Influence of Current and Frequency on Electromagnetic Stirring in Continuous Casting of Steel

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ABSTRACT

Mould electromagnetic stirring (M-EMS) in continuous casting of steel improves the quality of the strand. Because the measurements during casting are extremely difficult, a numerical model was developed for a square billet caster as appears since 2015 in Štore-Steel company.

Different time scales of the electromagnetic (EM) field and fluid flow allow decoupling of the equations for the EM field and fluid flow. Since the latter has already been modelled by our own meshless library [1,2], it is the most straightforward way to include M-EMS through the time averaged EM force, calculated with the open source finite element method (FEM) solver Elmer [3]. This solver was used particularly because of the extremely geometrically complicated EM arrangement. Since its use is not widespread in this field, a successful comparison with our own EM meshless solver on an axisymmetric case was first made for verification.

The EM field causes a rotational flow in the billet and distorts the solidification front. Simulation of the effect of the stirring current and frequency on the fluid flow and solidification was performed. For small fields solidification front is rotated around the axis, whereas for stronger fields it is round. The results of the developed coupled meshless-FEM approach are consistent with the previous studies, which were in most cases made with the finite volume ANSYS software [3,4].

Further studies will be directed towards upgrading of the meshless EM solver capabilities for geometrically complex 3D electromagnetic field calculations. This will allow treating the described multiphysics problems entirely in a meshless sense.

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