Development and Validation of a Lagrangian-Eulerian Multi-phase Model for Simulating the Argon Stirred Steel Flow in a Ladle with Slag

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A validation study of a CFD model for predicting the multiphase flow in a steel ladle with argon bottom stirrer is presented. The CFD model uses a new OpenFOAM Improved Delayed Detached Eddy Simulation (IDDES) solver which combines the Lagrangian Particle Tracking (LPT) model for the dispersed bubbles with a multiphase Volume of Fluid (VOF) Eulerian solver for the continuous steel and slag phase with free surface. The influence of the different LPT force models used for the dispersed phase is investigated. For validation purposes, two experimental water model studies were used: 1) an external reference case [Deen et al., 2000] of a square bubble column with a uniform 4 mm bubble size distribution, and 2) an in-house experimental study of a scaled water model of a steel ladle with off-centric bottom stirrer producing a non-uniform bubble size distribution in a range of 1 to 30 mm. It is shown that the different approaches towards drag, lift, and added mass have a profound influence on the gas/liquid flow of the plume and the overall ladle flow pattern. A best modelling practice for a full scale ladle model with free surface covered with slag is proposed.

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