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MHD modeling of a copper slag cleaning process

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ABSTRACT

In non-ferrous industry, the slag cleaning process aims at recovering the valuable metallic materials from the waste, which still contains up to 8% of copper concentrates. Two-third of the total copper is present in the form of entrained matte droplets of the size from 5 to 1000 μm, while the rest is dissolved in the slag and can be segregated by applying a strong direct electric field in a sedimentation tank. Gravitational sedimentation of the fine dispersed droplets take several hours and can be accelerated through intensive electromagnetic stirring by a superposed external magnetic field, which is orthogonal to the electric field. The stirring increases the probability of collisions between droplets, which accelerates their growth and therefore improves the settling process.

An Euler–Lagrange approach was employed to numerically study the slag cleaning process with the CFD code ANSYS Fluent. For the continuous phase, MHD simulations were used to calculate the slag flow under the influence of the superposed electric and magnetic field. For the dispersed phase, a new hybrid collision algorithm was implemented to overcome the mesh-dependency problem of the purely stochastic algorithm. The outcome of collisions among liquid metal droplets in a slag was determined by regime maps for droplets in a viscous shear flow with low shear rates, which are based on the capillary number and critical offset ratio. Simulations on a lab-scale slag cleaning process, for which experimental data are available, were performed to determine essential model parameters and to validate the simulations.

KEYWORDS: collision model, copper slag cleaning, MHD, non-ferrous metallurgy