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

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In order to realize the planned deuterium plasma experiments using the Large Helical Device (LHD), the National Institute for Fusion Science (NIFS) is planning to install a system for tritium recovery from exhaust gas.

While adopting typical tritium recovery systems, NIFS has also made plans for the development of a compact reduced-waste recovery system by applying a membrane type dehumidifier [1]. The applicability of a commercially available membrane dehumidifier has been evaluated experimentally, with the results indicating such a membrane is feasible for practical application [2].

Based on performance test results, the optimum specifications of the membrane dehumidifier are also evaluated quantitatively [3].

As the next step, we have carried out the basic design of the actual tritium recovery system for LHD.

**Basic Design 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 membrane dehumidifier to the Vacuum-Vessel Purge-Gas Treatment System having the treatment capacity of 300 $m^3$(STP)/h [4].

**Construction of Test Apparatus for Verification of Continuous Recovery of Tritiated Water**

In this system, the wet outlet air (purge gas) of the membrane dehumidifier is returned to the inlet of the feed pump and dehydrated under compressed condition.

Continuous wet purge gas recycling operation between the membrane dehumidifier and the feed pump under various flow conditions is the key function in this tritium recovery system.

So, we have just constructed the small test apparatus having the capacity of 1/10th (30m3/h) and applying the same flow control system as the actual tritium recovery system [4].

**Verifying Performance in Continuous Moisture Collection**

The experiments were carried out using a commercially available polyimide hollow-fiber module (Ube Industries, UM - 10, OD: 90 mm, L: 1160 mm). The feed side pressure was kept at 0.9 MPa (abs) and the permeate side was operated under atmospheric pressure.

Studies on another type of dehumidifier module have indicated that conventional PID control of the purge gas flow rate is effective in maintaining a target dew point during long duration operation, as follows.

$$m(t) = K_p e(t) + K_j \int e(t)dt + K_d(\frac{de(t)}{dt})$$

Here m(t) is the output signal (purge gas flow rate), e(t) is the error signal (difference between the target dew point and the actual value), $K_p$ is the proportional gain, $K_i$ is the integral gain, and $K_d$ is the derivative gain.

As shown in Fig.1, this control method is also effective for the test module used in the actual system.

As shown in Fig.2, the inlet feed gas flow rate, as measured with a volume flow meter, remains almost constant throughout, which shows continuous moisture collection could be achieved in this system by compression under inverter control.

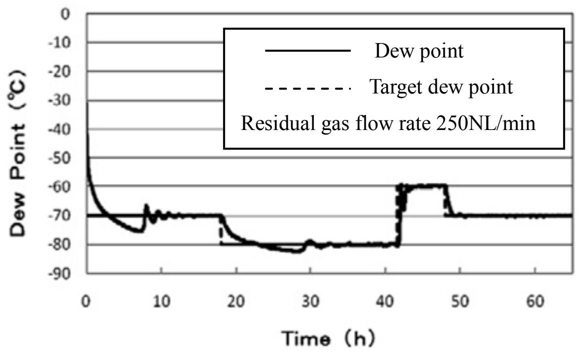


Fig.1 Dehumidifier performance under PID control

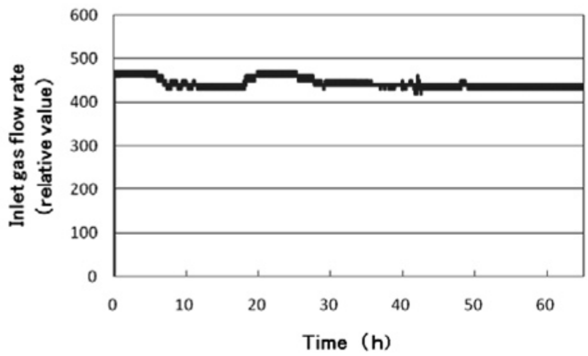


Fig.2 Inlet feed gas flow rate over time

1) Y. Asakura, et al., Fusion Sci.Technol.,Vol.48,401(2005)
2) Y. Asakura, et al., Fusion Sci.Technol.,Vol.54,75(2008)
3) Y. Asakura, et al., J. Nucl. Sci. Technol., Vol.46, 641 (2009)
4)Y. Asakura, et al., Ann. Rep. NIFS (2009-2010) 472