Tritium Produced During Spontaneous Fission of Californium-252†

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(Received 30 January 1964)

The tritium produced during the spontaneous fission of californium-252 was collected and measured in a liquid scintillator system. One tritium atom was observed for every 4520±107 fission events.

INTRODUCTION

THE number of tritons per spontaneous fission event of Cf^{252} using $E-dE/dx$ detectors has been measured by Watson[1] and Wegner.[2] Both obtained a value of approximately 4500 fission events per triton[3] with 10–20% errors. In this work the tritium to fission ratio was determined by milking the tritium from two Cf^{252} sources, converting it to THO, and determining its disintegration rate using a liquid scintillator system.[4]

EXPERIMENTAL

The spontaneous fission rates of the two Cf^{252} sources[5] were determined by counting aliquoits in an ionization detector. The rates were 3.275×10^7 and 4.421×10^7 fissions per min. The sources were placed in separate tubes, evaporated to dryness and redissolved in dilute HCl several times to remove background tritium. The samples were finally dissolved in dilute HCl, the tubes evacuated and isolated by closing stopcocks (1) and (2) (Fig. 1). After periods of 4–6 weeks the samples were made slightly basic (to prevent the distillation of most of the fission products) by the addition of NaOH solution. The tritium and water were vacuum distilled from tube I. The water and THO were trapped in tube II. Any tritium as gas was converted to THO by the CuO in the furnace section (approx. 750°C) and trapped in tube III. The water was then distilled from tube II to tube III. The CuO-Cu acted to remove any halogens which might distill as organic halides.[6] After rendering the water in tube III just basic with NaOH the water was distilled into a volumetric measuring flask and the total volume recorded. Two ml of this water were added to 15 ml of a scintillator solution[7] and the tritium disintegration rate was determined in a liquid scintillation spectrometer by the method described elsewhere.[4]

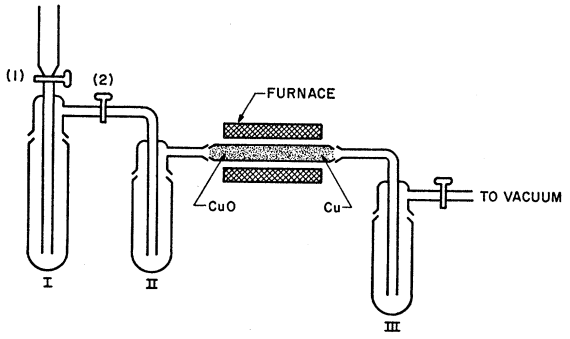

FIG. 1. Experimental apparatus for tritium isolation.

RESULTS

For three milkings (two with the sample having 3.275×10^7 fissions per minute) the number of fission events per tritium atom observed was calculated (Table I). The error for each determination is the standard deviation from the counting data. The value of the average and its standard deviation were obtained using the method of averaging by least squares.[8]

TABLE I. Spontaneous fission events per tritium atom from Cf^{252}.

Run	Fissions/tritium atom
1	4570±200
2	4430±200
3	4560±127
Average[a]	4520±107

[a] From Ref. 8.

* Based on work performed under the auspices of the U. S. Atomic Energy Commission.

[1] J. C. Watson, Phys. Rev. **121**, 230 (1961).
[2] H. E. Wegner, Bull. Am. Phys. Soc. **6**, 307 (1961).
[3] The ratio calculated from Wegner's data will depend on the value of the fission to alpha ratio used.
[4] D. L. Horrocks and M. H. Studier, Anal. Chem. **33**, 615 (1961).
[5] Loaned for this experiment by P. R. Fields and D. F. Peppard of Argonne National Lab.
[6] E. N. Sloth, D. L. Horrocks, E. J. Boyce, and M. H. Studier, J. Inorg. Nucl. Chem. **24**, 337 (1962).
[7] Composed by volume percent 75% p-dioxane, 12.5% 1,2-dimethoxyethane and 12.5% anisole with scintillator solutes PPO (7 g/liter) and M_2-POPOP (0.5 g/liter).
[8] With several independent determinations, $A_i\pm a_i$, the method of averaging by least squares can be used to obtain the average value $\bar{A}$ and its standard deviation;

$$\sigma^2(A_i)=a_i^2=1/w_i,$$
$$\sigma^2(\bar{A})=1/\Sigma\, w_i,$$
$$\bar{A}=\Sigma\, w_iA_i/\Sigma\, w_i.$$