§8. Application of Membrane Dehumidifier for Gaseous Tritium Recovery in LHD

Asakura, Y., Tanaka, M., Uda, T., Ogawa, H., Takami, S.

Deuterium plasma experiments are currently being planned for the Large Helical Device (LHD) of the National Institute for Fusion Science (NIFS), following the present hydrogen plasma experiments.

Among atmosphere detritiation systems, methods which collect gaseous tritium as tritiated water using the combined processes of catalytic oxidation and adsorption have been widely applied in Japan and overseas. To develop more compact and cost-effective systems, the applicability of using a commercially available membrane dehumidifier with the LHD detritiation system is evaluated experimentally under the following conditions.

(1) The permeate side is operated under atmospheric pressure.
(2) The dry bleed gas is purged to the permeate side with variable flow rates.
(3) The target dew point is less than - 60 °C, which is almost equivalent to the actual performance of a molecular sieves (MS) dryer bed.

Design Concept of Detritiation System in LHD

In the LHD, two types of tritium recovery systems are planed for installation. One system will be used to recover tritium generated during the plasma experiments (Vacuum Pumping-Gas Treatment Sys.) and the other to enable inspection and maintenance of the LHD vacuum vessel (Vacuum-Vessel Purge-Gas Treatment Sys.) [1].
we are planning to apply a polymer membrane dehumidifier to the Vacuum-Vessel Purge-Gas Treatment System. The applied configuration and process flow of the system are shown in Fig. 1.

Table 1 summarizes the design conditions at present.

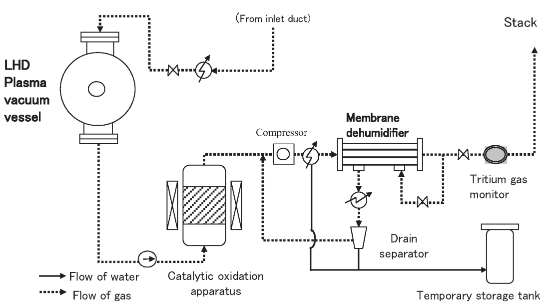

Fig.1 Design of the detritiation system for LHD.

Table 1 Design conditions

Treatment flow rate (m^3(STP)/h)	300(Max.)
Operation time (h/yr)	4,000
Tritium generation amount (GBq/yr)	55.5
Tritium conc. in treatment gas (Bq/cm^3)	0.05
Tritium recovery rate (%)	≧95
Humidity of treatment gas (ppm)	1000(Min.)

Hybrid System Combining Membrane Dehumidifier with Absorbent Column

As shown in the previous report [2], the time delay before the targeted dew point is reached cannot be disregarded in the membrane dehumidifier. This time delay is not acceptable for an atmosphere detritiation system in which tririated gas is treated only once and continuously exhausted to the environment. In order to improve the transitional performance, we have designed a system that combines the membrane dehumidifier with an absorbent column, as shown in Fig.2.
The operating procedures for this hybrid system are summarized as follows.

(1) Non-static operation

Non-static operation is implemented just after start-up or in case of a sudden change in operating conditions. In this case, the residual gas from the membrane dehumidifier is fed to the absorbent column in order to reduce the dew point to a level below the target value. Part of the dry gas from the absorbent column is used as the purge gas for the membrane dehumidifier.

(2)Static operation

When the residual gas from the membrane dehumidifier has reached the dew point and has been kept constant for a given length of time, the absorbent column is separated from the system.

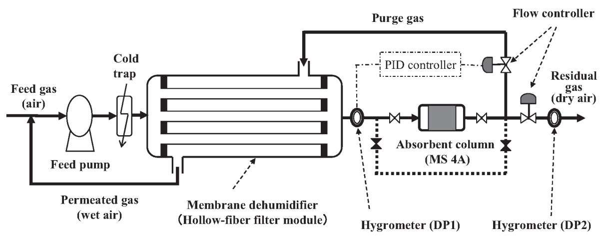

Fig.2-1 Non-static operation

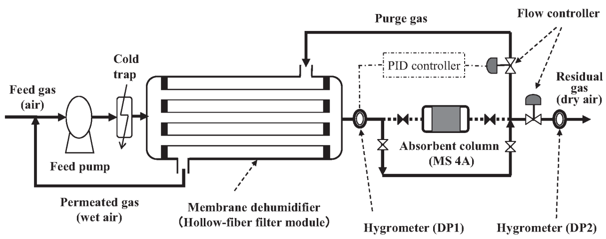

Fig.2-2 Static operation

Demonstration test data indicate that the proposed hybrid system can be applicable to an actual atmosphere detritiation system in which the designed tritium decontamination factor needs to be kept within acceptable limits at all times under various operating conditions. Now, we are planning to apply this hybrid system to the LHD.

[1] Y. Asakura, et al., Fusion Sci.Technol.,Vol.48,401(2005)
[2] Y. Asakura, et al., Annual Report of NIFS, p470 (2006)