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Thermal modeling of strip across the transfer table in the hot rolling process

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ABSTRACT

The transfer table is a fundamental stage between the roughing and finishing rolling stands in a hot-strip rolling process. The high temperature of the strip and the long time of its exposure to air at this stage lead to a considerable heat loss in the strip that accounts for its heterogeneous temperature distribution, non- uniform surfaces, reduced product quality, and increased production costs. Strip temperature prediction is essential for calculating the rolling force required and forecasting the resulting micro-structure. Reliable prediction of strip temperature is also essential for the proper set up of a hot strip mill. The use of thermal shields on the transfer table is considered to be an effective exterior tool for saving energy and improving the product quality. This paper investigates the temperature distribution and heat loss from a strip passing through the transfer table. For this purpose, the hot rolling process operating at Mobarakeh Steel Complex (MSC), Isfahan, Iran is used under three cases, namely, in the absence of a thermal shield, in the presence of a thermal shield, and using both a thermal shield and a heat source. The results from the numerical solution indicate that the last case is the most beneficial for reducing heat losses and achieving a better temperature distribution in the strip.

1. Introduction

Rolling is a common process in many industrial applications such as metal, plastics, and glass processing plants. In this process, the material to be shaped is passed through two counter rotating rollers to obtain a desired thickness from a larger initial one.

In the steel industry, the quality of the hot rolling process greatly depends on the temperature distribution in the strip by affecting such properties as yield stress and strip micro-structure or steel dimensions; hence, it is particularly important to predict the strip temperature in order to achieve a higher quality product. However, measuring methods do not provide sufficient information on strip temperature distribution. Pyrometers and thermal cameras, for instance, simply provide data on the strip's surface temperature, and trail thermocouples cannot be used because of the relatively rapid movement of the strips. Simulation models provide the most effective method of determining temperature distribution over the whole strip. Using them, it is possible to experiment with easily changeable system parameters such as different strip dimensions, strip materials, and transport speeds. Modeling steel hot rolling processes is, thus, required for their optimization, and prediction of the strip temperature is unquestionably an essential research objective.

Reliable prediction of the strip temperature drop is also required for determining the desirable temperature of the strip leaving the preheating furnace. Clearly, the predicted strip temperature can be used to adopt measures required for reducing strip heat loss and, thereby, the preheating temperature. High temperature, the long distance between roughing and finishing, and the long time of strip exposure to air at this stage lead to considerable radiative heat losses. Different ways of reducing the rate of heat loss have been investigated. Application of thermal shields on the transfer table is one of the most common methods used for saving energy and improving product quality.

Ginzburg [1] developed the principles for the computer simulation of rolling mills. His simulation led to optimized production conditions, improved product quality, and energy savings.

Ginzburg and Schmiedberg [2] studied the main parameters involved in temperature variation during rolling process and methods of avoiding heat losses between roughing and finishing stands in order to determine optimal working conditions. According to them, the main parameters affecting temperature changes include temperature losses due to radiation and convection to the environment and rollers, conductive heat transfer to work rollers and water spray for oxide removal, and temperature gains due to

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