Modification of conventional furnaces into energy efficient Furnaces

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Abstract— one of the most important parts of metal processing is hot forming of ingots through reheating and subsequent hot forging/hot rolling. Due to abnormal increase in fuel price, reheating cost also is increasing astronomically. Initially before the year 2009, the fuel consumption was around 1T/per ton of processing. Critical analysis was carried out. The study revealed that ceramic fiber has less thermal conductivity compared to that of conventional insulation brick. Suitable ceramic fiber was chosen and furnaces were modified with ceramic fiber. This has drastically reduced LPG consumption from 1T/ton of production to 0.5T/ton of production.

Index Terms— Ceramic fiber, Monolane, Monomax, Specific fuel consumption, Thermal conductivity

1 INTRODUCTION

KEEPING in mind the concept of sustainable development of the country efforts were made to reduce the consumption of hydrocarbons by using energy efficient furnaces. MIDHANI uses Liquefied petroleum product (LPG) for reheating to various alloys during hot processing to maintain cleanliness of the finished material. Over the years price of LPG has increased abnormally (by two fold) and major consumption is in forge shop furnaces. LPG consumption can be reduced by suitable modification of the refractory material used in lining the furnaces. As the same time material should be cost effective so that cost of production does not increase. Keeping in view of requirements of MIDHANI, it was decided to reline the furnaces thermally efficient and cost effective refractory material

2. Material used: Which and Why??

Out of the available material for relining furnace, it was an obvious choice to go for an optimized product by keeping in mind dual parameters for selection i.e. desired properties and cost of a material. For the purpose of heat saving it is theoretically proven to go for a material having low thermal mass, an optimum density showing higher thermal insulating property as well as sufficient load bearing capacity for sustaining under its own weight at elevated temperatures for long heating cycles. Alongside these property parameters it should be most economical product which suits all the above desired properties.

Choices available for relining products for furnaces are given in table-1

Table 1: showing comparison of various types of materials

Materials	Density (Kg/m3)	Thermal Conductivity (w/mk) at 1000° C	Cost /sq meter lining (INR)
Conventional Fire bricks	2300	1.2	3000-4000
Conventional ceramic fiber/module	160	0.39	2500
Monolane/monomax module	192	0.32	4000
Pyroblock module	240	0.28	16000

Monolane /monomax modules are having optimum thermal conductivity & density with comparably low price than other options shown in table-1. It was optimized to go for MONOLANE Ceramic fiber of 96 kg/cm3 mass density having thermal conductivity of 0.39 w/mk at 1000° C and having a cost of INR.1800 per roll(roll size: 7300 X 610 X 50 mm) and then roll it into a density of 192Kg/cm2 by compressing it with addition of monolane solution. Therefore we have tried for achieving the benefits of higher density grade ceramic fiber by applying low grade low cost monolane

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ceramic fiber thereby optimizing the cost and property parameters.

3. Work done for Modification:

Modification works started from an outer shell structure of steel having special designed anchors welded inside the shell for holding the monolane ceramic fiber to walls and roof. Design of anchor was one of critical area on which depends the holding of whole fiber lining. It should be designed in such a way that it can withstand the load of fiber blanket, not to be directly exposed to high temperature of furnace and properly hold it tightly on shell. As there is a chance for shrinkage for this type of fiber lining, it should be tightly staged. SS310 grade stainless steel material of was used for anchoring.

After welding of anchors in fixed places on shell as per design parameters, Monolane ceramic fiber blanket of 96kg/cm2 density was rolled into 192kg/cm2 density grade by adding monolane solution (solution+ water) to it by compression rollers. Then cut it according to design and shape requirements.

Rolled ceramic blanket was properly anchored to the walls (two side walls and a back wall) and roof of furnace shell as per design. For the purpose of sufficient load bearing strength in burner areas, burners were placed on brick lined portion and in between burner areas we put same monolane fiber blanket. After full lining of furnace, it was calibrated and handed over for production purpose.

Before Modification

After Modification

4. Outcome:

4.1 To know the increase in fuel efficiency after revamping of 3 reheating furnaces (2 fixed hearth +1 bogie hearth), these furnaces were calibrated and then subjected to identical situations i.e. same heating cycle, same load of same sizes and grades as in previous conventional type brick lined furnace. Hence Outcome of revamped furnaces is shown in below (in table 2) after taking samples in identical conditions.

Table 2: showing input of and output from revamped furnaces

Name of furnace	Year of revamping	LPG consumption before modification	LPG consumption after modification	% saving of Fuel	Cost incurred
004	2012-13 2013-14	587 Nm^3 587 Nm^3	467.3 Nm^3 518.9 Nm^3	20.5 11.5	59 lakhs
08B	2012-13	807 Nm^3	546 Nm^3	32.34	19 lakhs
09A	2013-14	395.5 Nm^3	307.3 Nm^3	22.30	13 lakhs

4.2 Overall specific fuel consumption (LPG consumption/charged load) of all LPG fired furnaces:

Specific fuel consumption continuously declining from last five years which can be attribute to continuous improvement

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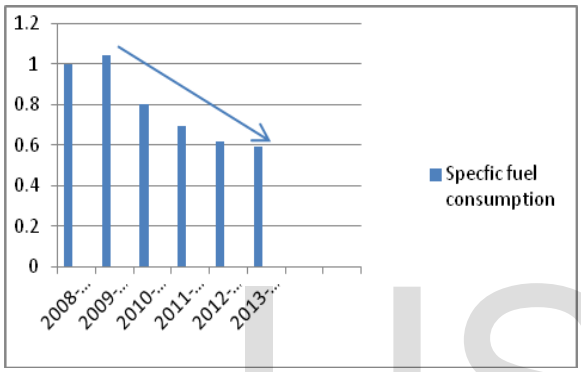
in methods of arresting leakages, continuous operation (long heat cycles) and less frequent breakdowns etc, but the decline after 2011-12 i.e. from 0.690 to 0.590 in 2013-14 (~15%) is more significant as it is more difficult to go down below the value of 0.6. This was mainly achieved through revamping of furnace lining by Fiber blanket (as shown in table no 3).

Year	specific fuel consumption
2008-09	1.000
2009-10	1.045
2010-11	0.804
2011-12	0.690
2012-13	0.614
2013-14	0.590



Yearly Specific fuel consumption in revamped furnaces have shown in table-3

Table: 3 Comparison of fuel saving before and after modification.

Name of furnace	Specific fuel consumption (T/T)			% fuel saving before and after revamping
	2011-2012	2012-2013	2013-14	
004	0.71	*	0.516	28
008B	0.72	*	0.410	43
009A	0.58	0.60	0.430*	27

(* - Year of revamping having mixed results,

@ -year of revamping and data is after revamping)

In 2014-15 it is aiming specific fuel consumption target of 0.5T/T by taking more furnaces for revamping by fiber lining and other innovations like more optimized fiber product with long life and application of high emissivity coating on fiber.

5 Conclusions:

It is evident from above shown calculations that revamping of forge shop reheating furnaces has considerably enhanced the fuel efficiency of furnaces which has direct correlation with reducing LPG consumption i.e. low fossil fuel consumption and therefore decline in exhaust of green house gas (CO2). Therefore we are on the way of promoting sustainable development by reducing our carbon footprint.

Apart from ecological concerns, it has benefitted organization economically by reducing fuel consumption expenditure. In monetary terms it is saving crores for our organization:

(***Average LPG consumption 180 tonnes/month, Price of LPG= 70,000Rs/tone Total expenditure on LPG (monthly) = 180*70000= 1, 26,00000Rs. Average saving after revamping: 15%= 12600000*15%= 18, 90000 Rs/month= 2.26crore annually.***)

After revamping of furnaces it is giving other benefits like reduction in breakdowns of furnaces, easy maintenance of furnaces, and increase in availability of furnaces.

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