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Evaluation of Various Heat Losses in a Rotary Furnace

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Abstract - Essar steel India Private limited is a fully integrated flat carbon steel manufacturer based in India from iron ore to ready to market products with a current capacity of 10 million tonnes per annum. Essar steels manufacturing facility comprises pellet making, iron making and steel making and downstream facilities spread across India. A rotary furnace is a rotated around its axis and rotation can also induce mixing or stirring of the sample. The rotary furnace will be rotating at 7.5 revolutions per minute. In that disc slurry will be placed and rotated those particles around it. Now water will be separated from the sample, and then filtrate the slurry in three different types of filtrations. Finally, the filter cake will come with a solid (90%) and moisture (10%). Heat the pellets by using induration process .Finally pellets are obtained. In the present work, sensible heat losses through pellet car, radiation losses, sensible heat loss through hot pellet discharge and cooling water losses and other losses are evaluated with respect to variation in quantity of pellet car, quantity of heat losses, quantity of pellet discharge, heating pellet car. Graphs are presented in order to study the effect of various losses with respect to input parameters like pellet discharge. The data obtained from analysis is consolidated in tables and presented in appendix.

***Key Words*:** Essar steel India Private limited, Rotary Furnace, Heat losses.

1.INTRODUCTION

1.1. Furnace theory: A furnace is an equipment to melt metals for casting or heat materials for change of shape (rolling, forging etc.,) or change of properties (heat treatment). A furnace is essentially a thermal enclosure and is employed to process raw materials at high temperatures both in solid state and liquid state. Several industries like iron and steel making, non-ferrous metals production, glass making, manufacturing, ceramic processing, calcination in cement production etc. employ furnace.

The principle objectives are a) To utilize heat efficiently so that losses are minimum, b) To handle the different phases (solid, liquid or gaseous) moving at different velocities for different times and temperatures such that erosion and corrosion of the refractory are minimum.

1.2. Source of energy: a) Combustion of fossil fuels, that is solid, liquid and gaseous. b) Electric energy: Resistance heating, induction heating or arc heating. c) Chemical energy: Exothermic reactions

1.3. Types and Classification of Different Furnaces: Based on the method of generating heat, furnaces are broadly classified into two types namely combustion type (using fuels) and electric type. In case of combustion type furnace, depending upon the kind of combustion, it can be broadly classified as oil fired, coal fired and gas fired.

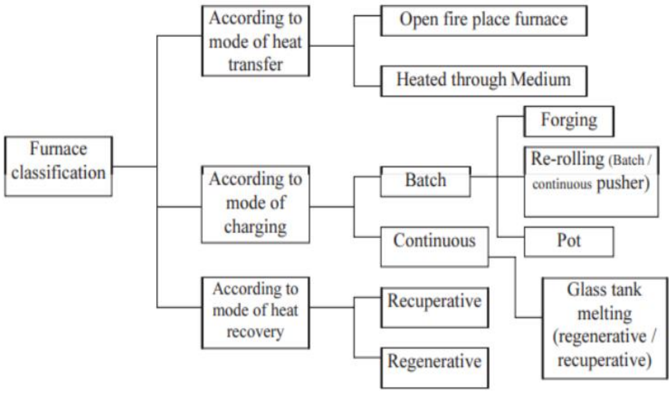

Figure 1.1: classification of furnace

1.4. Characteristics of an Efficient Furnace: Furnace should be designed so that in a given time, as much of material as possible can be heated to a uniform temperature as possible with the least possible fuel and labour. To achieve this end, the following parameters can be considered.

1. Determination of the quantity of heat to be imparted to the material or charge.

2. Liberation of sufficient heat within the furnace to heat the stock and overcome all heat losses.

3. Transfer of available part of that heat from the furnace gases to the surface of the heating stock.

4. Equalization of the temperature within the stock.

5. Reduction of heat losses from the furnace to the minimum possible extent.

1.5. Heat Transfer in Furnaces: The main ways in which heat is transferred to the steel in a reheating furnace are shown in Figure 1.2. In simple terms, heat is transferred to the stock by:

1. Radiation from the flame, hot combustion products and the furnace walls and roof.

2. Convection due to the movement of hot gases over the stock surface at the high temperatures employed in reheating furnaces, the dominant mode of heat transfer is wall radiation. Heat transfer by gas radiation is dependent on the gas composition (mainly the carbon dioxide and water vapour concentrations), the temperature and the geometry of the furnace.

1.6. Performance Evaluation of a Typical Furnace: Thermal efficiency of process heating equipment, such as furnaces, ovens, heaters, and kilns is the ratio of heat delivered to a material and heat supplied to the heating equipment. The purpose of a heating process is to introduce a certain amount of thermal energy into a product, raising it to a certain temperature to prepare it for additional processing or change its properties. To carry this out, the product is heated in a furnace. This results in energy losses in different areas. For most heating equipment, a large amount of the heat supplied is wasted in the form of exhaust gases.

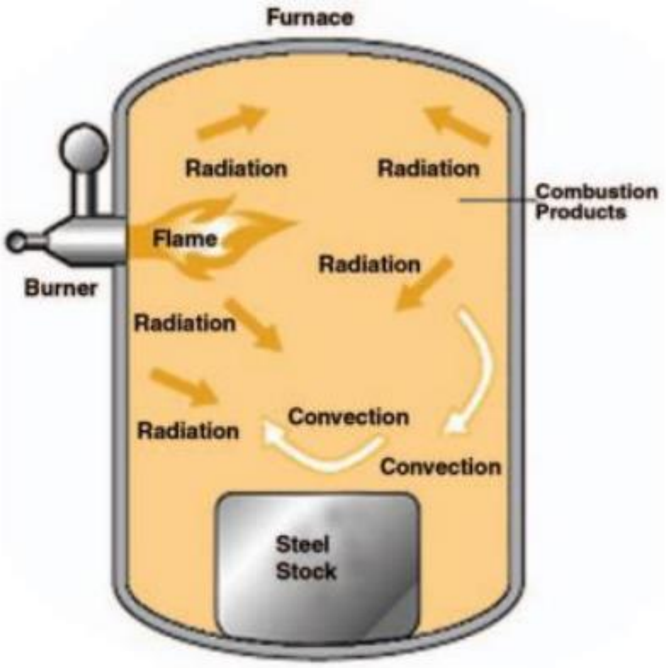

Figure 1.2: Heat Transfer in Furnace

Figure 1.3: Rotary furnace

II. INTRODUCTION TO ESSAR STEELS

Essar Steel India Private Limited is a fully integrated flat carbon steel manufacturer based in India from iron ore to ready –to- market products with a current capacity of 10 million tonnes per annum (MTPA). Essar Steel's manufacturing facility comprises ore beneficiation, pellet making, iron making and steel making and downstream facilities spread across India.

2.1 Kirandul Plant: • 8.0 MMTPY capacity (2×4 MMTPY each). • India's beneficiation plant in operation. • Value addition to Bailadilla Range Ion ore fines of NMDC. • HGMS of highest capacity in operation in India. • Gravity separation, Magnetic separation are the key processes. • Upgradation of ore by removing gangue is called Beneficiation.

2.2 Pellet Plant Visakhapatnam: • Only DR pellet producing plant in India. • 8.0 MTPY capacity (2×4 MTPY each). • Flow sheet with state of art technologies of After cooler and Ceramic filters. • Ideally located for sea transport. • Key processes are Filtration, Green Balling, Induration.

2.3 Preparation of Raw Material for Green balling: This step involves mixing the finely ground Iron Ore particles (filter cake) with Binders and Additives in right proportions to achieve the final chemical and physical properties of the end product i.e. Pellets. Binders: In conjunction with the finely-ground ore particles, Binders serve to improve the properties of Pellets in wet and dried or indurated condition. However, nowadays only Bentonite, Slaked lime, Limestone, and Dolomite are used. Bentonite is used as a Binder in Our Plant.

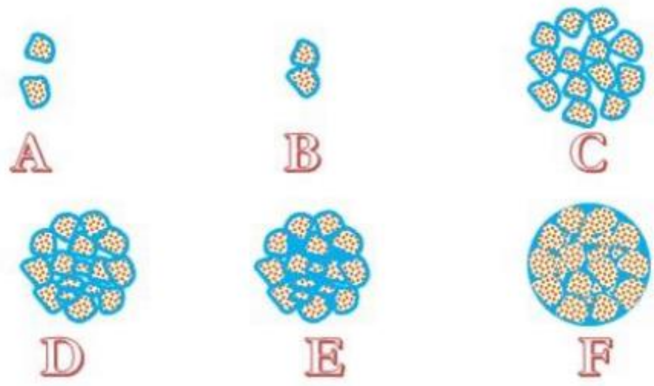

Figure 2.1 phases of greening the ball

A. *Solution to the Problem*

Sensible heat to remove moisture of pellet

= ρcvdT/dt = hA(t0 – ti)

Where, ρ = Density=0.6 kg/m3

C= Sensible heat

V = volume = 204177.6 m3

h = heat transfer coefficient = 5045599 kcal/m2 hr°C

A = area = 1422 m2 to = outlet temperature = 1260 °C

ti = inlet temperature = 30 °C Sensible heat required for heat of pellet cars

$$\frac{2 \times q}{1 + (T_{entry}/T_{exit})}$$

q = heat pellet car = 59508398.44 kcal/hr

Tentry = temperature of pellet car centre casting at entry = 88°C

Texit = temperature of pellet car centre casting at exit = 95°C

Sensible heat required for heat of pellet cars

$$= \frac{2 \times 59508398.44}{1 + (\frac{88}{95})}$$

= 61784678 kcal/hr

III. RESULTS AND DISCUSSION

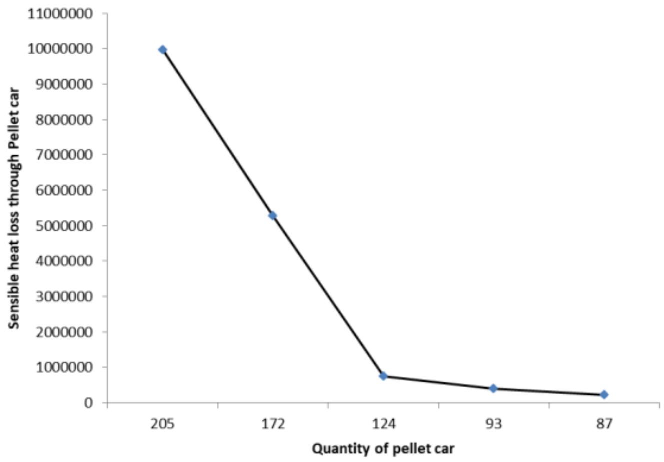

Figure 6.1. variation of quantity of pellet car on sensible heat loss through pellet car

The above represented graph is variation of quantity of pellet car on sensible heat loss through pellet car. The quantity of pellet car is gradually decreasing with respect to sensible heat loss through pellet car.

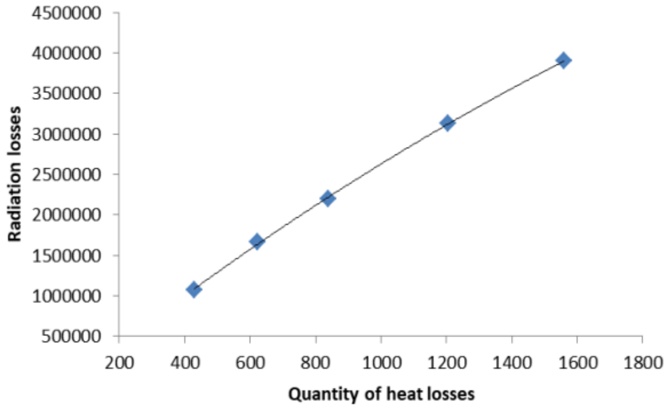

Figure 6.2 variation of quantity of heat losses on radiation losses

The above represented graph is variation of quantity of heat losses on radiation losses. The quantity of heat loss with respect to radiation losses will increasing gradually.

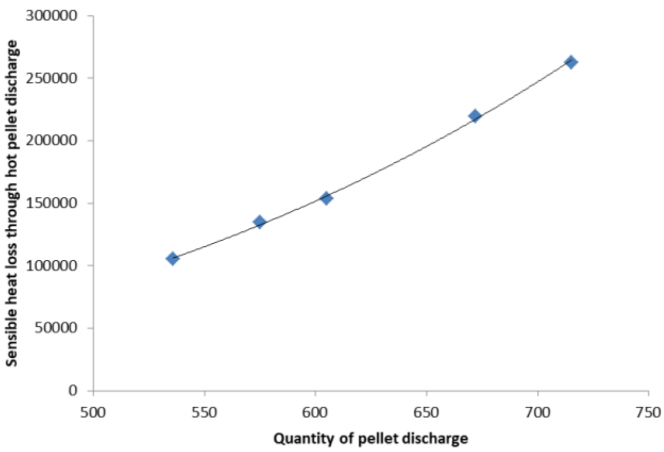

Figure 6.3 Variation of Quantity of pellet discharge on sensible heat loss through hot pellet discharge

The above represented graph is variation of quantity of pellet discharge on sensible heat loss through hot pellet discharge. The quantity of pellet discharge with respect to sensible heat loss through hot pellet discharge will increasing gradually.

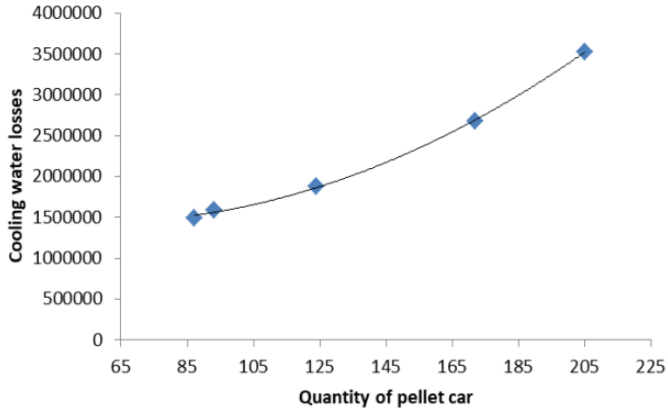

Figure 6.4: Variation of Quantity of pellet car on cooling water losses

The above represented graph is variation of Quantity of pellet car on cooling water losses. The quantity of pellet with respect to cooling water losses is increases gradually.

IV. CONCLUSION

The performance test on horizontal rotary furnace, by using this rotary furnace finally calculate a total heat consumption of pellets and percentage of pellets to produce a how much quantity per day. The variation of quantity of pellet car with respect to sensible heat loss through pellet car is gradually decreasing. The Variation of quantity of heat loss with respect to radiation losses is increasing gradually. The Variation of quantity of pellets discharge with respect to sensible heat loss through hot pellet discharge is gradually increases. The variation of quantity of pellet car with respect to cooling water losses is gradually increases.

V. FUTURE SCOPE

Based on the experimental study, obtained results and conclusions the following future scopes are summarized.

1. By using rotary furnace in future we implement the production of pellets also we improve the furnace.

2. We can also implement the computational fluid dynamics by using this rotary furnace.

3. In future comprises of manufacturing of pellets will increasing the production rate and as well as quality.

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