TRANSIENT RESPONSE SIMULATION OF TRITIUM REMOVAL WITH GAS SEPARATION MEMBRANE

T. Sugiyama[1], N. Miyahara[1], M. Tanaka[2], I. Yamamoto[1]

[1] *Nagoya University, Fro-cho, Chikusa-ku, Nagoya 464-8603, Japan*

[2] *National Institute for Fusion Science, Oroshi-cho 322-6, Toki 509-5292, Japan*

Corresponding author: t-sugiyama@nucl.nagoya-u.ac.jp

For fusion reactors, where a huge amount of tritium will be handled, it is necessary to establish the technology for the confinement and removal of tritium. A conventional method is to oxidize tritium by a catalytic reactor and to remove tritium by a molecular sieve bed. Some dozens of molecular sieve beds and a complex switching control of the beds are required for continuous processing with a large throughput because molecular sieve beds need desorption treatment before the breakthrough time. In addition, desorption process consumes a large amount of energy. These problems will be fatal defects for a future fusion reactor which needs a quite large confinement space.

One of the alternatives is a gas separation system using a hollow fiber membrane. The advantages of the membrane system are compact scale, low energy consumption, and high reliability for operation and maintenance without a complex switching control. A number of studies have been presented in order to apply gas separation membranes to tritium removal systems of fusion reactors. Although it is very important to investigate transient responses of such membrane systems in practical use the simulation method has not been established yet. The concentration of water vapor at the outlet of the membrane module is very slow to respond against the concentration change at the inlet of the module and this slow response cannot be simulated by the simple model which is based on the experimental parameters such as permeability ratio.

The purpose of the present study is to develop a mass transfer model which enables us to simulate transient responses of a membrane module. The polyimide membrane consists of two layers: a very thin non-porous layer and a thick porous support layer. The competitive adsorption of the gas molecules at the surface of non-porous layer, the diffusion in the non-porous layer, desorption at the interface between porous and non-porous layers, the Knudsen's diffusion in the porous layer and the adsorption-desorption equilibrium at the porous layer are considered in the present model with time variation.

The hollow fiber type of polyimide membrane module used in the experiments was manufactured by Ube industries Ltd. (code UMS-B2). The size of the module was 65 mm diameter and 430 mm long. Water vapor concentration at the outlet of the module was measured under the condition that the water vapor concentration at the inlet was changed as stepwise and that the reflux ratio of the dried gas was changed as stepwise. These transient responses of the membrane module were well simulated by the present model.

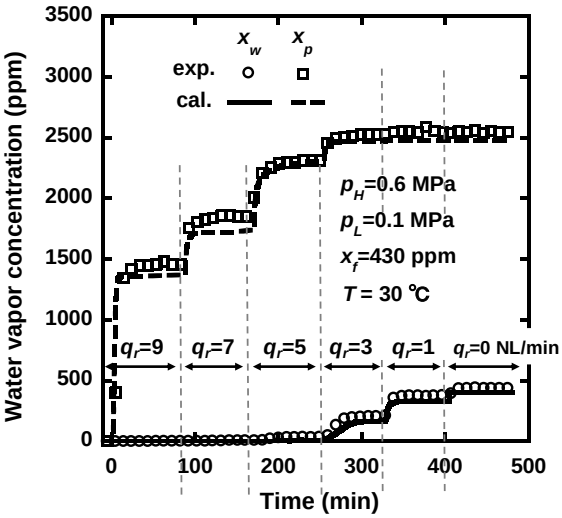

Figure 1: Transient response for the stepwise change in the reflux ratio