# §19. Advanced Design of the Three-surface-multilayered Channel by Optimizing Structure of the Metal Layer

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Our research group has proposed the three-surface-multi-layered channel to reduce MHD pressure drop[1] in Li/V (liquid lithium/vanadium alloy channel) blanket system. The MHD pressure drop can be reduced to be acceptable value by using an inner thin metal layer with a thickness of <0.02 mm. However, the thickness is too small to insure its structural integrity. To solve the problem, we proposed a new design for the channel, in which the inner layer is partially reinforced by attaching reinforcing structure[2] as shown in Fig. 1. In this collaborative study, we conducted an experiment using a small annular channel developed in a previous study[3] to investigate influence of reinforced structure on flow field as well as numerical investigation.

Fig. 2 shows a schematic illustration of the open annular channel with an inner diameter of 80 mm and an outer diameter of 156 mm used in this study. A working fluid was melted eutectic alloy of Bi-Sn. The channel simulates a half region of the three-surface-multi-layered channel and the stainless steel bottom plate corresponds to the inner thin metal layer. In this experiment, we prepared two kinds of the bottom plate; one simulates uniform metal layer with a thickness of 0.3 mm and another simulates reinforced metal layer having the inner half region with a thickness of 0.3 mm and the outer half region with a thickness of 1.0 mm. Two kinds of stainless steel probes with a diameter of 0.9 mm were also inserted into the channel with a width of 38 mm to measure voltage drop for evaluating velocity; Probe A has one measured region with a width of 28 mm and Probe B has four measured regions with a width of 7 mm. The test section is set into bore of a superconducting magnet which can generate the maximum magnetic field of 6 T.

Fig. 3 shows velocity distribution evaluated by Probe B and numerical prediction at 2 T and 0.3 m/s. The experimentally evaluated velocity distribution did not agree with the numerical prediction because the existence of the probes influenced flow field in which pressure drop increased by 10-20%. Fig. 4 shows average velocities evaluated by Probe A, in the most inner measured region of Probe B and numerical predictions as a function of average velocity evaluated by voltage drop between channel's inner and outer walls at 3 T. Velocity evaluated by Probe A agreed with numerical prediction though more probes are needed to evaluate detail velocity distribution. To improve the method to evaluate velocity distribution, we plan to set the probes on backside of the bottom plate or introduce ultrasound Doppler measurement.

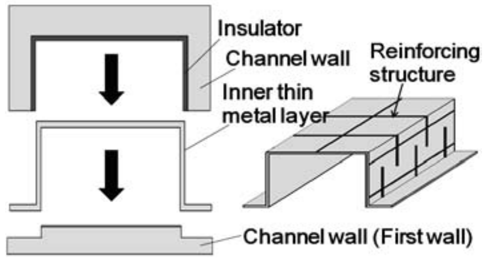


Fig. 1. Reinforcement of inner thin metal layer in the three-surface-multi-layered channel

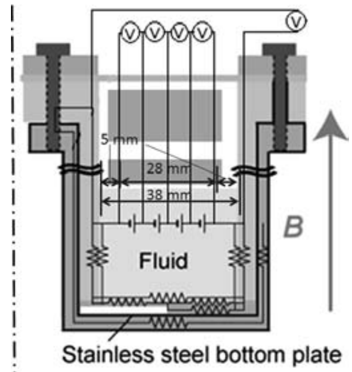


Fig. 2. Schematic illustration of annular channel and probes to evaluate velocity distribution.

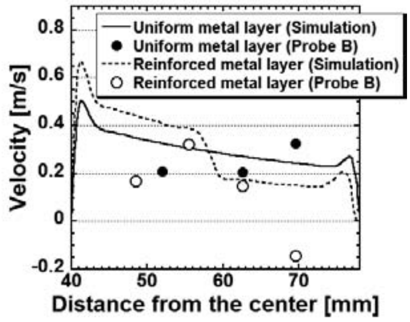


Fig. 3. Velocity distribution evaluated by Probe B and numerical analysis.

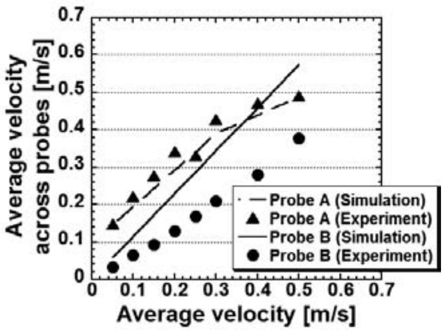


Fig. 4. Characteristics of average velocity evaluated by Probe A, Probe B, and numerical analysis.

1) Hashizume, H.: Fusion Eng. Des., **81** (2006) 1431.
2) Inage, Y. et al.: Proc. NTHAS8. (2013).
3) Aoyagi, M. et al.: Fusion Eng. Des., **85** (2010) 1181.