§96. Study on Effect of Concentration Effect on Catalytic Combustion of Hydrogen Isotopes

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Recovery of tritium released into the working area of fusion power plants is an important technique to establish safety of the fusion technology. The catalytic oxidation and adsorption is the most conventional and reliable method for removing tritium that is accidentally released into the working area of these facilities. The catalysts used for these purposes need to possess high catalytic performance for low temperature combustion of tritium. The air cleanup system needs to be designed to be able to deal with the air with high volumetric velocity. Up to now, the authors have worked on the development of such catalysts. More recent experimental results carried out by other authors suggest that rate of catalytic combustion is affected by variation in concentration of hydrogen isotopes. This effect should be thoroughly examined for design of the air cleanup system. With this background, the authors examined the effect of concentration of hydrogen isotopes on their catalytic combustion.

The effect of concentration of hydrogen isotopes on their catalytic combustion was investigated using an experimental apparatus shown in Fig. 1. In the experiments, the catalysts were charged in a reactor made of quartz. The temperature of the reactor was varied in the range of 0 to 80 °C. The argon gas containing hydrogen (100 – 10000 ppm) and oxygen (20%) was introduced to the reactor. The concentrations of hydrogen at inlet and outlet streams of the reactor were measured with a gas chromatograph and a mass spectrometer. The flow rate (10,000 1/h of space velocity) was controlled with conventional mass flow controllers. The catalyst used in the experiments is a 4.1%/L Pt/Al_2O_3 catalyst (DASH-520) manufactured by NE CHEMCAT Co. (shown in Fig.2). The catalysts were reduced under the stream of hydrogen at the temperature of 4000 °C before the experiments.

Figure 2 shows the conversions hydrogen with different inlet concentrations over the catalyst used as a function of temperature. As seen in the figure, conversions of hydrogen decreased with decreasing inlet hydrogen concentration. On the assumption of pseudo first order reaction, the mass transfer capacitance was evaluated using the experimental data. Figure 3 shows the mass transfer capacitances as functions of reciprocal temperature. It is seen in this figure that the mass transfer capacitance for catalytic combustion decreases with decreasing inlet hydrogen concentration. The values of mass transfer capacitance at the hydrogen concentration of 100 ppm are approximately 1/2 of those values at 10000 ppm of hydrogen concentration. In terms of activation energy for the mass transfer capacitance, effects of variation in concentrations of hydrogen appear to be week and the effect seems to be more prominent in frequency factors. The experimental results shown above indicate that the concentration of hydrogen affects their catalytic combustion rate. Further investigation needs to be carries out using deuterium.

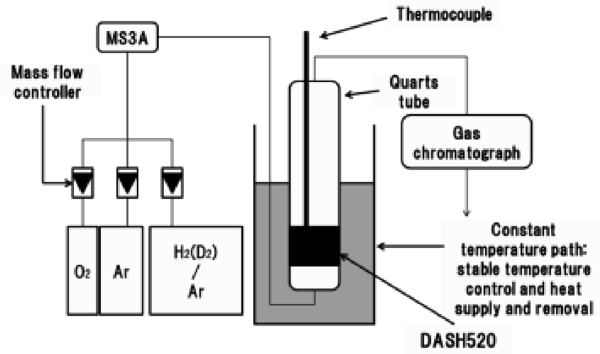

Fig. 1 Flow diagram of experimental apparatus

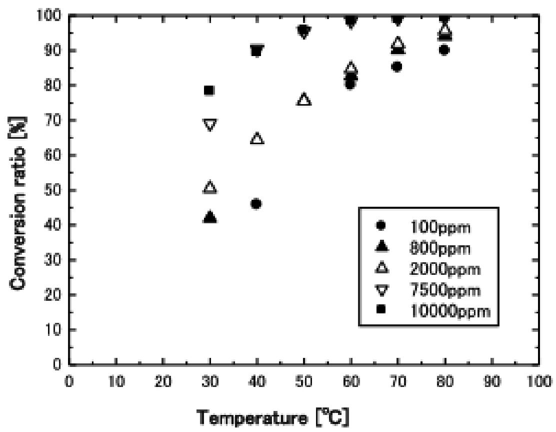

Fig. 2 Conversion of hydrogen over DASH 520

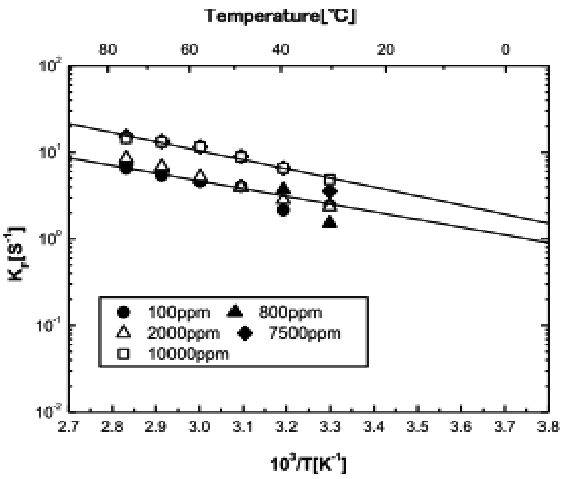

Fig. 3 Mass transfer capacitance over DASH 520