Half-Life of Yttrium-90*

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A series of determinations on the half-life of yttrium-90 have been made, resulting in an average value of 64.24±0.30 hours. Y^{90} was separated from its Sr^{90} mother by either a carbonate or phosphate precipitation, followed by conversion to oxalate as the final counting vehicle. The efficiency of the chemical separations, precision of the determinations, and good agreement with the latest published results suggest that the half-life of this nuclide is now known to an accuracy of 0.7 percent.

PAST measurements of the half-life of Y^{90} have resulted in values ranging from 60.5±2 hours[1] to 65 hours[2,3] with intermediate values of 61±1 hours,[4] 62 hours,[5] and most recently 64.60±0.43 hours.[6] As a by-product of the use of certain radioactive tracers to study the separation of alkaline earth and rare earth elements, a new determination of the half-life of Y^{90} has been made, giving 64.24±0.30 hours.

A Sr^{90}—Y^{90} calibrated standard supplied by the National Bureau of Standards was utilized in the study. The chemical technique consisted of a two step procedure, (*a*) a precipitation to separate the Sr^{90} from the Y^{90} and, (*b*) a re-precipitation of the Y^{90} in a form suitable for beta counting. The separation step was carried out either by the precipitation of the phosphate or the hydroxide of yttrium. In hot well-stirred HCl solution, in the presence of excess phosphate ions, the phosphate of yttrium is completely precipitated below *p*H of 1.5, but strontium phosphate does not crystallize until about *p*H of 2.2. Careful *p*H control produces a quantitative removal of Y with negligible quantities of strontium. (Less than 0.05 percent of the initial activity of the separated yttrium precipitate can be attributed to Sr^{90}.) The hydroxide separation consists merely of adding NH_4OH to the acid solution until the gelatinous $Y(OH)_3$ precipitate appears at about *p*H of 8. In both separation methods sufficient "dead" yttrium is added to carry the Y^{90}. The precipitate is washed with distilled water after which the filtrate and washings are stored for re-accumulation of Y^{90} and subsequent milking. The precipitate is then dissolved off the filter paper with warm, dilute HCl solution. The re-precipitation step is identical for both phosphate and hydroxide methods. Concentrated NH_4OH is added dropwise to the yttrium solution until the first signs of precipitation appear, then dilute HCl is added dropwise to barely dissolve the precipitate. Concentrated oxalic acid is then added in excess. This results in an abundant, heavy precipitate of the crystalline yttrium oxalate. The oxalate precipitate is digested for about ten minutes before suction filtering through a steel precipitation funnel with one and one-eighth inch diameter Whatman No. 42 paper. The sample is dried by pulling air through the sample for about fifteen minutes after the filtrate had been removed. The filter paper with the yttrium oxalate sample (about 20 mg/cm²) is mounted under a thin pliofilm cover on a brass disk and ring assembly for counting.

TABLE I. Half-life measurements of Y^{90}.

Sample No.	Initial counts/min	Half-life (hours)
HC-97	1087±15	64.4±1.1
HC-98	1358±20	64.0±1.0
HC-99	1171±20	63.5±1.0
HC-100	940±10	65.0±0.5
HC-101	1010±10	64.3±0.4
HP-100	1220±10	64.6±0.5
HP-101	860±9	64.0±0.3
HP-102	1000±10	63.5±0.5
HP-103	1260±11	64.5±0.5
	Average	64.24±0.30

The counting apparatus consists of an Anton Electronic Laboratories Model 1007 mica window flat Geiger counter. The counter is mounted in a special Lucite housing to insure reproducible geometry in sample changing. The normal background of this unit, encased in a lead shield and an anticoincidence ring, is 2.51±0.03 counts per minute on a "dead" yttrium sample.

A total of 9 samples were prepared in this way and periodically counted over a period of about three weeks (about 8 half-lives). Semilogarithmic plots of the data gave well-defined decay curves. The pertinent data are presented in Table I.

The samples with letters HC were run as hydroxides in step (*a*) while those with HP were precipitated as phosphates. The average value for the half-life has been calculated by weighting the individual value with the reciprocal of the square root of the error of the particular run. The error on the average is 2σ for the nine runs (95 percent confidence level). The final result of 64.24 ±0.30 is in good agreement with the determination by Chetham-Strode and Kinderman.[6]

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