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A SCINTILLATION PROBE FOR CONTINUOUS MONITORING OF TRITIATED WATER

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Continuous monitoring of tritiated water has been achieved conveniently by dipping into the sample water a scintillator probe wherein a scintillator sheet having serrated surface is attached to a surface of prismatic light guide for dividing and transmitting the optical scintillae into two phototubes leading to the coincidence circuit.

Tritiated water is difficultly determined by the ordinary methods which are currently employed for counting tritium radioactivity of organic compounds. Liquid scintillation requires an emulsifier suited for homogeneous mixing of sample water, scintillator, and wave length shifter in a suitable organic solvent. It is not easy, however, to find the best condition under which the emulsified system maintains of the homogeneity high enough to assure the constancy of counting efficiency[1]). Gas phase counting in the form of water vapor is accompanied by the memory effect to which the disturbance of count rate is due[2]). To avoid the problems, therefore, it is recommended to employ Grignard reagents[3]) or metal carbides[4]) for converting sample water into corresponding hydrocarbons. All of these methods are rather complicated and not much practical. Especially, they are not useful for continuous monitoring of tritiated water which has recently got increasing uses in various fields of science and technology, specifically in hydrology and civil engineering.

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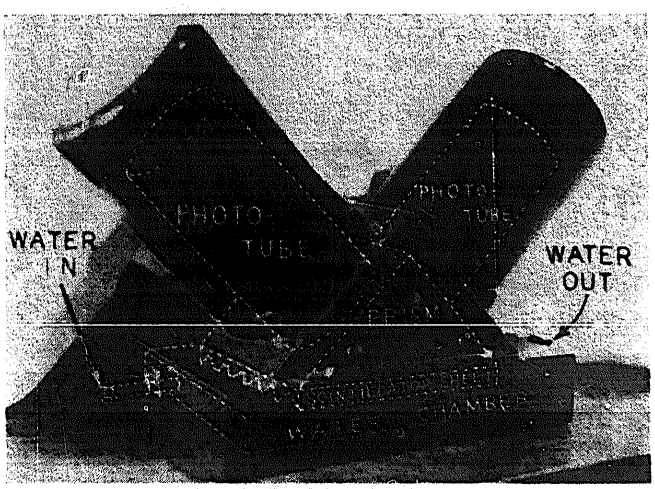

Fig. 1. Assembly of the scintillation probe and the sample chamber.

We have reported an end-window counting of tritiated specimens by means of scintillation probe wherein a sheet of scintillator phosphor is combined with a prismatic light guide for dividing and transmitting optical scintillae into two phototubes, which lead to a coincidence circuit for operating scaler with eliminating thermal noises[5]). The counting probe combined appropriately with an evacuation system enables us to determine easily, rapidly, and efficiently tritium radioactivity of solid specimens at a distance of even several mm from the scintillating surface[6]).

We have further found that the probe is useful for dip-counting of tritiated water, especially for continuous monitoring of tritiated water. The assembly of the probe was essentially the same as the previous ones[5,6]), except for the scintillator sheet (106 mm × 58 mm area, Pilot Scintillator B, made by Pilot Chemicals, Inc., Watertown, Mass.) which, as is seen in fig. 1, was indented in serrated shape with apex angle of 60° for enlarging the area of contact with tritiated water to be determined. The sheet was bonded to a surface of the prismatic light guide (polyacrylate resin of 93% transparency) combined with two phototubes (EMI 9536S), which lead to a beta ray spectrometer for liquid scintillation use (Aloka TDC-310, made by JRME). The probe assembly was dipped into sample water in a flat chamber, as is seen in fig. 1. The whole system comprising of the probe and the chamber was covered with 1.5 cm-thick lead shields.

It was found that the count rate is almost proportional to specific activity of tritiated water into which the probe is immersed. Such a proportionality is reasonably explained by extremely short range (ca. 1 μm in average) of tritium beta particles in water. Sensitivity of the counter was in a range of 5.7–11.4 cpm, depending on counting conditions, per 10^{-8} Ci/ml specific activity of tritiated water. On the other hand, a range of 3.1–5.7 cpm/10^{-8}Ci/ml was found for the sheet without indention. The difference between the

two ranges is due clearly to the enlargement of the surface by indention. Rather low values of sensitivity come from the fact that the counting has been made with very small portion of tritiated water in the limited range of β-particles, with excluding a great majority of the sample out of the measurable range.

It is noteworthy, however, that the rapidness and easiness in counting procedures are involved in the advantages of the present method. To change a sample of tritiated water with another, for instance, nothing but just replacing sample water was practically enough to proceed in the next counting. Radioactive contamination which sometimes took place at the scintillator surface was removed very easily by washing the chamber with running water. The present method thus seems to be suited especially for continuous measurement of tritiated water for hydrological and civil engineering purposes, for example.

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