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Full-Scale 3D Simulation of the Electroslag Rapid Remelting Process

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Abstract : The standard electroslag remelting (ESR) process can ideally control the solidification of an ingot and produce homogeneous structure with minimum defects. However, the melt rate of electrode is rather low that makes the whole process uneconomical especially to produce small ingot sizes. In contrast, continuous casting is an economical process to produce small ingots such as billets at high casting speed. Unfortunately, deep liquid melt pool forms in the billet ingot of continuous casting that leads to center porosity and segregation. As such, continuous casting is not suitable to produce segregation prone alloys like tool steel or several super alloys. On the other hand, the electro slag rapid remelting (ESRR) process has advantages of both traditional ESR and continuous casting processes to produce billets. In the ESRR process, a T-shaped mold is used including a graphite ring that takes major amount of current through the mold. There are only a few reports available in the literature discussing about this topic. The research on the ESRR process is currently ongoing aiming to improve the design of the T-shaped mold, to decrease overall heat loss in the process, and to obtain a higher temperature at metal meniscus. In the present study, a 3D model is proposed to investigate the electromagnetic, thermal, and flow fields in the whole process as well as solidification of the billet ingot. We performed a fully coupled numerical simulation to explore the influence of the electromagnetically driven flow (MHD) on the thermal field in the slag and ingot. The main goal is to obtain some fundamental understanding of the formation of melt pool of the solidifying billet ingot in the ESRR process.

Keywords : billet ingot, magnetohydrodynamics (mhd), numerical simulation, remelting, solidification, t-shaped mold.
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