Development of tritium recovery by flowing O_2+Ar gases at steam generator in fast breeder reactor

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In the fast breeder reactor, tritium is produced by some nuclear reactions. Although most of tritium will be scavenged by cold trap in sodium coolant, some of tritium will permeate through the metal pipe and extracted to the environment. Tritium behavior in the fast breeder reactor has been already simulated using TTT (Tritium Transport and Trap Analysis) Code and the amount of tritium leakage is concluded to be negligible small due to concentration regulation by the law.

However, to enhance the social acceptance for the fast breeder reactor, tritium released from the reactor should be lowered without major design reconsideration. In the present study, the tritium recovery technique in the steam generator under the double pipe concept was proposed. Argon or helium gas with a few amount of oxygen gas was purged inside the double pipe and tritium permeated through the pipe will be scavenged and converted to tritiated vapor. This paper presents recent experimental results using tritium gas diluted by deuterium gas and simulation results for the comparison of actual situation.

Two stainless steel (Type 316) membranes simulated as double pipe was installed in the tritium permeation and recovery system and Ar gas with a few amount of oxygen gas (10 – 10000 ppm) was filled between the two membranes. 1 GBq tritium diluted by deuterium gas was exposed to the first membrane with the pressure of 100 Pa at 623 K. Thereafter the permeated tritium was measured by dual proportional counters to separate HT and HTO.

It was found that the amount of tritium permeated through the first membrane was lowered by the addition of 10 ppm oxygen. In addition, more than 95% of tritium was converted to the HTO form. In the simulation, tritium permeation and leakage were simulated by combination of the DFT calculation and the Monte Carlo simulation. It was found that the amount of tritium permeated thorough the pipe was reduced by an oxide layer on the topmost surface, although additional oxide layers increased the tritium retention and was not effective to reduce the permeation amount. In the presentation, comparison with experimental results and deuterium permeation through the double pipe will be discussed in detail.

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