A NEW DESIGN OF FURNACE FOR INTRODUCTION OF CURTAIN FLAME IGNITION SYSTEM FOR SINTER IGNITION IN SINTER PLANT[1]

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Abstract

In the sintering process initial ignition of sinter bed plays crucial role and it is achieved with the help of number of conventional side burners. Overall size of the ignition hood becomes large if conventional burners are used. This system has several disadvantages like non uniform temperature distribution across the width of the sinter bed, loss of significant heat due to radiation from the ignition hood, etc. In these type of furnaces generally mixed gases are used for ignition and fuel consumption is very high. Average fuel consumption in this type of firing comes in the range of 0.025-0.045 G Cal per ton of sinter. In the newly developed curtain flame ignition system, furnace size has been drastically reduced and refractory consumption has come down to one tenth of the earlier design. Flame from a series of slit burners, across the width of the furnace, directly impinged on the sinter bed passing through the sinter hood. Sinter hood is made up of a number of modules of prefabricated preheated refractory structure and slit burners are sandwiched in between them. This furnace hood is supported by two front and back end refractory beams which act as curtain to the flame. With the adoption of this new system the fuel consumption has come down to 0.027 G Cal per ton of sinter apart from improvement in sinter quality. Refractory cost has also come down drastically. In this paper the developed system of refractory lining for sinter hood along with the benefits achieved after adopting the developed technology has been discussed and highlighted.

Key words: Sinter; Curtain; Energy; Refractory.

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Introduction

Sintering is a process where heat is generated by combination of solid fuels within moving beds of loosely packed particles, i.e. iron ore, lime dust, etc. into a compact porous mass. This porous mass is called sinter and is used in blast furnaces as an iron bearing charged material. The process envisages use of waste materials in steel plants. Sinter is an integral part for iron making through blast furnace route. Sinter mix is burnt in an ignition furnace. The traditional furnaces for sinter production is side fired long chambers with refractory lined side walls and hanging bricks for roof. Normally, 10-12 burners are installed in both the sidewalls and fired with mixed gases of calorific value in the range of 1500-1800 Kcal/Nm3. Problem faced with this type of firing are improper distribution of heat in the sinter bed which ultimately leads to huge percentage of return sinter in the forms of fines. Heating of large chamber of the earlier system leading to huge energy loss. Modified system developed by Research and Development Centre for Iron and Steel, Ranchi, India consists of a series of small burners along the width of the sinter bed mounted at the top of a designed small chamber. Flame generated through the burners is projected on the sinter bed and impinges on the bed top uniformly and sinter ignition takes place. The system has been introduced in almost all the steel plants of SAIL, India. Presently through this system about 11MT of sinter are produced in SAIL.

Conventional ignition furnace

In Bokaro plant of SAIL, we are having sinter machine of bed width 4080mm , bed height is 480mm and bed length 52000mm. Furnace is fired with 12nos. of side burners embedded in sidewalls of both sides. Mixed gas of calorific value 1300 Kcal/Nm3 and flow rate of 300-400 Nm3/hr. is used as fuel. Sintering of material to the bottom of the sinter bed takes place due to suction through the sinter bed. 38% alumina bricks are used as as refractory for 415mm thickness wall lining and 45% alumina bricks are used as hanger bricks in the roof. Total 110 tons of refractory are used for lining the furnace chamber of 12m length. View of the sinter furnace before modification is given below in Figure-1.

Figure 1. View of the sinter furnace before modification

The operating parameter of the sinter furnace before installation of the curtain type burners are given below in Table 1.

Table 1 Operating parameters of the sinter furnace

Operating parameter	**values**
Bed width	4000mm
Length of the furnace	12000mm
Height of the ignition hood	1600mm
Bed height	500mm
Bed suction	600mm WC
Average mixed gas flow	3000 Nm3/hr.
Production	300t/hr
Specific gas consumption	0.042 GCal/tp

New ignition system

The concept involves in mounting small capacity burners on the roof across the sinter bed. Flame generated in the burners touches the top of the sinter bed. Primary air is send through swirlers for better mixing of fuel gas and air. Secondary air slots are provided in the burner module to form a curtain flame configuration[1]. The new burner system has eight top mounted burner modules each consisting of four small capacity burners. The width of each module is 250mm and length 500mm to give a combined length of 4000mm i.e. covering the full bed width. Each module is supplied with mixed fuel with calorific value of app.1500 Kcal/Nm^3 and combustion air through flexible hoses. The new modified portion of the ignition furnace has a length of 3000mm compared to the former of length 12000mm and the height of the furnace dropped to 500mm from earlier 1600mm. View of the ignition furnace after modification is shown in Figure-2 below.

Figure 2. View of the modified curtain flame ignition furnace.

In sintering the top surface of the charge is ignited through burners. As the pellet moves forward beyond the ignition zone, air is sucked through wind boxes situated under the grate and the flame front travels vertically through the charge. A high temperature combustion zone is created in the charge bed due to combustion of solid fuel in the mix and by regeneration of heat from the incandescent sinter and outgoing gases. As a result of the forward movement of the pellet, the sintering zone travels vertically down through the charge.

Requirement of refractory for new system

The curtain flame ignition system in sinter furnace needs very stringent refractory quality for lining the furnace. Furnace length becomes one fourth of the earlier one and height also reduces considerably. Heat generated in the furnace remains in a very limited space and in closed chamber. Schematic diagram of the assembled curtain flame ignition furnace is shown in Figure-3.

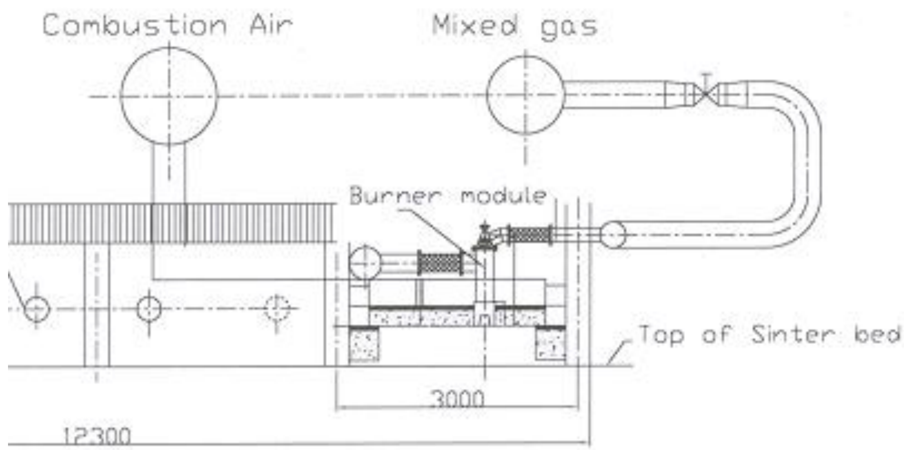

Figure 3. Schematic diagram of the assembled curtain flame ignition furnace.

Refractory has to withstand very high operating temperature. Flame falls directly on the sinter bed. However, if the suction in the furnace is not proper, flame shoots outside and in the process impinges on the refractory lining used as charging and discharging end walls. Also, because of the high pressure of short and intense flame dust particles goes out and impinges on the refractory lining. This dust particles consists mainly of iron oxide, silica and lime and at high temperature forms low melting compounds such as fayalite, calcium silicate and complex calcium iron aluminium silicate, etc. which sticks to the refractory lining of the roof and changes the composition of the front working surface of the refractory. Hence, there is a chance of refractory spalling in the lining. Porosity of the refractory used for lining should not be very high as chances of dust impingement on the lining will increase with the increase of porosity. Hence, all these points should be taken care for designing the lining of the furnace,

Furnace fabrication and installation:

The exposure of the furnace lining under the above environment necessitates the use of superior quality refractory material. Low moisture castable of alumina content 70% and of superior quality was chosen as the lining material. Quality of material used for preshape, prefired blocks is given in Table-2.

Table 2 Specification of low moisture castable

Chemical analysis, wt.(%),

Al_2O_3 ---70,min.

Fe_2O_3-- 0.5,max,

CaO —1.5,max

Physical Characteristics:

B.D.,gm/cc,min, at 110°C/24hrs. - 2.80

CCS,kg/cm^2,min., at 110°C/24hrs. - 700

at 800°C/3hrs. - 800

PLC(%),max. at1500°C /3hr - +/- 0.5

HMOR,kg/cm^2, min. on prefired samples, at 1400°C/30mins - 60

Design of the furnace in modular form has been done in such a way that installation can be done easily and quickly. Total furnace has been constructed by prefabricated, preshaped and preheated large blocks of 250mm cast thickness and placed in the furnace proper with the help of crane. Three meter length of the furnace has been divided into four parts and two roof beam modules and two beams for charging and discharging end walls were designed and fabricated. Burner is placed in between two roof beams. Two end wall beams act as curtain to flame.

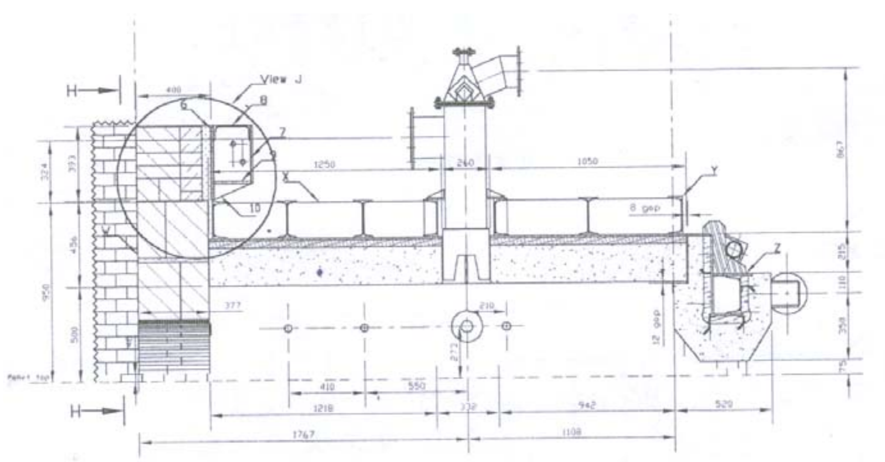

Figure 4. Schematic diagram of the refractory lining of the ignition furnace.

These beams are supported by two supporting cross beams at both sides of the furnace between two vertical columns. Stainless steel anchors are placed on the flat plates and casting of low moisture castable was done with the help of pneumatic vibrator. The cast beams are then cured naturally and then preheated to 700-800^{o}C in a designed preheating chamber for 40hrs. Prefabricated and preheated beams for installation in the roof is shown in figure-4 in assembled condition. Two pilot burners were fabricated and installed in the sidewalls just below the top mounted burner modules,. Two igniters are provided to ignite the pilot burners. The external length of the furnace is 2700mm and the internal length is around 2100mm and inside height is 500mm. Hence, furnace volume has been reduced by more than 90% com-pared with the original furnace. The designed refractory lining gave a lining life of two years for the roof structure of the ignition furnace without any repair.

Results

The performance of the furnace with regard to gas consumption and sinter produced before and after modification shows that average specific gas consumption before modification was 0.0424Gcal/ton of product and after modification specific gas consumption dropped to 0.027Gcal/ton of product. Hearth ignition temperature i.e. around 1100^{o}C, is measured through a thermocouple inserted in the side wall of the hearth. Actual temperature of the top layer shall be higher than the wall reading. There was apprehension that the small capacity burners might result in their nozzles getting choked. To overcome this, a blanked flange has been provided above the gas nozzle pipe so that a rod can be inserted to clean any blockage. The productivity data of the shop showed an increase in productivity by 5% i.e. from 1.13t/m2/h to 1.188t/m2/h due to the extra 9m length now available on the sinter band for cooling. Refractory cost has also come down drastically because of the smaller furnace volume. From the earlier requirement of 120Tof 38% and 45% alumina bricks along with insulation bricks, the consumption has come down to 12T of low moisture castable only.. Repair and maintenance shut down has also come down which has improved the furnace availability and hence improvement in productivity.

Conclusion

Successful implementation of the developed technology in sinter furnace has resulted in following benefits:

- Reduction in overall specific gas consumption to 0.027Gcal/ton of product from 0.0424Gcal/ton of product.
- Furnace volume was reduced by 90% and cost of refractory for lining the furnace has come down by 50%.

Productivity of sinter machine improved from 1.13t/m2/h to 1.188t/m2/h.

- Occurrence of fused sinter on top layer has been minimized thus quality of sinter improved.
- Reduction in damage to pellet side plate as furnace length is shortened.
- Social and environmental benefit due to less generation of flue gas.

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