ABSTRACT

The ever increasing demand of steel products internationally requires a huge investment of resources into their manufacturing processes. Numerical modelling of the physical processes in such manufacturing units provides detailed information to help analyse and investigate ways to improve quality of production with minimal amount of resources. This work encompasses numerical modelling and analysis of two units of steel production: continuous casting and reheating furnace. In the first part of the thesis, an industrial continuous casting process of steel billet is analysed using numerical models for the heat transfer and mechanical deformation in the mould based on experimental data. The turbulent flow of the molten steel passing through the mould, subsequent heat transfer and solidification of the strand are also captured through numerical modelling. Important results from the models are discussed, particularly revealing the effect of remelting of the solidified shell due to recirculatory flow inside the mould. Subsequently, these models are used to determine an optimal taper profile of the mould which ensures maximum heat transfer from the steel strand to the mould. A separate model is also developed to calculate heat transfer from the strand to mould for a wide range of casting conditions. In the second part of the thesis, two numerical models are developed for a pusher type reheating furnace, which accurately capture the heat transfer from the combustion of coal particles dispersed in air to billets moving inside the furnace through intermittent pusher strokes. These models are applied to different industrial furnaces to evaluate their thermal efficiency based on energy distribution. Finally the more efficient model is applied to a furnace to quantitatively realise the effect of changing the geometric design of the furnace towards improving thermal efficiency and performance of the furnace.