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Simulation and optimization of electromagnetic stirring and braking in slab continuous casting mold

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With increasing demands regarding efficiency and product quality, flow control by electromagnetic fields is becoming the state-of-the-art in continuous slab casting technology. In such systems, the flow is controlled by Lorentz forces, which arise from the interaction between liquid steel flow and externally applied magnetic field. Static magnetic fields generated by Electromagnetic Braking (EMBr) systems serve to stabilize the flow. Conversely, traveling magnetic field systems, like the Electromagnetic Level Accelerator (EMLA), provide more active control over the liquid steel flow. Proper application of combined electromagnetic stirring and breaking within the mold results in a favorable flow behavior, which leads to an increased internal strand quality even at high casting speeds. Therefore, understanding and optimizing the interplay of electromagnetic fields with casting parameters is essential. The complexity of these systems calls for a numerical investigation. A substantial number of simulations is required to conduct a comprehensive parametric study and optimize the performance of the electromagnetic flow control system. In this work, a system equipped with AC and DC coils, which can generate combined electromagnetic fields, is presented. Using Computational Fluid Dynamics (CFD) simulations, we examined the impact of EMBr and EMLA on mold flow patterns across a range of casting parameters, including casting speed, width, and sub-entry nozzle immersion depths commonly used in the casting process.

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