§8. Tritiated Water Measurement with High Measurement Efficiency by Plastic Scintillator

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On the nuclear fusion reactor research, the concentration measurement of tritium is one of the important issues. Generally, a liquid scintillation counter (LSC) is used for measurement of tritium concentration. Mixture of an organic solvent and surfactant is indispensable for LSC measurement of tritium. After the measurement by LSC, liquid scintillator becomes the radioactive waste and the treatment of radioactive waste needs time consuming and big budgets. The measurement method with plastic scintillator (PS), which is alternative material of liquid scintillator, is superior, because it is a no waste method for LSC[1)]. The purpose of this study is to develop a new measurement method of the tritium in high efficiency with no waste appeared. A characteristic of the tritiated water to the PS was examined as preliminary experiments for the PS conditions of measurement in 2011.

Tritiated water (Water, [3H]-; MT-924C) by using BC-400 (Saint-Gobain) was measured with cpm mode of Beckman 6500 without an external standard source. For a comparison, tritiated water was dissolved in liquid scintillator of ACS-2 and measured the radioactivity. The shapes of the PS were sheets, beads, chips and a cylinder with many holes. The examinations were as follows: 1. Possibility of the reuse after the tritiated water measurement with the PS. 2. Change of the measurement efficiency with the pH of the tritiated water. 3. Change of the background (BG) counts with the PS beads when used the vial of glass or polyvinyl for LSC. 4. Change of measurement efficiency by the shapes of the PS.

Some results were obtained as follows: 1.As a characteristic of the tritiated water, almost all radioactivities had not remained behind water evaporation by the natural drying. On the other hand, it was able to return the radioactivity to BG level by dipping the PS into the pure water after an experiment about 3 days, because there was little penetration to PS. 2. When the sheet PS was dipped into the tritiated water and added acid or alkali, around 10% of each count increased soon after the addition. However, it gradually decreased afterwards and agreed with the counts of before the addition. 3. The BG count of the beads PS was about 25cpm with a glass vial and about 50cpm with a polyvinyl vial. However, the measurement efficiency of tritiated water with the PS beads was almost 0.35% with a glass vial and almost 0.25% with a polyvinyl vial. 4. Many holes of 2.5mm in diameter were made onto the cylindrical PS. The measurement efficiency became high along the number of holes. When the number of holes of the PS was 9 vertical lines, 8 sides per step and 7 steps in polyvinyl vial, the measurement efficiency was approximately 0.33% at 100 h after addition of tritiated water.

For the measurement of the tritiated water using the PS, the drying down of it on the PS was impossible unlike a general tritium of labeled compounds[2)]. On the other hand, reuse of the PS was possible to put it in water because adhered tritium to PS was substituted with the water. The reason was that the surface of PS was not hydrophilic. There was a merit of reuse of the PS in this method because PS was not cheap, except for liquid scintillator did not become the waste fluid. The change of efficiency by addition of acid or alkali did not continue, so the addition was unnecessary. Furthermore, It was confirmed for a long time measurement that the tritiated water leaked out even if sealed it up. It is desirable to measure before tritiated water leak out, so a method to hasten measurement time is necessary. Further studies such as how to open holes on PS and/or how to improve of PS surface to be hydrophilic will be continued.

1) Furuta, E. et.al.: Radiocarbon, LSC-2010, (2011) 283-289.
2) Furuta, E. et.al.: Radiocarbon, LSC-2008, (2009) 19-26.