Abstract

The industrial production of Cu-Fe-P billet Direct Chill (DC) casting exhibits often difficulties related to the generation of surface cracks on the cast piece. The demand for always higher productivity leads to increased casting speed with significant cooling requirements. This in turn affects the thermal gradient within the billet leading often to stress concentration responsible for surface cracking. In order to deal with this issue while keeping productivity at high levels lowering the industrial cost, a 2D thermo-mechanical Finite Element (FE) model was developed, which was applied and validated based on industrial conditions. The model targets to predict the material failure during DC casting. Based on the proposed approach the billet’s temperature profile and its stress state during secondary cooling are calculated. The simulation results revealed that strong cooling using water jets cannot be applied immediately at the exit of the mold at any casting speed. However, as the distance of the secondary cooling unit from the mold exit increases, the stress concentration drops significantly, so that the jet nozzles can be applied from 750 to 2500 mm away from the mold, depending on the casting speed, without material failure. On the contrary, milder water spraying applying a lower local heat transfer coefficient, but on the same time covering broader impact surface, can result in a more efficient billet cooling. Thus, due to milder cooling the cast-piece material is less prone to failure and cooling can be applied immediately at the mold exit. Furthermore, a sequence of numerous spray arrays can further increase the cooling capacity. Concluding, it is shown that a validated thermo-mechanical 2D FE model can provide deeper insights used industrially as a setting tool, which optimizes the casting conditions in order to further improve productivity and the quality characteristics of the as-cast billet.