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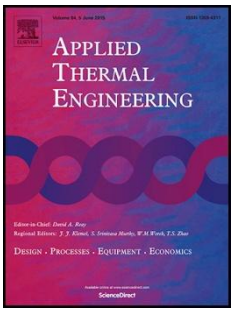

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Transient simulation of conjugate heat transfer in the roof cooling panel of an electric arc furnace

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Highlights

- Conjugate heat transfer analysis of the roof cooling panel was presented.
- There is severe temperature gradient in the bends which is the source of fatigue.
- Using cooper instead of steel decreases panel temperature around 6%.
- Using circular roof cooling panel created more uniform temperature distribution.

Abstract

Temperature variation of an electric arc furnace roof cooling panel during the charging stage is a major source of thermal fatigue and cracks in cooling pipes and consequently frequent stops in the furnace operation. In this research, transient heat transfer analyses of the cooling panel pipe have been used in order to understand the grounds for crack generation. Conjugate heat transfer has been considered in the analysis of roof cooling panel including water and tube thickness. The temperature variation of the pipe wall and water were simulated and the results were validated with experimental data obtained from a real site. The simulation results revealed that there are severe temperature gradients versus time in the bends and also in the peripheral direction of the pipe initiating thermal stress and cracks. Using cooper instead of steel for roof cooling panel material showed that panel temperature decreased around 6%. Also, changing the roof cooling panel geometry to circular shape reduced the temperature gradient in the panel and created more uniform temperature distribution.

Keywords: Electric arc furnace, conjugate heat transfer, temperature gradient, roof cooling panel.

1. Introduction

One of the common technologies used in steel-making industries is electric arc furnace as shown in Fig. 1. Production of steel in an electric arc furnace consists of four stages of charging, melting, melt super-heating, and discharge. In charging stage, it is required to open the furnace roof by rotating the roof and putting iron scrap inside the furnace as shown in Fig. 2. The temperature inside the furnace reaches up to 1600°C due to electric arc and melting inside the furnace. To protect the furnace body, water circulating cooling panels are used in the shell and roof of the furnace.

Charging stage is very important for the process since during this stage rapid temperature change occurs in the roof panels. As long as the roof is on the furnace, its bottom side is exposed to very high heat flux emitted from the melt inside the furnace. When the roof is rotated and set aside during