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Interface tracking in modeling of nozzle clogging in steel continuous casting

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A common problem in continuous casting of steel is clogging of submerged entry nozzle (SEN) that occurs due to the continuous build-up of solid material. Clogging reduces productivity of the process and quality of the final product. The authors have developed a volume average model for particulate clogging of the nozzle. In this model, clog is treated as a developing porous medium due to the continuous deposition of solid non-metallic inclusions (NMIs) on the nozzle wall. With development of the clog, wall boundary conditions are not valid anymore and it is necessary to introduce proper conditions at the clog-melt interface to mimic the porous nature of the clog. In the present work, a new front tracking model is introduced to the clogging model using piecewise linear interface calculation (PLIC) approach. The main advantage of the PLIC model is more accurate calculation of the turbulent flow in partially clogged computational cells where the interface between clog and melt flow is defined. To verify the model, two similar cases were prepared for a predefined clog geometry on the nozzle wall: in one case the clog geometry was created by porous medium and in the other case, the clog interface was formed by deforming the nozzle wall geometry. The comparison of the results of two cases showed that the PLIC treatment in the volume average model can reproduce conditions at the porous clog-melt interface properly.

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