

The Half-Life of Yttrium-90

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Radioactive yttrium-90 separated from two aged samples of fission product strontium was allowed to decay. The change in activity was followed for more than 650 hours with standard mica-window beta counters. From the observed changes, the mean half-life of yttrium-90 was calculated to be 64.60 ± 0.43 hours.

THE half-life of yttrium-90 has been reported by a number of investigators.¹⁻⁵ The reported values fall in two sets, one at 61 hr, the other at 65 hr.

Lawson and Cork¹ first reported a half-life of 60.5 ± 2 hr for yttrium-90, produced by deuteron bombardment of a sample of yttrium nitrate. This was confirmed by Bothe² who obtained a value of 61 ± 1 hr for the decay of yttrium activity produced by neutron bombardment of yttrium oxide. Yttrium activity was isolated from among the spallation products from bismuth by Goeckermann and Perlman³ who identified activities of 10-hr, 62-hr, and 57-day half-lives. The 62-hr activity was assigned to yttrium-90.

Nottorf⁴ used strontium produced by uranium fission as a source of active yttrium. His measurements indicated a half-life of 65 hr for yttrium-90. More recently, Schott and Meinke⁵ have isolated yttrium activities of 18 min, 3.5 hr, and 65 hr from $Zr(n,p)$ reactions. To resolve the discrepancy, a new determination of the yttrium-90 half-life was made.

Two separate samples of fission strontium-yttrium mixture furnished by the Isotope Division, U. S. Atomic Energy Commission, were used. The samples had aged for 18 months or more since their preparation. Separation and purification of the yttrium-90 daughter from the parent strontium-90 was by TTA (thenoyltrifluoroacetone) extraction. The original solution was buffered with acetate to a pH of 4.5 and contacted with 0.5M TTA in benzene. The organic phase was removed and

contacted with a 0.01M HNO_3 solution. This cycle which has proven effective for the separation⁶ was repeated four times, and an aliquot of the final aqueous phase was mounted for counting. Examination of the radiations of sample I with a beta spectrometer showed only the characteristic spectrum of yttrium. Counting for each sample was with separate standard mica-window beta counters. The response of the instruments was checked each day with uranium standards and all observed counting rates corrected for the day-to-day variations in response as well as for background activity.

Data for sample I were obtained by measuring the activity from the second-shelf position for 311 hours after separation; beginning at 237 hours and continuing until 743 hours, the activity of the sample was measured on the first shelf. The 15 determinations of activity on the second shelf gave a half-life of 64.57 ± 1.37 hr, as determined by a least-squares treatment. The 16 determinations at the first-shelf position gave a value of 65.51 ± 3.4 hr. These were combined to give a value of 64.70 ± 1.2 hr. The total time the sample was under observation was 743 hr or 11.4 half-lives with no detectable deviation from linearity.

Sample II was counted at the second-shelf position only. For the first six determinations of activity (291 hr of decay or 4.5 half-lives) a total of more than 10^6 counts was observed for each determination. No deviation from linearity was observed for 673 hr (10.4 half-lives) at which time the experiment was discontinued. The half-life computed from these data was 64.59 ± 0.59 hr. The weighted mean half-life of samples I and II is 64.60 ± 0.43 hr.

¹ Stewart, Lawson, and Cork, *Phys. Rev.* **52**, 901 (1937).

² W. Bothe, *Z. Naturforsch.* **1**, 179 (1946).

³ R. H. Goeckermann and I. Perlman, *Phys. Rev.* **76**, 628 (1949).

⁴ Nottorf, Coryell, and Sugarman, *Radiochemical Studies: The Fission Products* (McGraw-Hill Book Company, Inc., New York, 1951), Paper No. 77, National Nuclear Energy Series, Plutonium Project Record, Vol. 9, Div. IV.

⁵ G. L. Schott and W. W. Meinke, *Phys. Rev.* **89**, 1156 (1953).

⁶ A. Chetham-Strode, Jr. (unpublished work).

⁷ Precision figures are at the 95 percent confidence level.