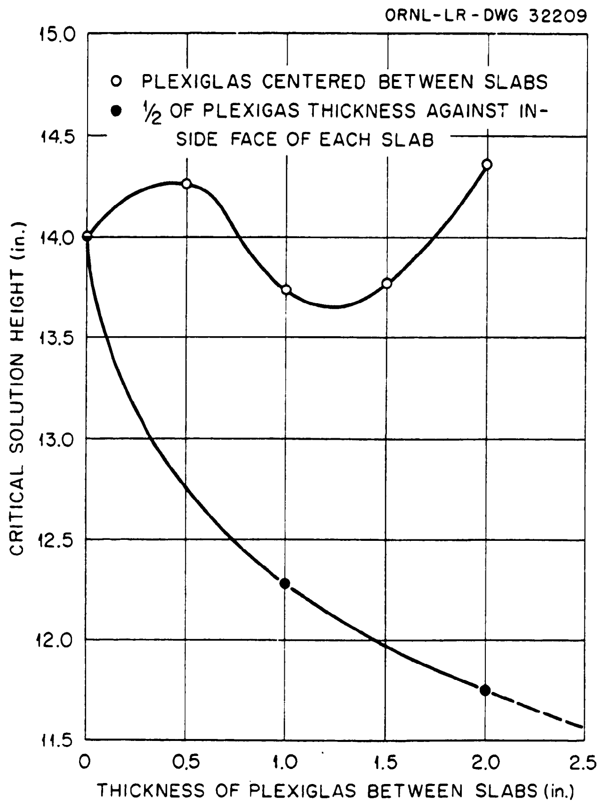

Fig. 3.6.1. Critical Height of Two Unreflected 6-in.-thick Slabs of 93% U^{235}-Enriched Uranium Solution 12 in. Apart as a Function of the Thickness of Plexiglas Moderator Between the Slabs.

[1]Styrofoam is the trade name for a foam-like form of polystyrene ($C_6H_5CH:CH_2$) in which small gas bubbles are homogeneously distributed throughout the plastic. The bubbles are apparently closed since Styrofoam does not absorb water.

Table 3.6.1. Critical Parameters of U^{235}-Enriched Uranium Solutions in Single and Interacting Slab Geometries Reflected with Styrofoam, Water, and Plexiglas

Density of Styrofoam:	0.028 g/cc
Concentration of solution:	0.0850 g of U per g of solution; 0.0878 g of U^{235} per cc of solution; H:U^{235} atomic ratio = 293
Isotopic analysis of uranium:	93.18% of U^{235}, 5.51% of U^{238}, 1.04% of U^{234}, and 0.27% of U^{236}
Specific gravity of solution:	1.108
Solution container:	Aluminum vessel 6 in. wide, 48 in. high, and 48 in. long with $\frac{1}{8}$-in.-thick walls

Reflector Conditions	Critical Solution Height (in.)
One 6-in.-thick Slab of Solution	
No reflector	27.25
Water reflector on bottom and on all four sides of slab to height of solution	8.09
3-in.-thick Styrofoam reflector on each face of slab	22.90
6-in.-thick Styrofoam reflector on each face of slab	21.83
3-in.-thick Styrofoam reflector on each face of slab plus a water reflector on bottom and on all four sides of slab-Styrofoam assembly to height of solution	10.84
6-in.-thick Styrofoam reflector on each face of slab plus a water reflector on bottom and on all four sides of slab-Styrofoam assembly to height of solution	12.35
Two 6-in.-thick Slabs of Solution 6 in. Apart	
No reflector	11.72
No water reflector: 6 in. of Styrofoam between slabs	12.14
Water reflector on bottom and on outside of assembly to height of solution: 6 in. of water between slabs	7.90
Water reflector on bottom and on outside of assembly to height of solution: 6 in. of Styrofoam between slabs	7.93
Two 6-in.-thick Slabs of Solution $12\frac{1}{6}$ in. Apart	
No reflector	14.58
No water reflector: $12\frac{1}{6}$ in. of Styrofoam between slabs	14.21
Water reflector on bottom and on outside of assembly to height of solution: $12\frac{1}{6}$ in. of water between slabs	8.09*
Water reflector on bottom and on outside of assembly to height of solution: $12\frac{1}{6}$ in. of Styrofoam between slabs	8.74
Two 6-in.-thick Slabs of Solution 12 in. Apart	
No reflector	14.01
No water reflector: 0.5 in. of Plexiglas centered between slabs	14.26
No water reflector: 1.0 in. of Plexiglas centered between slabs	13.74
No water reflector: 1.5 in. of Plexiglas centered between slabs	13.77
No water reflector: 2.0 in. of Plexiglas centered between slabs	14.36
No water reflector: One 0.5-in.-thick Plexiglas sheet positioned against inside face of each slab	12.28
No water reflector: One 1.0-in.-thick Plexiglas sheet positioned against inside face of each slab	11.75

*Value obtained with single 6-in.-thick slab in water. Previous experiments with interacting slabs in water have shown that 12 in. of water effectively isolates the individual slabs.

The effect of placing various thicknesses of Plexiglas between two 6-in.-thick slabs spaced 12 in. apart was also investigated. In one case successive thicknesses of 0.5, 1.0, 1.5, and 2.0 in. of Plexiglas were centered between the two slabs, and in other experiments 0.5- and 1.0-in. thicknesses were placed against each inside face of the two slabs. The data are plotted in Fig. 3.6.1. These curves should approach as asymptotes the critical heights corresponding to slabs one-half reflected with water or Plexiglas, since 12 in. of either material would effectively isolate the two slabs.

This paper has been issued as a separate report.[2]

[2] J. K. Fox and L. W. Gilley, *Some Studies of Water, Styrofoam and Plexiglas Reflectors*, ORNL CF-58-9-39.