§5. Development of a New Tritium Monitor by using a Plastic Scintillator -2

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Introduction Tritium measurement with plastic scintillator sheets (PS-sheets) by a prototype plastic scintillation counter (PSC-1) was effective to get high counting efficiency[1] and the speciality of PSC-1 is low environmental load because the method does not use liquid scintillator. Though the detection limit of PSC-1 was 0.01 Bq mL^{-1} for a tritium compound, it is able to be better when using more sample solutions to more PS-sheets. On the other hand, the PSC-1 is impossible to measure volatile tritiated water because the PS-sheets method needs drying process for the sample solution. As we developed a plastic scintillator pellets (PS-pellets) method[2], volatile tritiated water is possible to measure with high counting efficiency. So, we adapted the PSC-1 for PSC-2, which was able to measure tritiated water with PS-pellets.

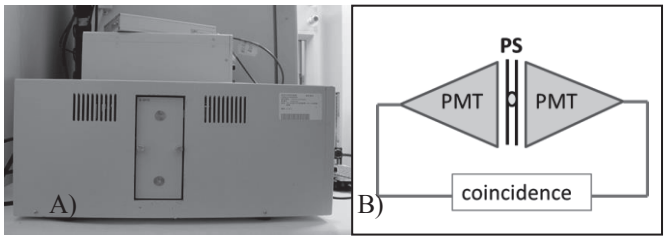
Experimental The PSC-2 was adapted the distance between 2 PMTs for 36.3 mm, which was 20.2 mm at PSC-1. So, containers for PS-pellets were able to attach to the PSC-2, which were made by quartz and/or acrylic, and the size was 48 mm in diameter and 25 mm in width. So the volume of the container was 2.2 times larger than the vial of 20 mL for a LSC. The equipment for the PSC-2 was able to attach to a 20 mL glass vial and also to attach to a PS-sheets holder as shown in Fig.1.

Tritiated water (Moravek Biochemicals) of 76Bq mL^{-1}~ 6.6kBq mL^{-1} were used to dilute with distilled water.

The PS-pellets used was EJ-200 (G-tech), which was 2,3 or 4 mm in diameter and in length. A liquid scintillator of ACS-2 (GE-Healthcare) was only used when the activity (Bq) was evaluated by using a Tri-Carb 3110TR (PerkinElmer).

We studied **1.** The difference of the counting efficiency depending on the PS-pellets size. **2.** Possibility of qualitative analysis. and **3.** Detection limit.

Results and discussion **1.** Though the weights in the acrylic container of 3 types of pellets were same, the counting efficiency of 2 mm, 3 mm and 4 mm were 4.4 to 6.4 %, 10.6 to 11.2% and 9.8 to 10.7%, respectively. Because the 3 mm pellet is general versatile products, the 3 mm pellets were used for this experiment. **2.** When 50 µL sample solution were used for each container, the relationship between the count rate and the activity at 2 h after the measurement start showed good linearity as shown in Fig.2. The elapsed time which showed the maximum counting efficiency of the PSC-2 was earlier compared with those of LSC. On the other hand, the counting efficiency was lower compared with that of using a 20 mL vial. The reason was that the the surface of the PMTs in the PSC-2 (PSC-1 was same) were covered with duralumin and the



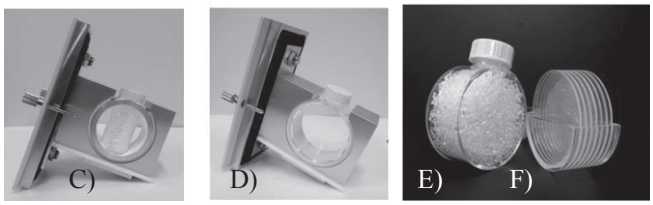


Figure 1 Plastic scintillation counter-2. A) is an outward, B) is a schematic diagram of inner PSC-2, C) is a holder with 20 mL glass vial for LSC, D) is a holder for a new container, E) is an acrylic container filled full with PS-pellets and F) is a holder for 7 PS-sheets.

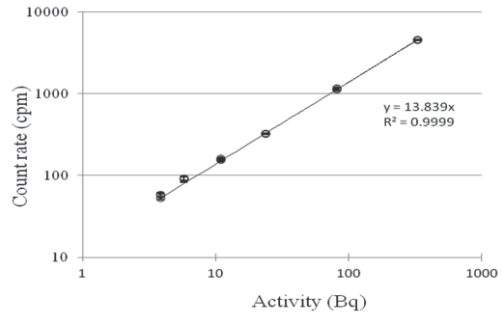


Figure 2 Relationship between activity and net count rate. The samples concentration from 3.8 Bq to 330 Bq/50µL showed good linearity.

open area was narrowed by the cover approximately 1/2.6. So, the cover was cut with a lathe. By this remake, the counting efficiency showed same of that of LSC; however both of the containers showed slight leakage. So, the counting efficiency was not so high depending on the volume increased. We need to make other type of container without leakage. **3.** The detection limit of 2 mL tritiated water with the PSC-2 was calculated 0.26 Bq mL^{-1} at 100,000 sec measurement. More shield for lower counts will be necessary for the PSC-2.

Conclusion A prototype device for plastic scintillator pellets was developed. The device was measureable for tritiated water without generation of liquid organic waste. Though the stable counting efficiency got earlier, slightly leakage occurred using the quartz and/or acrylic containers. So we need to remake the containers for PS-pellets. It is considered that more shield is necessary, the PSC will be a good device for tritiated water measurement.

1) Furuta, E. and Kawano T., *J. Appl. Radiat. Isotopes*, 104, 175-180 (2015)
2) Furuta, E. et al., *Isotopes in Environmental & Health Studies* on line 2016.1.4.