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§3. Development of Advanced Catalyst for Isotope Exchange Reaction Quantification of Reaction Rate

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The isotope separation by chemical exchange is an indispensable process, which is used for the treatment of tritiated water generated in heavy water reactors. In fusion power plants, which are now under development, the treatment of tritiated water is required as well, and thus the establishment of the chemical exchange process is necessary. In the chemical exchange process, the catalyst, which promotes the isotope exchange reaction, plays a key role. Therefore, catalysts with advanced performance need to be developed. Diversified processes would be placed in the limited space of fusion power plants. The development of the catalysts with advanced performance could lead to higher operation efficiency and decreased volume of the chemical exchange process. In this work, an experimental apparatus used for measurement of the isotope exchange reaction rate was prepared, and the performance of the Pt/Kogel catalyst, which is generally used in the chemical exchange process, was examined.

In the experiments, a reactor made of quartz was used. The temperature of the reactor was changed in the range of 20 K to 373 K. The argon gas containing hydrogen and heavy water vapor was introduced to the reactor. The concentrations of hydrogen and heavy water vapor at inlet and outlet stream of the reactor were measured with a mass spectrometer. The flow rates were controlled with conventional mass flow controllers.

Figure 1 shows the conversion ratio of deuterium atom from heavy water to D_2 when the argon gas containing hydrogen of 4900 ppm and heavy water vapor of 5300 ppm was introduced to the reactor charged with the 0.46 g of Pt/Kogel catalyst. Detailed experimental conditions are summarized in the figure. As seen in the figure, the temperature dependence of conversion ratio is small, which is almost 35 % in the whole temperature range. Since isotope ratio of D_2O and H_2 in the argon gas introduced to the reactor, the conversion ratio is expected to be 50 % if the exchange reaction rate is very fast and it reaches equilibrium. However, the conversion ratio obtained in the experiment is lower than the value. Therefore, the experimental condition used in the experiment is thought to be appropriate for the quantification of the exchange reaction rate. Experiments with different conditions in terms of concentration of hydrogen isotopes, gas flow rate and amount of catalyst are planed to be carried out to quantify the exchange reaction rate.

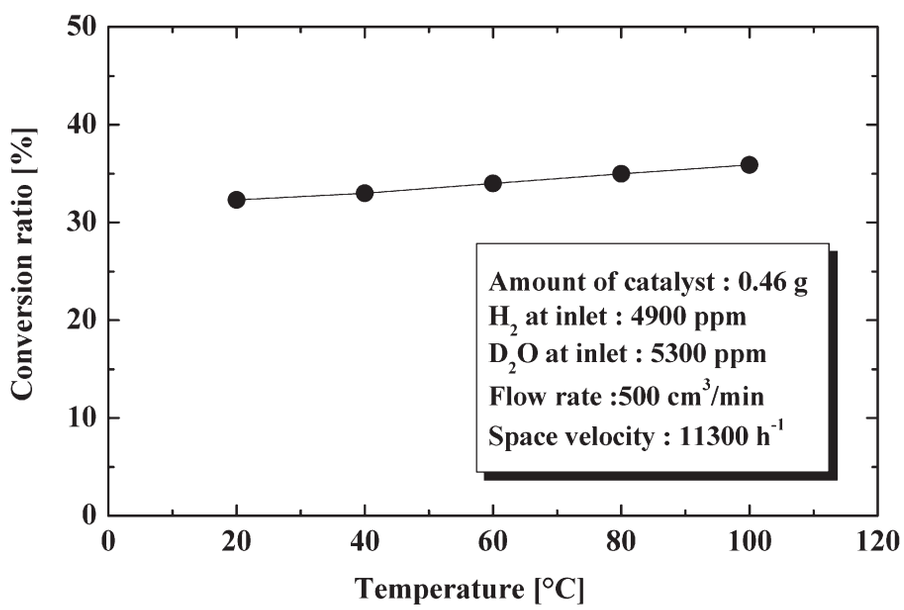

Fig. 1 Conversion ratio of deuterium over Pt/Kogel catalyst