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Thermal mixing enhancement of liquid metal film-flow by various obstacles under vertical magnetic field

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Heat removal from liquid metal film flow has been widely studied for liquid divertor concepts of fusion reactor. In this study, thermal mixing characteristics of the liquid metal film-flow with locally heated on the surface under the vertical magnetic field was experimentally investigated by using various types of obstacle as a vortex generator. The temperature distributions on the bottom wall were measured by 40 thermocouples installed on the channel bottom downstream of the vortex generator. In order to evaluate how much heat transports from the locally heated free-surface to the bottom wall, the efficiency of heat transport was investigated for the various vortex shaped generator. The velocity distributions were measured with using a rake consisted of 40 electrical potential probes on the downstream of the channel. A delta-wing, hemisphere or cubic obstacle was used as a vortex generator installed at the center of the bottom. The experiments were conducted for laminar flow region where Re=1000-1700 and in the range of N(=Ha2/Re)=0-36.0 in the presence of the vertical magnetic field in the acrylic rectangular duct. GaInSn alloy was used as a working fluid. According to the comparison of heat flux distributions obtained by the experiments, the entire distributions moved towards the upstream with increasing of the strength of the vertical magnetic field for all the vortex generator types. This tendency meant the heat removal from the free-surface of liquid metal film-flow quickly in case of relatively high vertical magnetic field. The horizontal velocity distribution of the liquid metal film-flow obtained by the probe rake showed the typical M-shape distributions in case of without the vortex generator, some MHD characteristics of the velocity fluctuations were observed in case of various types vortex generators.

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