§10. Feasibility Study of Gaseous Tritium Sampling and Measurement System

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Tritium is radioactive hydrogen isotope emitting low energy beta and it had been generated in many nuclear facilities. In a future nuclear fusion facility large amount of tritium will be produced and processed. Regarding radiation safety and control, development of gaseous tritium monitoring system is indispensable issue. It also will be useful for safety management of a trivial tritium producing facility. To improve a convenient tritium monitoring system, we began to develop a system with functions of sequential tritium gas sampling and its measurement. A nebulizer and a denuder tube combined equipment, which is available as gaseous substance collector made by Kaken Co., would be applicable to tritaited gas sampling system [1]. The main process of the equipment is that water form tritium is continuously absorbed and separated as liquid solution by the nebulizer and through the denuder tube. The advantage of using the denuder is that it is not necessary to use dehumidifier like zeolite absorber packed bed. When applying this equipment, tritiated water would be directly collected as liquid. Conventional tritium concentration measurement in the collected liquid had been done by a liquid scintillation counter. However we selected a solid plastic scintillator as a detector. The advantage of the solid scintillator is expected to not produce organic and radioactive liquid waste.

The plastic scintillator used in this experiment was commercially available type NE102A. The plate size was width and length of 35 mm square. To the opposite side plastic plate width of 1mm and depth 0.5 mm long length of liquid flow groove was placed. When sample of tritiated water flow into the groove, photons produced by the plastic scintillator with incident β rays. The photons are incident to a photomultiplier tube and electrically counted. Figure 1 shows the image of the photons detecting system. Using this detector, background including noise of the photons detecting system was examined. Then various tritium concentrations solution was flow into the plastic plate groove. As result it was found that the photons count ratio was proportional to tritium radioactivity intensity namely tritiated water concentration. However its sensitivity was low as detection efficiency less than 1%. As comparison a little tritiated water and liquid scintillator mixed solution in a vial was directly measured by the photon counting equipment. Then it was possible to confirm sufficient sensitivity and linear relationships between tritium intensity and photons counting rate. Its detection efficiency was about 10%. As results of the preliminary experiments the following issues were clarified. One is to adopt more sensitive plastic scintillator, second is to quench the noise of the photons counting system and third is to effectively detect tritium β-rays in solution. In the present study we did feasibility study considering detection properties of the measurement system and discuss about various factors to sensitivity and background and noise level.

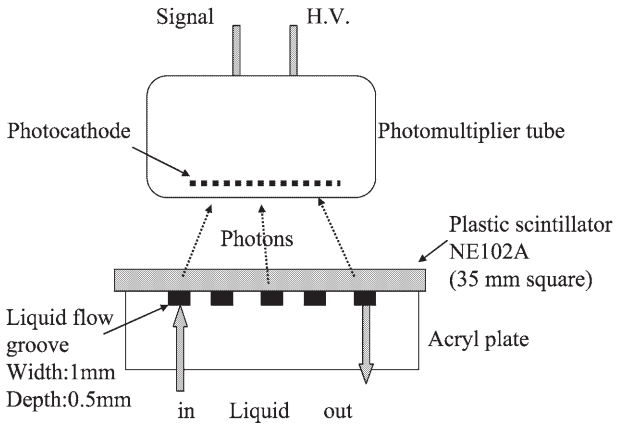

Fig. 1. Photons produced by plastic scintillator detecting system to measure in water.

Based on the feasibility study of the monitoring system, we designed concept of the tritiated gas sampling and measurement system. Figure 2 shows the air sampling system to capture hydrogen and hydride gases including tritium. When sampling air is evacuated into the system, hydrogen and hydride compounds are oxidized to water by high temperature catalyst of precious metal. The water vapor is absorbed to the liquid absorber in the nebulizer, and denuder tube, then the gas and liquid is separated through the separator. Finally the enriched solution is flow into the plastic scintillator and photon counting equipment. The near future problems are to design precisely and to make experimentally the air sampling system and the improved photon counting equipment.

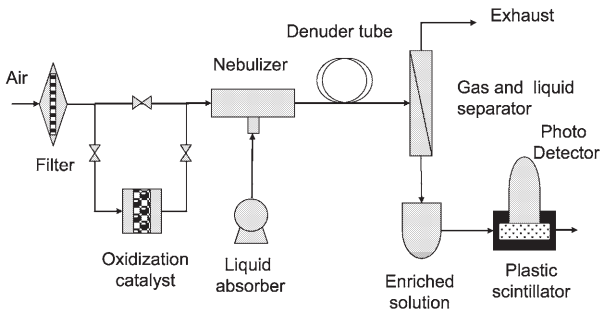

Fig. 2. Conceptual design for the tritiated air sampling and measurement system by using plastic scintillator

1) Kurosawa, K.,: Bunseki Kagaku **54** (2005) 1175