Manganese Thermal Neutron Activation Cross Section

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The thermal activation cross section of manganese has been remeasured and found to be $\sigma_{act}=13.1_9\pm0.3_0$ barns (standard error). This value, combined with previous values, yields a "best average value" of $13.2_7\pm0.2$ barns.

BECAUSE of its characteristic response to neutrons, manganese is often used for the calibration of thermal neutron densities. The precision of absolute calibrations is limited by the experimental error (2.2 percent) in the value of the thermal neutron activation cross section of manganese. The following measurement was carried out in order to reduce the error in the cross section value to less than 2.0 percent.

The thermal neutron activation cross section of manganese has been determined by measuring the absolute activity of a sample of manganese sulfate solution irradiated in a known thermal neutron flux. A small cell, containing about 3.5 ml of manganese sulfate solution and a 2.0×3.4 cm^2 manganese foil, was placed in a graphite column three or four centimeters from a ten-curie Po-Be neutron source (Fig. 1). At this distance from the source the thermal neutron density is of sufficient magnitude and uniformity to provide enough activity for 4π counting of an aliquot of the activated manganese sulfate solution. The diagonal positioning of the foil used to calibrate the neutron density insures that the foil and solution sample the same average neutron density, regardless of the attenuation throughout the cell.

After irradiation for several hours the cell was removed and 0.200 ml of the solution was pipetted onto a quarter-mil mylar film and the absolute activity was determined with a 4π proportional flow counter (only the manganese activity is present). Then the foil was 2π counted in the same counter. After correction for decay, the ratio of the manganese sulfate activity, $C_{4\pi}$, to the foil activity, A_c, for the unknown flux is obtained. Next the cadmium difference activity for the foil was measured in the NBS standard thermal neutron density[1] (originally calibrated with boron). This measurement calibrates the manganese foil activity, A_s, in terms of the known thermal neutron density, n.

[1] J. DeJuren and H. Rosenwasser, J. Research Natl. Bur. Standards **52**, 93 (1954).

The manganese thermal neutron activation cross section is then determined from the equation

$$C_{4\pi}\times A_s/A_c=n\bar{v}\sigma N,$$

where N is the number of manganese nuclei in the 0.200 ml manganese sulfate aliquot, and σ is the manganese activation cross section at $\bar{v}=2.2\times10^5$ cm/sec.

Two sets of measurements were taken for each of the activities, and the result obtained is

$$\sigma_{act}=13.1_9\pm0.3_0 \text{ barns (standard error).}$$

Most of the error stems from the uncertainty in $n(\pm2$ percent). The 4π data, including absorption correction, should be accurate to ±0.7 percent.

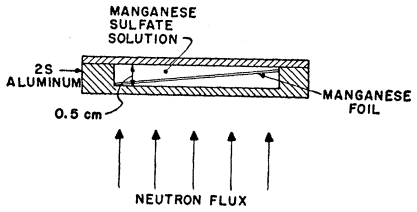

FIG. 1. Cell geometry during irradiation.

This result agrees well with the "best average value" of 13.4 ± 0.3 barns for the activation cross section and 13.2 ± 0.4 barns for the absorption cross section listed in Supplement 2 of the Neutron Cross Section Compilation.[2] When all three are combined, the error is reduced to 0.2 barn (1.5 percent).

A more detailed description of the preparation and use of thin manganese sulfate sources will appear in a later paper describing the absolute calibration of a neutron source.

[2] *Neutron Cross Sections*, Atomic Energy Commission Report AECU-2040 (Technical Information Division, Department of Commerce, Washington, D. C., 1952).