Total Refractory Management in Re-heating Furnace in HSM of Bokaro Steel- A new experiment, new experience & Scope for further improvement

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Introduction

- RH Furnace is one of the most important unit in an integrated Steel plant.
- 15 % of total energy required for steelmaking is used in hot rolling of steel.
- 1.5 -2.0 GJ/Ton energy is used in hot rolling of steel.
- 80% of that energy is due to the reheating furnace.
- Energy is not only expensive but is associated with environmental issues

RH Furnaces in Bokaro

- Hot strip mill in Bokaro Steel has got three RH furnces with capacity 300 Ton/hour each, for heating slabs.
- Furnace dimension – 40 Mtr Long, 11 Mtr width and 4 Mtr inner height.
- Furnace has flat roof with 126 radiant burner in the roof.
- There are 26 burners are at the wall.
- The furnace has got both stationary and moving vertical skid pipes to facilitate the movement of slabs.
- The furnace preheating zone temperature is at 700C and the temperature at the discharge end is 1250C

TRM

- The first TRM of reheating furnace in the country was awarded to SKG Refractories in 2015 for RHF-3
- The TRM was run for 4 years.
- After running for 4 years it was found that both Refractory cost has come down and also the furnace availability has gone up.
- Earlier the furnace used to go for three yearly shutdown on account of refractories which is improved to two annual shutdown.
- As a result SKG Refractories have been awarded three more furnaces for the TRM for the tenure of 4 years.

The Refractory development and challenges

- The most critical refractories for the reheating furnace was found to be roof refractories and the burner blocks, especially the roof burner blocks and the refractories used for covering the skid pipes.

- Burner blocks are hanged by special arrangements. Four cavities of special design are provided in the burner block where a SS pin of special design is inserted and on turning to 90 degree it gets locked and the burner block can be lifted and fitted to roof.

- The weight of the different size of burner blocks varies from 150 to 250 kg.

- The roof bricks and especially burner blocks experience very high thermal shock and thermo-mechanical stresses and need to have good degree of volume stability, thermal shock resistance and low MOE.

- All these products are developed by SKG refractories indigenously out of special raw materials.

- Earlier norms were to change 150 burner blocks in four year campaign period and after the TRM has been taken by SKG the number of burner blocks changed is about 125-130 in the same period, which itself is about 16-17% improvement.

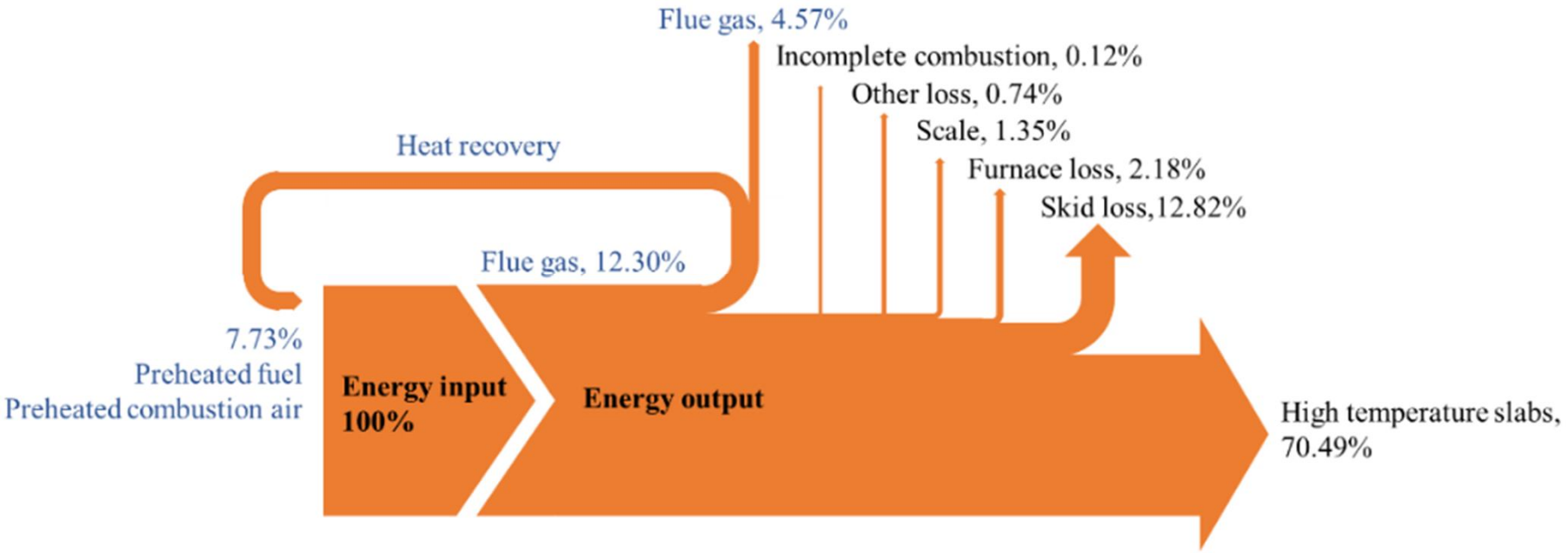
Roof **Burner block photos**

Wall burner block and Roof brick

Performance of the Roof Burner Blocks

- The burner blocks found to give a very good campaign life. The Photo below shows the roof burner block after use of one year.

Sankey diagram for Walking beam furnace



Skid Pipes in reheating furnace

- The length of the horizontal skid pipe - 400 Mtr
- The length of vertical skid pipes – 200 mtr
- Water flowing is about -300 Cu.Mtr/hr

Scope of Further improvement

- There is immense scope of further improvement in furnace availability, to reduce the downtime and to reduce the energy cost by proper management of skid pipe lining.

- The Skid pipes are the most frequently repaired area in the RH furnace and is majorly responsible for most of the downtime.

- 30% of the Refractory BOM for RH furnace maintenance is Castable used for skid pipe lining.

- The gas consumption increases with time as the skid refractories worn out and more heat passes to the cooling water through skid pipe refractory.

Effect of Energy conservation techniques on operating parameters of the furnace

Energy Conservation Technique	Heat Transfer to Load	Reduction of Exhaust Gas Mass	Temperature Uniformity	Productivity
Improving the Performance of Existing Equipment				
Reducing Heat Storage		√		√
Reducing Wall Losses		√		√
Reducing Material Handling Losses		√		√
Reducing Cooling Media Losses	√	√	√	√
Reducing Radiation Losses	√	√	√	√
Optimizing Fuel-Air Ratio	√	√		√
Reducing Air Infiltration	√	√	√	√
Improving Scheduling & Loading		√		√

- **Conclusion**- The skid pipe refractory lining is very important to control energy loss and helps smooth operation of the RH furnace.

Present practice of Skid pipe casting and its drawback

- In-situ casting.
- No proper time can be given for consolidation, curing and preheating, which are most essential parameters to be observed for successful campaign of a castable lining.
- Reason - Time constraint
- Effect – Develops poor strength. Gets abraded fast.
- Result – Energy input in the furnace goes to water without heating the slabs.

Solution

- The only solution to improve the performance and to reduce the downtime of the furnace is to use PRECAST REFRACTORY blocks to cover the skids.
- This blocks are of composite design where the outer part is made of high strength LC Castable and there is an inner insulation layer.
- The outer layer can withstand the mechanical abuses and the slagging reactions with scales.
- The inner insulation layer can prevent the heat flowing from the furnace to the cooling water and can save energy.
- It is supplied in two halves, cast over a SS plate having the same profile of skid pipe, which is just fitted over the pipe section with tack welding. It saves 75% of the installation time of the skid pipe lining compared to present practice.
- It will have a campaign life at least 6-8 times of the present lining being used.

Precast Skid pipes

- Precast Refractories for single riser, double riser and horizontal skid pipes are developed in SKG.

Application of the Precast refractory blocks Skid blocks in RHF-3

Performance of Skid Pipes

- The Precast skid pipe cover refractories were tried in RH-3 in Bokaro.
- The performances were very encouraging when it was seen after one year.

Estimated saving in using precast skid pipe refractories

- The gas consumption norm in the furnace is 24000 NM3/hr at the beginning after the furnace is newly lined with refractory.
- After 3-4 months of operation the gas consumption increases by about 45% to 35000 NM3/hr
- Therefore the average gas consumption becomes 29,500 NM3/hr.
- So the extra gas consumption is 29500-24000 = 5500 NM3/hr.
- If we calculate the cost of the energy due to extra gas consumption, over a year, considering the CV of the gas as 2200 Kcal/NM3 and the cost of energy is Rs 1080/Gcal , the value is

  (5500 NM^3/hr x 24 hr/day x (360-90)days x 2200 kcal/NM^3 x Rs 1080/Gcal) /10^6 = Rs 84.7 Million /year.
- There will be another extra saving due to lesser use of Castable = Rs 2 Million year.
- If we consider the total cost of the PRECAST Skid pipe refractories and its installation as Rs 30 Million/furnace, The net saving per furnace is Rs (84.7+2-30)= 56.7 Million/year.
- For Four furnaces it will be Rs 56.7 x 4 = 226.8 Million in first year.
- In the next year the savings will be Rs 86.7 Million/furnace per year and for four furnaces it will be

  Rs 346.8 Million per year.

Extra Benefits

- The furnace availability will go up because the installation of Precast shapes takes 75% less time than the in-situ casting.
- Huge saving in manpower as the furnace downtime gets reduced.
- The burning of less fuel will reduce the emission of CO2. The consumption of fuel gas will drop by 140 Million NM3/year and the associated generation of CO2 will be nil.
- The job of Removal of Castable debris will be eliminated and furnace will remain much cleaner and maintenance will be easier.
- Better productivity.
- Scale formation per ton of slab will also be reduced.

THANK YOU