ABSTRACT

Increasing environmental concern and depletion of coking coal, has led the researchers to find a coke-free routes of ironmaking. Rotary Hearth Furnace (RHF) has emerged as one of the alternative routes of sponge iron production, especially to utilize the iron bearing solid waste from plant. RHF is a donut shaped reactor, where self-reducing iron ore coal composite pellets is reduced to value added sponge iron. In the present study a comprehensive CFD study in the free board over the solid bed in RHF is carried out to understand and optimize the operating parameters to enhance heat transfer to the solid bed and lower the emission, fuel consumption using ANSYS-Fluent CFD platform.

In total eight burners were used across the periphery of the RHF and each burner was equipped with four air tubes at the top and two air tubes at the bottom to burn the fuel injected through the three middle tubes. The lower air inlet tubes orientated at 5º upwards and other tubes remaining horizontal, emerged as the most recommended configuration for the burner to attain maximum combustion and temperature.

Various alternative fuel composition using downstream gas from steel plant, categorized in terms of calorific values, were investigated. It was found that for the same calorific value, a combination of blast furnace gas and coke oven gas (BF+COG) emerged better in terms of CO_2 emission compared to a combination of COG+BF+NG (Natural gas).

Oxygen enrichment of air has been found to reduce the fuel consumption by 14.9% at 35% oxygen in air and it also reduced the specific CO_2 emission in the exhaust stream. If fuel is kept constant irrespective of oxygen enrichment, it enhanced heat transfer to the solid burden at the bottom but without any improvement in emission.

The CFD model was also used to calculate the amount of fuel required to keep the furnace preheated during the offload period and it was found that a fuel amount of 12.19 Nm^3/hr, corresponding to steady-state heat loss of 15.6 kW through refractory, was required to maintain a preheat temperature of 1000ºC.

Key words: Rotary hearth furnace; sponge iron; Gas dynamics; Combustion; Burner configuration; Fuel gas composition; Oxygen enrichment.