6. Efficiency of a Liquid Scintillation Counter

Sakae SHIMIZU, Hidekuni TAKEGOSHI and Eiko TAKEGOSHI

(K. Kimura Laboratory)

The characteristic of a liquid scintillation counter with a xylene-terphenyl (1: 0.004) scintillator has been studied.

Since the absorption coefficient of xylene for gamma-rays of about 1.2 Mev is 0.047 cm^{-1}., about 20 percent and 37 percent of these rays are scattered by xylene of 5 cm. and 10 cm. thickness respectively. These values should be the ulitimate counting efficiency of a scintillation counter with xylene of such thickness, however, the actual efficiency seems to be less than the above values because it is impossible to gather all light from a scintillator upon the photo-cathode of a photomultiplier. To ascertain this fact we measured counts from the counter with the liquid scintillator used, which was irradiated sidewards at various points by a canalized beam of 0.5 mm^2. cross section of gamma-rays from Co^{60}. In this case, the scintillater liquid was surrounded on all sides by aluminium foils to gather effectively the light produced. With the constant gain of the amplifier, it was found that the counting rates with irradiated points 2 cm., 5 cm., and 10 cm. apart from the photo-cathode of RCA 5819 were 80 percent, 20 percent, and 6 percent, respectively, of that at 1 cm. These counting rates are not only dependent on the efficiency of the light-gathering, but are varied according as the gain of the amplifier used, nevertheless these values must be considered in the case of the measurement with a scintillation counter.

In order to measure the absolute efficiency of a scintillation counter used, we constructed an another counter same as the former one. These two counters were placed 30 cm. apart and facing each other, and a Co^{60} source was placed at the center of two counters. Then, the coincident counts, c, were measured by the use of a coincidene circuit with the resolving time of 2×10^{-7} sec. Since Co^{60} emits simultaneously two quanta of gamma-rays with nearly equal energy, namely 1.33 Mev and 1.17 Mev, the relation, $c=\varepsilon d$, should be satisfied in our case where ε is the apparent counting efficiency of each counter and d is the true number of gamma-ray quanta entering each counter, and the efficiency of the counter used is assumed to be same for each of these gamma-rays. Since the intensity of Co^{60} was 2 millicuries and the values of d and c were obtained as $d=3.2\times10^{3}$ sec^{-1} and $c=1.3$ sec^{-1}, we obtained $\varepsilon=4\times10^{-4}$. On the other hand, ε is a product of a ratio of the solid angle subtended by the scintillator at the gamma-ray source to the total solid angle, the efficiency of the light-gathering, and the true counting efficiency. In the present case, the product of the ratio abovementioned and the efficiency of the light-gathering was found to be about 0.20 percent, therefore the true counting efficiency was (20±5) percent for the gamma-rays from Co^{60}. But the counting efficiency of a scintillation counter is generally increased as the gain of the amplifier used. In our case the noise of each counter was observed to be about 20 sec^{-1}.

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7. The Extraction of Some Radioisotopes: P^{32} and I^{128}

Kiichi KIMURA, Masakatsu SAKISAKA, Sukeaki YAMASHITA,
Kōzō MIYAKE and Isao KUMABE

(K. Kimura Laboratory)

Radioactive phosphorus P^{32} was produced by the S^{32}(n,p) P^{32} reaction, through the bombardment of CS_2 with the Li-D neutrons from the high voltage machine of Cockcroft-Walton type, and radioactive phosphorus so yielded was extracted by electrolysis.

Copper electrodes supplied with various voltages were immersed in irradiated CS_2, and then P^{32} adsorbed on the electrodes were dissolved in hot dilute hydrochloric acid.

Table 1. Activities of various extracts yielded P^{32}.

Supplied field (V/cm)	125	100	75	50	25
Anode Counts	1034	980	1052	1280	1186
Cathode Counts	98	100	112	134	174

As can be seen in Table 1 the optimum voltage was 50 volts/cm., and the time required for the separation was four hours. This method of separation is very simple and needs no carrier. And the rate of separation seemed to be very satisfactory. But CS_2 to be used must be chemically pure, and if there exsists any impurity, the process of separation may meet with various disturbances.

When we used platinum electrodes instead of copper ones in the above procedure, there occurred no adsorption of P^{32} on either the anode or the cathode.

Further, we produced radiooctive iodine I^{128} by irradiating on C_2H_5I with the slow neutrons, and attempted to separate I^{128} by the Szilard-Chalmers' method from the target, but the yield of radioisotope was not sufficient.