§7. Performance of Honeycomb Type Catalysts for Oxidation of Tritiated Hydrogen and Methane Gases

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Recovery of tritium released into a tritium processing room in a nuclear fusion plant is a key issue of safety. The catalytic oxidation of isotopic hydrogen including tritium is a conventional method for removing tritium that is released accidentally into the working area. If tritium release occurs in the fusion plant, large volume of air should be treated by an air cleanup system. Thus, the cleanup system would be designed by considering the high volumetric velocity of the process gas. Such high throughput of air causes pressure drop in the catalysis bed, which results in high loads to pumping systems or compressors. The present study dealt with honeycomb catalysts, which are generally used in the automotive industry, and examined their feasibility to the tritium recovery system operated under higher volumetric gas rates. At first the pressure drop was estimated for particle-packed beds (3 mmϕ particles) and a small-diameter (1 mm) tube modeled for honeycomb catalysts. Comparison of the two cases shows that the pressure drop of honeycomb catalyst is smaller than that of the packed bed by one order of magnitude. Therefore, the honeycomb catalyst is apparently suitable for the high throughput of air. The next attention is to obtain the oxidizing properties of honeycomb catalysts whether it is suitable for application to the fusion tritium cleanup system. The catalytic oxidizing experiments of honeycomb catalysts have been performed using hydrogen and methane mixture gas. It was performed using two honeycomb substrates which are cordierite and Al-Cr-Fe metal alloy with cell density of 400 CPSI (cells per square inches). In the experiments, the gas flow rate and temperature were varied to obtain more detailed engineering data. Figure 1 shows the example of oxidation of H_2 and CH_4 over the Pt/cordierite catalyst Pd/cordierite catalyst. As seen in this figure, H_2 is almost completely converted to water at 100 °C even at the space velocity of 3800 h^{-1}, which indicates that the performance of the Pt/cordierite catalyst is higher than that of conventional Pd/cordierite catalyst. Thus, it was found that the Pt/cordierite catalyst is effective for oxidation of hydrogen isotopes gases with high throughput.

It was also examined about the conversions of H_2 and CH_4 over the Pt/20%Cr-5%Al-Fe catalyst with the cell density of 400 CPSI. In comparison with the results for the cordierite and metal honeycomb catalysts considerable well catalytic oxidizing performance was observed.

As the results, it was found that honeycomb catalysts are useful; especially the cordierite honeycomb possesses better oxidizing property than the metal honeycomb. Whereas the metal honeycomb has an advantage for oxidation of hydrogen gas under room temperature, because it does not have structural water molecule that would cause memory effects via tritium contamination. Based on the database obtained, the catalyst volume was estimated for a volumetric velocity of 1000 Nm^3/hour. The volume estimation results are shown in table 1 and 2. Here DASH-520 is conventional particle type catalyst. It was found that these honeycomb catalysts can be used for the high-performance removal system of tritium from tritiated gases. They are also applicable to the collection of tritiated gases for tritium measurement in atmospheric air around the fusion facility and the environment.

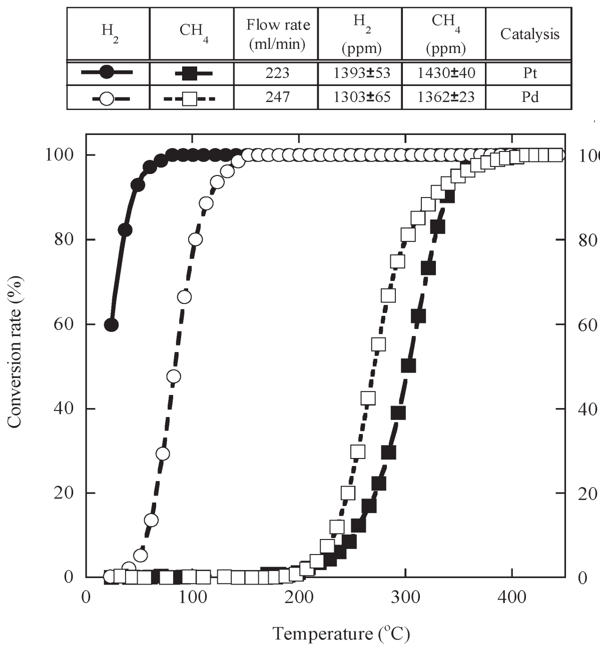

Fig. 1 Efficiency of oxidizing catalysts for cordierite honeycombs.

Table I Volume estimation of catalytic reactor for H_2

Catalysis metal	Operation temperature (°C)	Catalyst volume for H_2 (m^3)		
		Metal honeycomb	Cordierite honeycomb	DASH-520
Pt	60	2.3	0.5	0.7
Pd	60	6.6	11.3	1.9

Table II Volume estimation of catalytic reactor for CH_4

Catalysis metal	Operation temperature (°C)	Catalyst volume for CH_4 (m^3)		
		Metal honeycomb	Cordierite honeycomb	DASH-520
Pt	300	2.0	2.8	3.7
Pd	300	0.4	1.0	0.4**

**at 290°C