Experimental study on helium gas flow through pebble bed of ceramic tritium breeder in a test blanket module

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In a Japanese test blanket module for ITER, Li_2TiO_3 and water have been considered as the tritium breeding materials and coolant, respectively. The produced tritium in breeding layer is recovered by helium purge gas. The estimation of the phenomenon for the helium gas flow through the pebble bed of tritium breeding layer is important from the view point of the effective tritium recovery. In this study, therefore, the distributions of the helium gas flow in the pebble beds were estimated by the measurement and the calculation of the pressure drops.

The pebbles of a glass or Li_2TiO_3 with the diameter of 1.0 mm were packed and the helium gas was purged in the membrane box. The flow rates of helium gas were controlled in the range of 0-50 L/min. The range of the flow rate was applied strategically on the assumption of the partial pressure of tritium in the outlet of the test blanket module. The dependence of the pressure drops on the flow rates of the helium gas was measured with the differential manometer in each pebble bed.

In the case of a laminar flow for the pebble bed, it is well known that a magnitude of the pressure drop linearly increase with increasing the flow rate. In this study, it was also observed that the distribution of the pressure drop was linearly increased with the increase of the flow rate in all the cases of the pebble beds. In comparison between the glass and Li_2TiO_3 pebble beds, the pressure drop in Li_2TiO_3 pebble bed was larger than that of the glass pebble bed. It was considered that the difference of the pressure drops between the different kinds of the pebbles was derived from the difference of the surface roughness of pebbles. Moreover, the result of this study indicates that the values of the pressure drops in all of the cases were slightly different from the values estimated by the Ergun equation.

In this presentation, the phenomenon of the helium gas flow through the pebble beds of the tritium breeding layer would be minutely discussed with the experimental results.