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Numerical simulation of fluid flow and inclusion motion in continuous casting mold with electromagnetic stirring

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ABSTRACT

The electromagnetic stirring (EMS) in the continuous casting mould is an effective technique of improving the inner and surface quality of steel blooms and slabs by means of electromagnetic force to intensive fluid flow and heat/mass transfer in the solidification process of steel. In this paper, the numerical simulation of electromagnetic field and fluid flow in a continuous casting mould of steel bloom was carried out to investigate the behavior of fluid flow under different process parameters. First, the influence of EMS structure parameters on the distribution of magnetic induction intensity and electromagnetic force were simulated and is verified with the measured values in metallurgy factory. The results show that the magnetic induction intensity and electromagnetic force reaches to maximum in the center of EMS. The different proportion of pole and yoke has little effect on the distribution of magnetic induction intensity and electromagnetic force in the center line of outer surface. The numerical simulation of 350 mm $\times$ 470 mm bloom show that all of the magnetic induction intensity, electromagnetic force, velocity, turbulence kinetic energy, and turbulence kinetic energy dissipation are increase with the electric current. However, the magnetic induction intensity is decreased as the increases of electric power frequency. Without EMS, most of inclusions in the mold downflow directly to the outlet of mold with melt steel which will bring some defects in the bloom. Using applied EMS, the inclusions in the melt steel do rotating motion with molten steel, and more and more inclusion particles accumulate to the upper zone of mold when the electric current increases, so that the removal rate of inclusion particles in the mold will increase and the internal and subsurface quality of bloom is improved.

KEYWORDS: continuous casting, electromagnetic stirring, fluid flow, inclusions, bloom, numerical simulation