§5. A Level Transition of Organically Bonding Tritium Concentrations of Pine Needles at Toki Area

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Considering the environmental radiation safety issues, environmental tritium monitoring will be desired for the future experiments of LHD deuterium plasma discharges. The variation of environmental tritium level at Toki site should be measured previously to the deuterium plasma experiments and the tritium level transition should be understood. Environmental tritium measurement had been done for environmental water, atmospheric gases and organically bonding tritium (OBT) of pine needles. The atmospheric tritium sampling had been measured for three chemical forms such as water HTO, hydrogen HT and methane CH_3T since 2004. Also OBT and tissue equivalent free water TFWT of pine needles had been measured since 2000. This analysis had been conducted mainly by Japan Chemical Analysis Center JCAC and by Kyushu Environmental Association.

Pine sampling and measurement method

The OBT of pine needles was analyzed and the measured values were cross checked. Pine needles were collected every 3 months at the NIFS Toki site and at Shiomi park where is 9.5 km south far from the Toki site. In the early phase, it was collected at Heiwa park in Nagoya city. The fresh pine needles of about 600 g were sealed in a polyethylene bag and they were stocked in a freezer just on the sampling day. Usually to obtain the annual trend the collected 4 samples from May to February in the next year were mixed just time when they were analyzed. The analytical procedure conducted by KEA (Kyushu Environmental Association) was almost based on the method reported by Takashima of Kyushu University. The pine needles were cut into a few cm in length to dry for 2 days by vacuum drying method. Then the pine weight was decreased to a half. The dried pines 100-150 g was combusted in a quartz tube under gas purge of nitrogen and oxygen. To get completely combustion 0.5% Pt-alumina catalyst was set before the outlet. The water vapor including HTO was trapped by a cold trap. Finally almost a quarter of the pine needles weight was obtained as water. The tritium concentration in sampled water was measured with a low background liquid scintillation counter. The OBT analyses in the early phase had been conducted by JCAC. Mostly difference with analyzers was counting time, namely the counting time by JCAC was 500 min, and KEA was 1000 min.

Results of measurement

Fig. 1 shows the annual variation of the OBT and TFWT concentrations in pine needles at Toki site and reference places. It tends to decrease slowly since 1998. The analytical data conducted by JCAC and KEA were almost consistent. The data of KEA were expected with small error deviation because it took long counting time. Using the observed OBT data in the Toki site, its decreasing rate to half was estimated about 9.4 years by using the exponential curve fitting equation. It was found that the decreasing rate since 2004 seems to be very low. Also we analyzed about the pine needles in every three month as sampled. Unfortunately it was difficult to achieve apparently the seasonal variation tendency. This might be because the lack of measurement samples. So it is necessary to accumulate more data. The atmospheric tritium concentration of HTO in the same year was distributed around 0.5 Bq/L. Comparing with the level of atmospheric HTO concentration, the level of OBT and TFWT concentrations was almost the same.

Additionally the OBT concentrations of pine needles at Toki site were compared with the levels measured by ^{3}He mass spectrometric method. This method is unique because it is analyzing ^{3}He gas generated by tritium beta decay of which half time is 12.3 years namely about 5% of tritium is changed to ^{3}He in a year without dependent on the tritium chemical form. It is not necessary the process of combustion, catalytic oxidation and radiological detection. The ^{3}He mass spectrometry analysis was conducted in IES (Institute for Environmental Sciences) and its principal procedure is reported anywhere. The measured values were almost consistent with the data obtained by burning and liquid scintillation counting method. However more crosscheck examination should be performed. Also to confirm the seasonal trend more data accumulation is planned in the next stage by analysis for every 4 samples in a year.

To provide for future deuterium plasma experiments, continuous and long term atmospheric tritium monitoring data accumulation and the OBT measurement will be valuable for the environmental safety consideration. Also it might be important to measure in the environment around no nuclear facilities from view point of safety and environment on future nuclear fusion development.

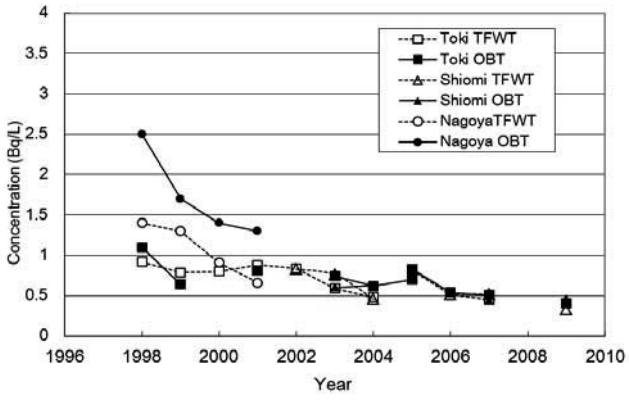

Fig. 1 OBT Tritium concentrations in pine needles at Toki and reference place.