§25. Development of Efficient Heat Removal Technology Using Functional Porous Media for FFHR Divertor Cooling

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In a divertor region, a heat flux of approximately $10MW/m^2$ is steadily loaded. In general, water cooling under high pressure, high-speed, and highly subcooled conditions or liquid metal cooling has been proposed as the divertor heat removal techniques. However, the development of heat removal technology with much lower pumping power becomes essential from the viewpoint of achieving low cost of electricity of the fusion power reactor. In this study, in order to evaluate the heat removal characteristics, *i.e.* a boiling curve, of the high heat flux removal device using functional metal porous media, a high heat flux removal equipment which enables heat transfer experiment on $20MW/m^2$ class was set up.

In the experiments performed in the past several years, a plasma arcjet was utilized as a heat source (1). However, in the experiments with the plasma arcjet, it was difficult to control the incident heat flux, which also makes difficult to obtain a detailed boiling curve of the porous heat removal device. Therefore, in this fiscal year, a large capacity of a cartridge heater with an allowable temperature of 1000 degrees C. and 3000W@200V is designed and fabricated at first. The newly introduced heaters of 10 pieces are connecting in parallel, and then 30kW (200V×150A) of heat input is possible in total. The heat flow from the heaters is increased by reducing the area of the cross section of the heat transfer block as shown in Fig. 1. As a result, it is considerably possible to achieve a heat flux over $40MW/m^2$ at the heat transfer surface of 30mm in diameter. Though this value is an ideal value when there is no heat loss from the heat transfer block, it is considered that the heat transfer experiment on the $20MW/m^2$ level could be possible. The overview of the test equipment newly set up is shown in Fig. 2. The equipment is composed of a circulating pump, flow measurement section, a heat transfer test section, a condenser, and a chiller to keep inlet temperature of distilled water constant. The flow rate of the cooling water is adjusted with a flow control valve and a bypass valve and then the coolant is evaporated in the porous medium. The vapor discharged is condensed in the condenser that is a spiral tube of heat exchanger. The inlet temperature of water is adjustable up to 70 degrees C. and the maximum flow rate is 40L/min. At present, the soundness of this equipment, *i.e.* leakage, gas generation in a high temperature case, etc., are evaluated. The detailed heat transfer performance of the functional porous device will be started to evaluate soon.

In the next fiscal year, the heat transfer experiments are going to be carried out by changing the flow rate, degree of subcooling, pressure as well as the geometries of the porous structures and the sub-channels.

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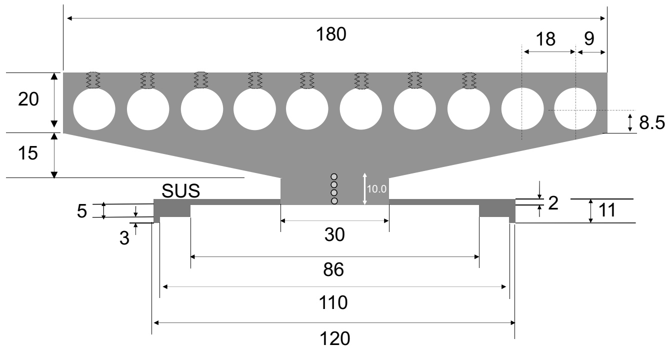

Fig. 1 Fig.1 Detail design of heat transfer block

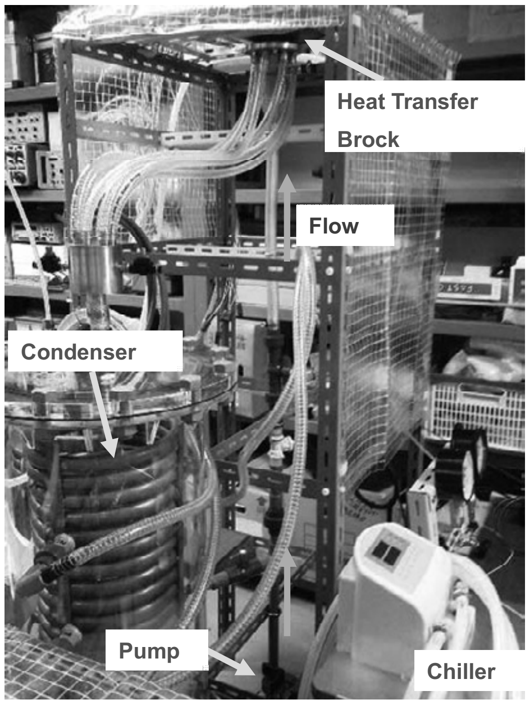

Fig. 2 Experimental apparatus for high heat flux removal tests

[1] K. Yuki, et al., Special Topics & Reviews in Porous Media - An International Journal, vol. 1, no. 1, pp. 1-13, 2011.