SUCCESS STORY

K1-MET
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INCLUSION BEHAVIOR AT THE STEEL-SLAG INTERFACE

CONSIDERATION OF DETAILED PARTICLE BEHAVIOUR IN UNRESOLVED SIMULATIONS OF NON-METALLIC INCLUSION REMOVAL IN A CONTINUOUS CASTING TUNDISH

Motivation

The cleanliness of steel is of vital importance for the quality and properties of the final product. The continuous casting tundish is the second to last process step, upstream of the mold, in which non-metallic inclusions (NMIs) can be removed from the melt. Thus, a better understanding of the NMI separation behavior in the continuous casting tundish is vital for achieving a good steel cleanliness.

Investigation

Numerical simulations of the flow in a complete tundish entail several simplifications and assumptions to keep the computational effort manageable. This includes modelling the NMIs as discrete Lagrangian particles in a simulation of fluid flow.

Since the mesh resolution in numerical simulations is usually coarser than the size of the NMIs, a detailed modelling of the interaction between the NMI and the steel-slag interface is not possible. This is generally referred to as an unresolved simulation. The interaction between NMIs and the steel-slag interface must be modelled using reasonable assumptions respectively simplifications.

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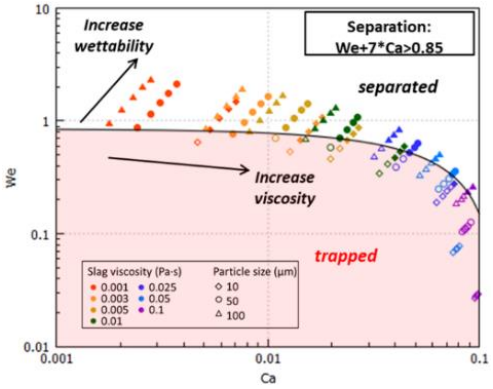

Figure 1: Phase diagram of particle behavior at the steel-slag interface, plotted as Weber number We vs Capillary number Ca. The solid black line (We+7*Ca=0.85) is the threshold above which the particle is separated into the slag. (Source: K1-MET/JKU Linz)

The know-how about the behaviour at the steel-slag interface has been incorporated into a simulation model for the whole tundish. The correlation derived from resolved simulations of individual NMIs at the steel-slag interface allows for a more realistic description of the behaviour of NMIs in unresolved simulations.

Outcome and implications

This work allows the consideration of a more realistic particle behaviour in an unresolved tundish simulation, without the need to resolve the NMI's contact with the steel-slag interface. In our simulations, the NMIs are tracked throughout the tundish. When they encounter the steel-slag interface, the derived correlation allows to decide whether the NMI will stick to the interface, or whether it will enter into the slag phase.

The insight thus generated gives valuable indications on the removal of NMIs in the tundish of a continuous casting plant, and thus provides a contribution to a more sustainable steel production.

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