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ヒートパイプの原理を用いたダイバータにおける熱伝達の特性 Heat transfer characteristics on divertor by heat pipe concept

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In the fusion reactor, the divertor is subject to high heat flux from plasma. The strike point is localized on 5~10cm width of the divertor surface, and the heat must be removed by coolant to prevent the damage of the plasma facing material. This study proposes two steps of effective transfer of high heat flux from target surface to coolant similar to that of heat pipe; heat load distribution by evaporation of coolant and C-fiber/SiC composite layer enhanced thermal conductivity as shown in Fig. 1.

Operation of heat pipe is limited by mass balance between working fluid and vapor depending on the operating temperature. In this study Na and H₂O were selected as working fluids, and various limits on heat transport capacity, sonic limit, entrainment limit, evaporation loss, were calculated with operating temperature. Fig. 2 shows the possible heat flux to be transferred by heat pipe using Na. In case of Na heat pipe system with inner diameter 50mm, heat-transfer capacity of heat flux on 10cm² area is expected to exceed 10MW/m² at 627°C under no MHD effect. This result was used for boundary condition of analysis to evaluate heat transfer characteristics of C-fiber/SiC composite. When direction of heat flux is same direction with orientation of C-fiber, heat flux moves from SiC(low T.C) to C-fiber(high T.C) at the boundary of top surface as Fig. 3. This simulation describes the enhancement of heat transfer with C-fiber composite.

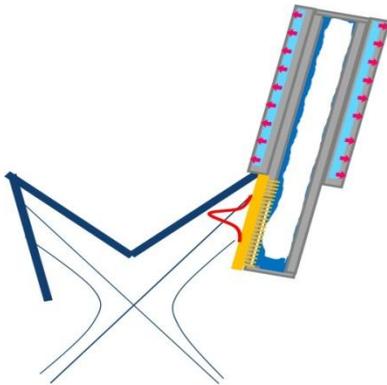


Fig. 1 Our new divertor model and the fusion reactor.

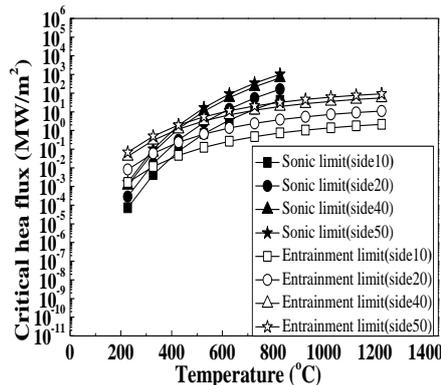


Fig. 2 The relation between limit heat transport capacity of heat flux and operation temperature in Na system

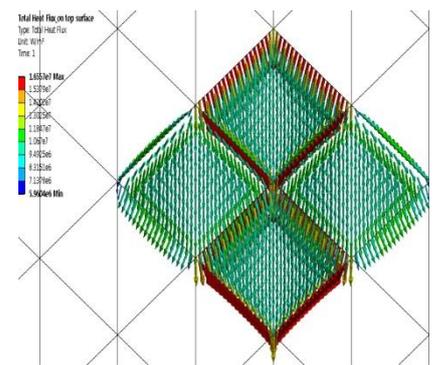


Fig. 3 Total heat flux on top surface.

[1] K. Wada, H.S. Gwon, K. Imano, K. Noborio, Y. Takeuchi, R. Kasada, and S. Konishi, "A Feasibility Study of Divertor Concepts with Enhanced Heat Load Distribution by the Heat Pipe Mechanism", TOFE 2012