

Pressurizing Behavior on Ingress of Coolant into Pebble Bed of Blanket of Fusion DEMO Reactor (P4-H-327)

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Solid breeder blankets are being developed as candidate blankets for the Fusion DEMO reactor in Japan. JAEA is performing the development of the water cooled and helium cooled solid breeder blankets. The blanket utilizes ceramic breeder pebbles and multiplier pebbles beds cooled by high pressure water or high pressure helium in the cooling tubes placed in the blanket box structure. In the development of the blanket, it is very important to incorporate the safety technology as well as the performance improvement on tritium production and energy conversion. In the safety design and technology, coolant ingress in the blanket box structure is one of the most important events as the initiators. Especially the thermal hydraulics in the pebble bed in the case of the high pressure coolant ingress is very important to evaluate the pressure propagation and coolant flow behavior. This paper presents the preliminary results of the pressure loss characteristics by the coolant ingress in the pebble bed.

Experiments have been performed by using alumina pebble bed (4 liter maximum volume of the pebble bed) and nitrogen gas to simulate the helium coolant ingress into breeder and multiplier pebble beds. Reservoir tank of 10 liter is filled with 1.0 MPa nitrogen. The nitrogen gas is released at the bottom part of the alumina pebble bed whose upper part is open to the atmosphere. The pressure change in the pebble bed is measured to identify the pressure loss. The measured values are compared with the predicted values by Ergun's equation, which is the correlation equation on pressure loss of the flow through porous medium.

By the results of the experiments with no constraint on the alumina pebble bed, it was clarified that the measured value agreed in the lower flow rate. However, in the higher flow rate where the pressure loss is high, the measured value is about half of the predicted value. The differences between the measured values and the predicted values will be discussed from the viewpoint of difference between loosely filled pebble bed and fixed porous medium, to identify the effect of constraint of pebble bed on the pressure relief performance of the pebble bed type solid breeder blanket.