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Numerical study of the turbulent two-phase flow in a steel mould

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ABSTRACT

Magnetic fields are an attractive contactless possibility in order to influence the liquid steel flow in the mould of the continuous casting process[1-4]. In slab casting, argon bubbles are commonly introduced through the submerged entry nozzle into the liquid steel in order to reduce nozzle clogging[5]. However, argon gas bubbles are very influential on the upper recirculation zone. Injection of Argon gas bubbles give rise to the entrapment of mould flux while bursting out at the free surface between the molten steel and the mould flux. On the other hand, several reports[6-9] show that argon gas bubbles ascend near the nozzle due to their buoyancy, and such ascending argon bubbles induce an upstream of the molten steel. Thus, argon gas bubbling is thought to be able to affect the flow pattern of molten steel and subsequently exert an influence on the initial solidification in the meniscus region. Therefore, it is essential not only to prevent the steel defects which are caused by both the entrainment of mould flux and the gas bubbles, but to control the two-roll flow pattern[10].

In our presentation, we will focus on the impact of the argon bubbles in a mould model with and without employed static magnetic field, as seen in Fig.1. An inhomogeneous Eulerian–Eulerian multi-phase model built in the commercial CFX software was adopted. The calculations show that argon gas bubbling increases the probability of an asymmetric instability and even unbalances the two-roll flow pattern in the slab mould with increasing the mass flow rate of gas.

For the magnetic field control, a steady magnetic field is applied either over all the mould span or just focussed to the nozzle region. The simulations show that the magnetic field primarily damps the local velocities in the mould with complex consequences on the local flow structure.

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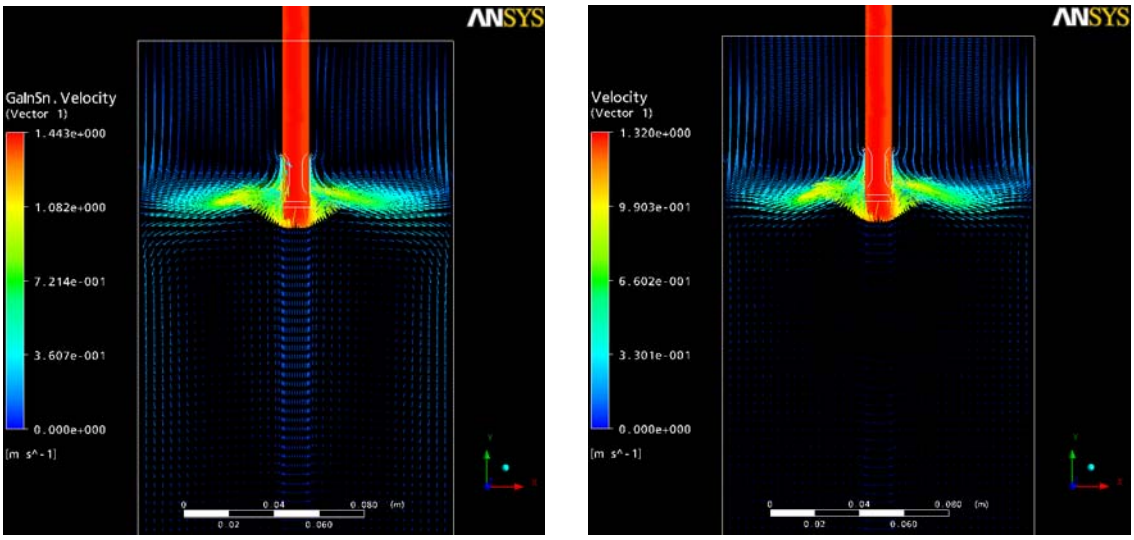

Figure 1. Flow pattern of gas-liquid in the mould without external magnetic field (left) and with a static magnetic field below the SEN (right)