# §27. Analysis of Tritium Transfer Dynamics for Helical Prototype Nuclear Reactor System Design

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**i) Introduction**

Many studied were devoted to elucidate fundamental tritium retention and transport behaviors in fusion reactor under well-controlled condition. However, it is quite difficult to apply these data derived under well-controlled condition to actual and larger scale plasma devices or fusion devices due to lots of uncertainties. Therefore, the key parameters should be acquired for the extrapolation of laboratory data (well-controlled condition data) to actual reactor design.

Plasma experimental device, namely EXPRESS (Effluence and Exchange Probe for Recycling Estimation at NIFS and Shizuoka University) was established to study plasma-surface-interaction (PSI) in last year. The deuterium was introduced to ignite plasma in this device. It was revealed that impurities such as concentrations of hydrocarbon and water were increased after ignition of deuterium plasma by knocking out of adsorbed impurities on the chamber and reaction between deuterium and impurities. These results indicated that impurities in emission gas during plasma operation were increased compared to that in plasma source gas. Therefore, emission gas should be purified to re-introduce as source gases of plasma. In this year, primary purification system for the decomposition of hydrocarbons and the other impurities, and secondary purification system to recover higher purified hydrogen isotope gas were designed and purification capacity of these systems was examined.

**ii) Establishment of purification system**

As ST 2002 manufactured by SAES Getters was chosen to use for primary purification material due to effective trapping of $O_2$ and $CO_2$ and decomposing of hydrocarbons. To decide the operation temperature during purification process, thermal desorption spectroscopy measurement (Heating range: R.T. - 1200 K, Heating rate: 5 K / min) for ST 2002 after $D_2$ exposure was performed. More than 90% of deuterium retained in ST 2002 was released from ST 2002 at 973 K, indicating that hydrogen isotope would be hardly retained in ST 2002 by steady heating at 973 K, which was determined as operation temperature.

Secondary purification to recover higher purified hydrogen isotope gas was performed using permeation technique through Palladium membrane manufactured by Nihon pionics. When test gas ($H_2$:99.5%, $N_2$:0.5%) was introduced into the membrane, only hydrogen was permeated, showing that higher selective permeation of hydrogen isotope and reduction of impurities by the Palladium membrane was demonstrated.

Figure shows the schematic view of purification system connected with PSI part of EXPRESS. In this device, emission gas during plasma operation is reserved in the Reserve Tank. After reservation, emission gas is passed through ST 2002 for primary purification. In all time, the progress of purification is monitored by quadrupole mass spectrometer. After the primary purification, The gas was transferred to the secondary purification system , namely palladium membrane In the same time, impurity containing gas not permeated into palladium membrane is passed through ST 2002 again for re-purification. The higher purified gas permeated through palladium membrane is stored by MS-5A or ZrCo. It was concluded that more than 99.97% of deuterium was purified by the present system.

In the next year, hydrogen isotope purified by the purification system will be re-introduced to clarify hydrogen isotope fuel cycling.

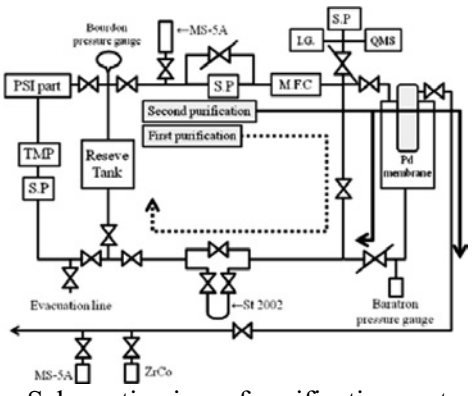


Figure Schematic view of purification system in EXPRESS