Establishing a Numerical Criterion to Verify the RANS-type Flow Simulation in Application to the Continuous Casting Process

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Abstract

The turbulent flow is a complex phenomenon, especially when it is related to such a sophisticated process as the continuous casting (CC). The flow in the submerged entry nozzle (SEN) or in the CC mold can often become very chaotic, if one casts at the operating condition limits. Moreover, there are some "butterfly effects", appearing even at the small flow fluctuations, which can dramatically affect the final product quality, as described by Lee et al. [1]. Thereby, the numerical simulations employing the Computational Fluid Dynamics (CFD) become a valuable tool to predict and to avoid the undesired flow scenarios with an aim to establish some recommendations and improvements to the casting process. In the presented studies a numerical model, previously developed by the authors, is verified by a water modelling experiment. According to the common practice, a 1-to-2 water model was constructed, including the SEN and a 2-m-long segment of the mold and the strand with the water level control. The water, exiting from the system, was recirculated back to the water tank, allowing establishing a developed flow regime. The paddle-type sensors were used to measure the sub-meniscus velocity, and the flow field was visualized by injecting dye into the SEN. The observations were digitally recorded, providing both qualitative and quantitative comparisons with the simulation results. Verification of the applied RANS-type turbulence models was performed, establishing a criterion for the numerical mesh resolution and quality based on the y+ function distribution in the SEN and mold to meet the experimental results. A number of the SEN designs were studied, operating in the transition regimes, which were caught by the numerical simulation as well, when the designed criterion was met.

References

1. Peter D. Lee and P. E. Ramirez-Lopez and K. C. Mills and B. Santillana. Review: The "butterfly effect" in continuous casting. Ironmaking and Steelmaking, 2012, vol. 39 (4), pp. 244-253.