Optimization of Water-Cooled Seal Boxes of the Pelletizing Furnaces of the Khuzestan Steel Company

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Abstract

Production efficiency of traveling-grate of pelletizing machine depends on design and insulation method of walls and roof. In KSC of Iran, water-cooled seal boxes are used to separate the interior of the traveling-grate from the exterior. This research indicates that substitution of water-cooled panels with refractory materials poured in steel-frames improves furnace operation and reduces incidental damages during the furnace operation. Different alumina-silica type refractory materials are critically studied in both laboratory and industrial scales. Experimental results indicate that utilization of a refractory material composed of 66 wt% Al_2O_3, 25 wt% SiO_2, 4 wt% CaO and 0.7 wt% Fe_2O_3 results in (a) lowering of the heat loss, (b) enhancement of the life-time, (c) reduction of the destruction risk and (d) improvement of the furnace performance. Performance of this material is compared with that of the seal-boxes traditionally used in KSC plants.

Key Words Refractory, Seal-Box, Traveling-Grate, Optimization, Heat Loss, Pelletizing

Introduction

Khuzestan Steel Company (KSC) located in Ahwaz, Iran has two 2.5 million tons/year granulating units. They feed 3.7 million tons per year of granulated materials into two traveling-grates which supply hard pellets for DRI plants.

Green granulates are collected by conveyer belt and charged to the entrance of the grate. There are two important pieces of equipment here: (1) a vibrating conveyer for even distribution of granulates on carrying pallets with 3.5 meter width and (2) a rolling conveyor separating fine granulates smaller than 6 mm. These fines are directed towards raw materials mixers that produce paste. The rolling conveyor also helps even distribution of granulates by their passage through roller spaces [1].

Firing is the most critical function of a traveling-grate [2]. Firing chamber has different parts: two granulate drying sections, three preheating sections, a fire chamber, an resting chamber and two cooling sections at the end [3]. The chain of the pallets (each having 1.5×3.5 m size) continuously move forward and then backward on two guiding rails by the help of rolling axes at the two end points of the furnace. The speed of the chain differs and is controlled by the distributing machine that measures the amount of the entering granulates in order to cause the height of the load to be the same. The exhaust of the cooling chamber warms the first drying chamber of the furnace and the second drying chamber is heated up by the warm air from the firing zone. The temperature of the air and the blowing gas is 320°C in the drying section. Granulates gradually move to the higher temperature sections and warm up to dry completely without rapid evaporation of the water content which may cause cracking of the granulates [2].

After drying, firing takes place. This process involves temperature raise of up to 1300°C with 38 natural gas burners at two sides of the firing chamber [2]. In designing of the industrial furnaces, sealing of the system possesses significant importance. In granulate firing furnaces, an important part is water-cooled steel box named seal box which functions as an insulating wall for the chamber.

Optimum performance of the walls has influence on energy consumption and economics of the pelletizing process. These will affect on drying, sintering, strengthening and stability of the hardened agglomerates. An optimum design prevents wasting of the heat and occasional escaping of pellets from the traveling grate. Optimization of material and design can save energy and reduce both capital cost and expenditure.

Seal box erosion at different locations including the firing zone of the furnace may cause severe deformation and outward leakage of water from the cooling panel. Frequent destruction of the side walls due to water leakage is detrimental to safe operation and satisfactory performance of the traveling-grate. Humidity, flame and mechanical destruction are usually observed at the firing zone of the traveling grate. Water leak causes malfunction of the system and reduction of the flow rate. Flow rate reduction causes box destruction. Box destruction damages furnace construction, enhances energy consumption, increases operational costs and creates probable burning events.

Experimental Procedure

Taking into account the problems encountered with water-cooled seal boxes, it was attempted to replace these system with an appropriate refractory material having appropriate mechanical properties and high temperature resistance. The recommended design was as illustrated in Fig. 1. It could totally eliminate water from the furnace wall with replacement of refractory cements in place of water-cooled panels.

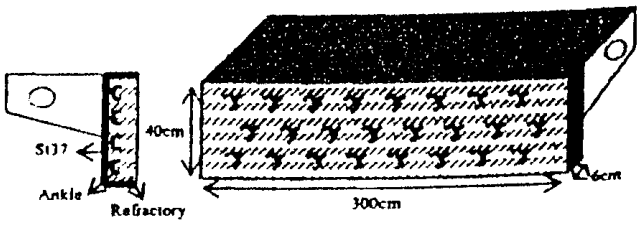

Fig. 1. Recommended design.