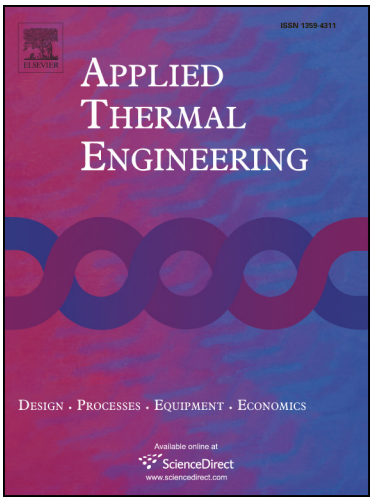

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Investigation of the heat-recovery/ non-recovery coke oven operation using a one-dimensional model

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Abstract

In order to predict the behaviour of the heat-recovery (HR) /non-recovery (NR) coke oven during the coke-making process, time-dependent numerical simulations have been carried out. A one-dimensional (1D), self-made (non-commercial) mathematical model has been used to predict temperatures, pressure and gas composition within upper-oven, down-comers and sole-flue of the oven analyzed. Moreover, mass flow rates of primary and secondary air, entrained from the surroundings, have been calculated. The results of the simulations indicate that the carbonization process performed in HR/NR ovens is slightly affected by surrounding conditions. A 15.8 % (from 253 K to 293 K) increase in surroundings temperature has resulted in a 0.6% of temperature change within the upper-oven and the sole-flue. The same variation in ambient temperature affects slightly (0.3%) the primary and secondary air mass flow rate entrained from the environment. The increase in surroundings temperature reduces the natural draft by about 6 Pa, but pressure losses in the air ducts become higher. The usage of the so-called "sliding gates" installed in the primary and secondary air inlets is of great importance for coke-making. Changing the closure level of the primary air inlets by 25% causes the gas temperature to be altered by 4.3%. Another important factor is suction generated by a fan/stack. This parameter (suction increased by 40 Pa) changes the temperature inside the oven by about 9.7% for the upper-oven and 3.7% for the sole-flue. Both parameters have key significance for the carbonization process. The gathered data provides an improved understanding of the HR/NR coke oven operation and allows optimizing HR/NR coke oven design and the carbonization process itself.

Key words: heat-recovery coke ovens, coke-making process, hydraulic network, carbonization

1. Introduction

Nowadays the HR/NR technology is becoming very attractive for the blast-furnace coke producers. This is due to the fact that this type of ovens is considered to be more environmentally friendly compared to the by-product (conventional) units. Relatively low emissions of harmful substances stem from the fact that the HR/NR coke ovens operate under negative pressure. As a result, pollutants cannot be emitted to the surroundings through the leakages and openings existing in the industrial units. The pollutants are also not released to the atmosphere with flue gases because the raw gas is oxidized directly in the oven. This technology has other advantages over by-product ovens. The HR/NR ovens are more flexible than alternatives when the coal blend type is concerned. Moreover, the coke produced is usually of higher quality. Unfortunately, the HR/NR technology also has some disadvantages. One of the most important drawbacks is the severely limited control of the process. Due to the oven's design and its principle of operation, an adequate control of the whole carbonization process requires substantial knowledge.