Contribution ID: **685** Type: **not specified**

P2.113 Heat transfer enhancement in MHD free-surface flow by controlling the electromagnetic force with fin structure

Tuesday, 18 September 2018 11:00 (2 hours)

Partly insulated fin structure has been proposed to mitigate the temperature stratification in the flowing-type liquid metal divertor. This structure consists of partly insulated fins which are infused in the flowing liquid metal. Our previous study observed the generation of a wavy flow by a checker-board like arrangement of insulated parts experimentally and numerically. Moreover, magnitude of the wavy flow increased with a rise in the magnetic field. However, the experiment was conducted using a closed channel due to the magnetic field direction of the experimental apparatus. Therefore, in this study, three-dimensional magnetohydrodynamics (MHD) flow simulation was conducted using an analytical model which has the free-surface to clarify the flow field in this concept.

The analytical model simulated two partly insulated fins which are infused in the liquid metal free-surface flow. Height of fins and liquid metal were 20.0 mm and 30.0 mm respectively. Streamwise length of the model was 120 mm and the insulated parts were switched every 30 mm alternately. Governing equations were Navier-Stokes equation and Poisson equation of the electric potential. Applied transverse magnetic field was up to 0.2 T due to the nonlinearity of the electromagnetic force term in the governing equation. Free-slip condition was applied on the free-surface and deformation of it was not considered.

Results showed that a ratio of the vertical component of velocity to streamwise component was 30% at the maximum. In addition, the wavy flow generated by the partly insulation reached near the free-surface region. This indicates that the structure possibly enhances the heat transfer near the free-surface. Evaluation of free-surface deformation using Arbitrary Lagrangian-Eulerian method and results of heat transfer simulation are also planned to be presented at the conference.

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Session Classification: P2