

§7. Development of an Environmental Atmospheric Tritium Monitoring System with Automatic Discriminate Sampling of Different Chemical Forms

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In the future experimental fusion, tritium monitoring system will be indispensable as the environmental radiation safety issues. In the case of the LHD experiments, it is necessary to establish the atmospheric tritium monitoring system to comprehend the detailed variation of background tritium level before the D-D experiment and to monitor the tritium level after starting of the experiment. Atmospheric tritium consists of three different chemical forms, HTO, HT and CH_3T . The quality factors of these species vary significantly in the Japanese law for radiation protection. Hence, it is desired that all tritium species should be monitored from the viewpoint of radiation protection.

The environmental tritium concentration at the Toki site has measured in association with Kyushu University and the technique used was confirmed as reasonable and proper though the technique was manually operated and rather complex. For the practical use of this technique, the automation of the measurement is essential. We report the results of trial run for an environmental atmospheric tritium monitoring system with automatic discriminate sampling of different chemical forms developed in this study.

i) Specification of the monitoring system

The system is active sampling type where the air is introduced into the collection system by a pump. The air was dehumidified by the first large sieve trap and the second insurance trap. After the water vapor was removed, the hydrogen carrier made by electrolysis of tritium-free water was added to the air, where the moisture which vaporized from the electrolytic cell was adsorbed in the third sieve trap. HT diluted by tritium-free hydrogen was then converted to HTO in the first combustion column loaded with the Pd catalyst. At this stage, only hydrogen was selectively oxidized and the generated vapor was adsorbed in the fourth sieve trap. At the following stage, a tritium-free methane carrier from the gas cylinder was added. CH_3T diluted by tritium-free methane was then converted to HTO in the second combustion column, and the vapor was adsorbed in the final sieve trap. The trapping columns were degassed at 400 °C under N_2 gas flow, and the vapors were recovered into the cold traps and stocked as the sample solutions for

counting.

The air sampling process and the successive degassing (recovering) process are operated automatically by the electrical timer in the predetermined intervals.

ii) Proof tests for collection and recovery processes

Prior to tritium sampling, all columns had already been degassed by heating them under N_2 gas flow. The sieve columns were kept at 400 °C until complete degassing. The columns were immediately capped and weighed. After sampling, the columns were again weighed. The weight of collected tritiated water was obtained from the increased weight of the trapping columns. In the same way, the weight of degassed tritiated water was obtained from the decreased weight of the trapping columns before and after the degassing process.

The results obtained are shown in Fig. 1. The weight of above 10 g is attained for almost sample solutions of all the different chemical forms, where 10 g is the minimum quantity to make a counting cocktail. The values for water vapor vary widely because of humidity transition. The typical recovery rates are 95 % for the sample of water vapor and 75 % for those of hydrogen and methane. In order to upgrade the accuracy of measurements, the recovery rates for hydrogen and methane must be heighten by improving the degassing process.

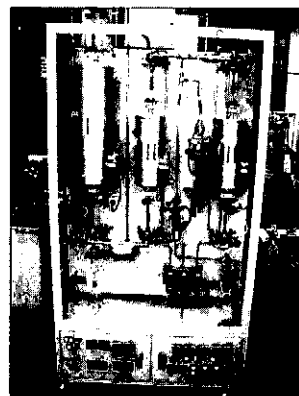


Fig. 1: Environmental atmospheric tritium monitoring system with automatic discriminate sampling of different chemical forms

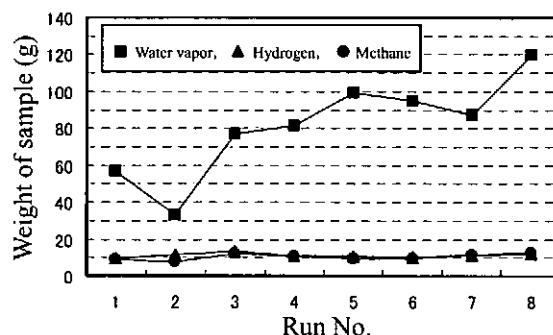


Fig. 2: Weight of the samples for different chemical forms