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FLUX MEASUREMENT IN HOLE 10, ORNL GRAPHITE REACTOR

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The relative neutron flux in Hole #10, ORNL Graphite Reactor, has recently been measured as a function of distance from the bottom of the hole. Two measurements were made; one when the hole was empty and another when the hole was fully loaded with irradiation cans containing a variety of materials.

Experimental conditions for making the measurements included the use of liquid monitors (solutions of manganese metal). Aliquots of the solution were placed in small plastic vials and these vials were then inserted into two-ounce polythene bottles arranged at one-foot intervals on a waxed cord. The bottom container was a six-ounce polythene bottle positioned in such manner so that a central geometry could be obtained for the series of containers. Irradiation time was for 30 minutes. The reactor power level at the time of the exposure was 3400 kw..

After the reactor discharge, aliquots of the irradiated solutions were placed in small glass tubes and the activity measured in a high pressure gamma ionization chamber. The decay of the activity was followed by obtaining activity data at different time intervals from the time of reactor discharge. The observed half-life was 2.60 hours (Mn^{56} , $t_{1/2} = 2.59h$), indicating that there was little, if any, interference from extraneous radioactivities in the monitor material.

The flux ($n/cm^2/sec$) was calculated in the following manner:

$$f = AM/6.02 \times 10^{23} W_{ac} S$$

where, A = disintegrations/second; M = chemical atomic weight of the element; W = sample weight in grams; and σ_{ac} = activation cross-section ($\times 10^{-24} \text{ cm}^2$); S = the saturation factor ($1 - e^{-\lambda t}$), where λ = decay constant of radionuclide involved and t = the length of irradiation. The activation cross-section for the reaction $\text{Mn}^{55} (n, \gamma) \text{Mn}^{56} (2.59\text{h})$ is $13 \times 10^{-24} \text{ cm}^2$ (1)

Table I tabulates the results of these measurements.

Table I

Relative Neutron Flux in Hole 10, ORNL Graphite Reactor

(Power Level = 3400 kw)

Hole Empty		Hole Fully Loaded	
Distance from Bottom (feet)	Flux	Distance from Bottom (feet)	Flux
0.0	$6.93 \times 10^{11} \text{ n/cm}^2/\text{sec}$		
1.0	6.89		
2.0	6.64		
3.0	6.54		
4.0	6.63	4.3	$6.65 \times 10^{11} \text{ n/cm}^2/\text{sec}$
5.0	6.38	5.3	6.53
6.0	6.08	6.3	6.07
7.0	5.62	7.3	5.74
8.0	4.98	8.3	5.00
9.0	4.34	9.3	4.37
10.0	3.41	10.3	3.34
11.0	2.53	11.3	2.45
		12.3	1.79
		13.3	1.00
		14.3	0.21
		15.3	0.04

The precision of these measurements is of the order of ± 2.0 percent.

It is believed that the use of small amounts of manganese (0.251 milligram, in this instance) in solution provides a more practical method for determining the flux of this particular irradiation facility. "Self-shadowing" effects are essentially eliminated, and it is not necessary to dilute the monitor before it is measured in the ionization chamber as in the use of alloy materials (Al-Mn, etc.) Additional measurements, using other metals as monitors, will be included in the Activation Analyses Group's program.

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1. H. Pomerance, "Thermal Neutron Capture Cross-Sections," The Physics Review, Vol. 83, No. 3, 641-645 (Aug. 1, 1951).

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