§1. Investigation of Tritium Tracking and Safety Confinement for D-D Burning in LHD

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When the D-D burning experiment will start in LHD in the near future, a trace of tritium will be generated in the plasma chamber of LHD in the course of D-D burning. Part of the tritium generated in the plasma chamber migrates through structural materials and is sorbed in/on the component materials, and rest of it is evacuated by a vacuum pump system and then is supposed to be transferred to a tritium removal system. Confinement of trace tritium is a passing point to go through a future commercial D-T fusion reactor to have to handle a large amount of tritium. Consequently, the former, i.e., the investigation of tritium tracking and tritium safety confinement and the latter, i.e., the establishment of the tritium removal or purification system, heavily affect the reliability of the D-D burning experiment of LHD. Especially, tracking and safety confinement of a large amount of tritium at a very low level have not been demonstrated anywhere. In the present study, the tritium-relating issues, tritium tracking in the fusion facing materials and the tritium safety confinement, were reviewed by many tritium researchers and discussed extensively at NIFS. Then experimental investigations were made on the tritium tracking and safety confinement.

Extensive discussion of the tritium tracking and safety confinement for the D-D burning in LHD was made on September in 2000 at NIFS. The workshop report was issued in 2000. Participants were more than 50 researchers including Japanese universities, JAERI, NIFS and other institutes. The number of the oral presenters was ten. The topics reviewed were (1) tritium tracking in the D-D burning in LHD, (2) tritium inventory in/on materials, (3) tritium in Laser fusion devices, (4) development of tritium technology in JAERI, (5) tritium environmental effect, (6) decontamination of tritium on metal oxides, (7) tritium recovery and removal apparatus, (9) tritium behavior in JT-60, (10) tritium generation in JT-60U. Other tritium-relating issues were also discussed there. The discussion was useful not only for the D-D burning experiment in LHD but also for the tritium safety study and fusion reactor designs worldwide.

Tritium experimental investigations were also carried out in Kyushu University. Rates of tritium release from 304 stainless steel and aluminum were experimentally obtained as shown in Fig. 1 [1]. The system effect of tritium arises from the interaction of tritium in gas phases with water on surfaces of piping materials. Water adsorption and two isotopic exchange processes between HTO and H_2O and between HT and H_2O were taken into consideration in the numerical analysis. The tritium release curves from 304 stainless steel or aluminum could be fitted by the numerical calculation in terms of a proper value of the mass-transfer capacity coefficient, K_Fa. The K_Fa values were almost independent of temperature.

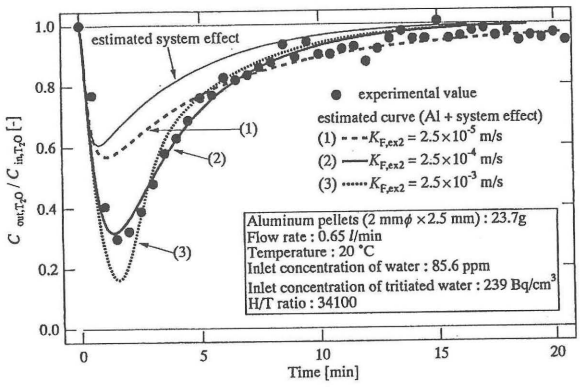

Fig. 1 tritium release curve from 304 stainless steel

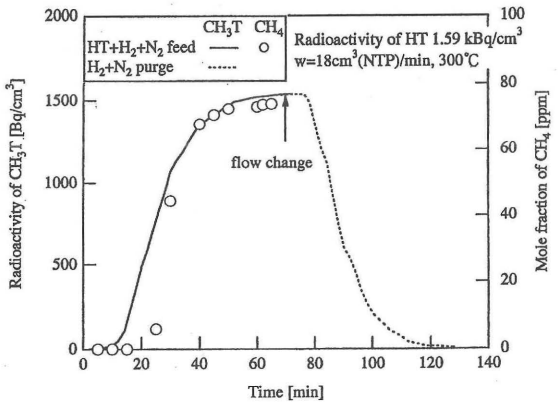

Fig. 2 Variations of tritiated methane radioactivity determined by ionization chamber and CH_4 concentration by gas chromatography with time

Tritiated methane is an important species generating in the reactor room and fuel exhaust gas of LHD. However, experiment has hardly been carried out using tritiated methane because generation of tritiated methane was difficult. We developed a new method using successive conversion from tritium gas to tritiated methane using a CuO-Al_4C_3 bed heated to 573K [2]. Figure 2 shows variations of CH_3T and CH_4 concentration. An arbitrary radioactivity of tritium methane could be generated by the CuO+Al_4C_3 bed. The difference in output between the ionization chamber and gas chromatography was explained based on the complete-mixing series-tank model.

Reference
1) Nakashio, N. et al.: Fus. Technol., **39** (2001) 189-197.
2) Fukada, S.: J. Nucl. Sci. Technol., **38** (2001) 273-277.