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Modernization of DRI Shaft Furnaces to Improve Performance and Product Quality

Y. M. Gordon[1,2], N. A. Spirin[2]

[1]Hatch, Canada
2800 Speakman Drive, Mississauga, ON, Canada, L5K 2R7
Phone: +1 905 403 3750
E-mail: iakov.gordon@hatch.com

[2]Ural Federal University, Russia
19 Mira Street, Ekaterinburg, Russia, 620002
Phone : +7 922 296 9283
E-mail: n.a.spirin@ustu.eu

ABSTRACT

Gas dynamics and gas distribution in shaft furnace play a crucial role in improvement of furnace productivity, product quality and reduction in natural gas rate. Optimum design parameters of gas distribution devices were investigated by means of mathematical modeling, pilot plant and industrial installation studies. New heat transfer co-current schematics of gas and material movement with self-reforming of natural gas in metallization zone was invented, patented and tested at the pilot plant. New shaft furnace design and improvements were proposed and new gas distribution deviCes were implemented, providing savings in fuel rate, increase in productivity and improvements in the quality of direct reduced iron.

Keywords: shaft furnace, DRI, gas-dynamics, metallization, heat- and mass-transfer

INTRODUCTION

The gas dynamics and gas distribution in shaft furnace play crucial role in optimization and improvement in furnace operation.

To optimize these parameters methods must be sought to predict how physico - chemical and heat exchange processes behave within the shaft furnace. In the analysis of the operation of simple units, mathematical models based on separate description of various phenomena and processes have proven to be satisfactory. However, for number of applications, simultaneous consideration has to be given to heat and mass transfer, material and gas flow. The formulation of models to include these inter-related phenomena, is generally easier to contemplate than to realize [1, 2]. Therefore, when calculations are based on such models, some essential assumptions must first be made to obtain a simple solution of the problem.

The optimum design and operating parameters can be determined in a course of experimental investigation as well as mathematical modeling. The adequate mathematical models also can be used as a basis for control methods. Application of modernized shaft furnace design, new technologies and new gas distribution devises provide savings in fuel rate, reduction in gaseous emissions into atmosphere, increase in productivity and improvements in quality of DRI.

MATHEMATICAL MODEL

The mathematical model of the interrelated processes of heat and mass exchange and gas-dynamics was developed and used to estimate the process conditions in the shaft furnace and determine the optimal design and operating parameters. This model incorporates the following equations [2, 3]

