Energy Saving & Best Practices in Reheating Furnaces

L&T Special Steels and Heavy Forgings Private Limited

Presented by,
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Kishore Reddy
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COMPANY PROFILE
LARSEN & TOUBRO-OVERVIEW

Founded
1938

Market Cap
USD 16+ bn
(March 2016)

Number of Emp.
84,000+

Sales- in Billion $

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-10</td>
<td>9.8</td>
</tr>
<tr>
<td>10-11</td>
<td>11.7</td>
</tr>
<tr>
<td>11-12</td>
<td>12.8</td>
</tr>
<tr>
<td>12-13</td>
<td>14.0</td>
</tr>
<tr>
<td>13-14</td>
<td>14.3</td>
</tr>
<tr>
<td>14-15</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Shareholders

- Financial Institutions: 36%
- General Public: 23%
- FIs: 15%
- Employees: 12%
- Others: 12%
L&T BUSINESS SPECTRUM

- CONSTRUCTION
- HYDROCARBON
- POWER
- METALLURGICAL & MATERIAL
- HEAVY ENGINEERING
- SHIPBUILDING-DEFENCE

- ELECTRICAL & AUTOMATION
- CONSTRUCTION & MACHINERY
- L&T VALVES
- EWAC ALLOYS
- L&T INFOTECH
- TECHNOLOGY SERVICES

- IDPL
- L&T METRO RAIL
- L&T FINANCE
- L&T REALTY
Operates under Department of Atomic Energy, India.

Sole operator of 20 Commercial Nuclear Power plants in India

> 320 Reactor years of safe & reliable operation

Capacity

- Present Installed - 10.6 GWe
- Planned (by 2032)- 63 GWe
PLANT DETAILS

LTSSHF - JV between L&T (76%) and NPCIL (24%)

100 Acres Of Green Field project

750 M Long Shop
SYSTEM CERTIFICATIONS
PROCESS FLOW
Processes:

- Charge Mix
- EAF Melting
- LF Refining
- Vacuum Refining
- Ingot Casting
- Reheating
- Forging
- Testing
- Finished Machining
- Dispatched Product

Fully Integrated Process – Scrap to Finished Forgings
REHEATING FURNACE-INTRODUCTION
REHEATING FURNACES-INTRODUCTION

- Batch type, Bogie hearth and Gas fired furnace.
- Fuel Used- Natural gas(NG)
- Sizes: 250 MT, 300 MT
- Used for heating Steel Ingots received from Steel Melting Shop from Ingot stripping temperature(600°C) to forging temperature of 1200-1250°C for forging operation.
- Also used intermittently for reheating jobs upto 1200-1250°C when temperature of jobs dropped to 850°C while forging. Hence the name reheating furnaces.
- 60% of Natural gas consumption in product attributed to reheating process.
Waste heat recovery from the flue gases – **Regenerative Burners**

For uniformity and Circulation- **High Velocity Burners**

**ENERGY SAVING TECHNOLOGY**

**COMBUSTION TECHNOLOGY**

- Selecting the right refractory – **Ceramic Module & High Al Castable**
- Use of ceramic coatings – **Reduce heat storage in Refractory**
- Reducing heat losses from furnace openings – **Sand and mechanical sealing**
ENERGY SAVING TECHNOLOGY

GOOD DESIGN PARAMETERS

- Complete combustion with minimum excess air – max 5% of Excess air
- Maintaining correct amount of furnace draft – Slight +ve Pressure
- Minimize furnace skin losses – Atm Temp + 50°C
- Operation at the optimum furnace temperature – 1200 to 1250°C
CONVENTIONAL vs REGENERATIVE BURNER

Conventional Burners

Regenerative Burners
1st - While one burner fires, the hot products of combustion enter the burner port of the other.

2nd - Products of combustion passes through the regenerative burner body case which contains special refractory material which can absorb heat contained in flue gases.

3rd - Refractory media gets heated by the exhaust gases, thus recovering and storing energy from the flue products.
B-BURNER FIRING

After certain cycling time burners switch their roles.

1st - The regenerative burner with the hot media bed begins firing.

2nd - Combustion air passes through the media bed gets pre-heated by the hot refractory.
1st, 2nd Air staging combustion
Recirculation of exhaust gas in flame

Stabilized flame
NO\textsubscript{x} – 70 ppm
Extension of cooling air increases nozzle life time.

<table>
<thead>
<tr>
<th>1st combustion air (Cold Air)</th>
<th>2nd combustion air (Preheat Air)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Furnace Temp operation</td>
<td>High Furnace Temp operation</td>
</tr>
<tr>
<td>30% Total air</td>
<td>5% Total air</td>
</tr>
<tr>
<td>70% Total air</td>
<td>95% Total air</td>
</tr>
</tbody>
</table>

Air Staggering

CHARACTERISTICS REGENERATIVE BURNER
SAVING COMPARISON OF REGENERATIVE BURNER

- **COLD AIR (20°C)**: The developed heat energy will be used to preheat the air from 20°C to 1200°C.

- **RECUPEERATIVE (500°C)**: 25% SAVING. The developed heat energy will be used to preheat the air from 500°C to 1200°C.

- **REGENERATIVE (1000°C)**: 50% SAVING. The developed heat energy will be used to preheat the air from 1000°C to 1200°C.

**PREHEATED AIR TEMPERATURE**

- 20°C
- 500°C
- 1000°C
- 1200°C
# Regenerative Burner Saving

<table>
<thead>
<tr>
<th>ITEM</th>
<th>BEFORE</th>
<th>AFTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Date</td>
<td></td>
<td>2005.10</td>
</tr>
<tr>
<td>Furnace Capacity (Heating/Loading/Driving)</td>
<td>CAR BOTTOM TYPE 450 / 600 / 700TON</td>
<td>CARBOTTOM TYPE 450 / 900 / 1000TON(30% Increasing)</td>
</tr>
<tr>
<td>Furnace Size(m)</td>
<td>H7.15 X W7.5 X L16.45</td>
<td>H7.15 X W6.5 X L16.45</td>
</tr>
<tr>
<td>Combustion Type</td>
<td>Top</td>
<td>Bottom</td>
</tr>
<tr>
<td></td>
<td>Recuperative Burnerx12Ea</td>
<td>Recuperative High-Velocity Burnerx12Ea</td>
</tr>
<tr>
<td>Fuel Consumption</td>
<td>11,448Nm³/Ch</td>
<td>6,267Nm³/Ch (45.3% SAVING)</td>
</tr>
<tr>
<td>NOx Emission</td>
<td>150ppm@O₂11%</td>
<td>65ppm@O₂11%(59.0%REDUCING)</td>
</tr>
<tr>
<td>Support &amp; Ingot Welding</td>
<td>Occurred</td>
<td>Non-Occurred</td>
</tr>
</tbody>
</table>
ENERGY SAVING - OPERATIONAL PRACTICES
<table>
<thead>
<tr>
<th>ENERGY SAVING-OPERATIONAL PRACTICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation of Magnetic Resonators</td>
</tr>
<tr>
<td>Waste heat recovery by Vapor Absorption System</td>
</tr>
<tr>
<td>Fine Tuning of Parameters</td>
</tr>
<tr>
<td>Effectiveness of Regenerative Media Box</td>
</tr>
<tr>
<td>Load Optimization</td>
</tr>
<tr>
<td>Partial Door Opening</td>
</tr>
<tr>
<td>Frequent Scale Cleaning</td>
</tr>
<tr>
<td>Receiving of Hot Ingots</td>
</tr>
<tr>
<td>Periodic Maintenance and Planning</td>
</tr>
</tbody>
</table>
MAGNETIC RESONATORS

WORKING
- Maximizes specific contact area between fuel molecules & inlet air for complete combustion.
- Installed in NG line near burner.

L&T SSHF
- Installed in both RH furnaces.
- 7% decrease in NG consumption in RH.
VAPOUR ABSORPTION REFRIGERATION SYSTEM

- STACK
- ID FAN
- CHILLED WATER
- VAM
- ADMIN BUILDING
- QUENCHING TANK
- Fresh Air Damper
- Main Inlet Damper
- Bellow
- DUCT
- RH-250
- RH-300
- 39/75
VAPOUR ABSORPTION REFRIGERATION SYSTEM

Monthly Saving – 4 lacs

No Generation of NOx & SOx
### FINE TUNING OF PARAMETERS

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-Fuel Ratio</td>
<td>Maintained at 8.5 to 9:1 for best results</td>
</tr>
<tr>
<td>Furnace Pressure</td>
<td>Slightly positive pressure of 2 to 5mm of water column</td>
</tr>
<tr>
<td>Damper min &amp; max position</td>
<td>Min 15% &amp; Max 90%</td>
</tr>
<tr>
<td>Fine Tuning of Burners</td>
<td>Shape of Flame &amp; Length &amp; Colour</td>
</tr>
<tr>
<td>% of excess air</td>
<td>Max 5%</td>
</tr>
<tr>
<td>Thermography</td>
<td>Not more than 100°C</td>
</tr>
<tr>
<td>Flue Gas temperature</td>
<td>In the range of 250 to 400°C</td>
</tr>
</tbody>
</table>
EFFECTIVENESS OF REGENERATIVE MEDIA BOX

- $T_{ai}$ – Combustion air inlet temp
- $T_{ao}$ – Combustion air outlet temp
- $T_{Ei}$ – Exhaust gas inlet temp
- $T_{Eo}$ – Exhaust gas outlet temp

$\eta \text{ (Regenerative)} = \frac{T_{ao} - T_{Eo}}{T_{Ei} - T_{Eo}} \times 100$

Regenerative Media box
Efficiency should be $\geq 90\%$
OPTIMISED LOADING

On average maintained 70% of rated capacity / Batch


**PARTIAL DOOR OPENING**

**MODIFICATIONS DONE**
- Special provision in HMI
- Opening of door as per job size

**ADVANTAGES**
- Less heat loss.
- 25% savings as compared to full opening.
- 7% Oxidation Loss during reheating.
- Act as an extra heat sink with no use.
- Savings = 10000 SCM/month
## RECEIVING OF HOT INGOTS

### (0-650ºC) Ramping stage

<table>
<thead>
<tr>
<th>T1</th>
<th>T2</th>
<th>Ingot weight</th>
<th>200</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>650</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T2-T1</th>
<th>650</th>
<th>Support weight</th>
<th>30</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Heat to air inside the furnace</th>
<th>M(air) x Cp (air) x (t2-t1)</th>
<th>34111</th>
<th>Kcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heat to steel</td>
<td>M(steel) x Cp (steel) x (t2-t1)</td>
<td>14300000</td>
<td>Kcal</td>
</tr>
<tr>
<td>2</td>
<td>Heat to supports</td>
<td>M(Supp) x Cp(supp) x (t2-t1)</td>
<td>2145000</td>
<td>Kcal</td>
</tr>
<tr>
<td>3</td>
<td>Refractory storage</td>
<td>M(Ref) x Cp (Ref) x (t2-t1)</td>
<td>8092030</td>
<td>Kcal</td>
</tr>
<tr>
<td>4</td>
<td>Heat loss in flue gases</td>
<td></td>
<td>8320000</td>
<td>Kcal</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Heat requirement**

|               | 32891142 | Kcal |

**NG Saving**

|               | 3915 | Nm3 |

**Cost Saving=₹1.33 Lacs/Batch**
<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regenerative Media box Ceramic balls cleaning</td>
<td>Yearly</td>
</tr>
<tr>
<td>Combustion &amp; Exhaust Blower filter cleaning</td>
<td>Monthly</td>
</tr>
<tr>
<td>Refractory Repair</td>
<td>Monthly</td>
</tr>
<tr>
<td>Door &amp; Bogie limit switches positioning</td>
<td>Fort Night</td>
</tr>
<tr>
<td>Calibrated furnace thermocouples</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>Proper door locking arrangement</td>
<td>Monthly</td>
</tr>
<tr>
<td>Sand sealing arrangement</td>
<td>Monthly</td>
</tr>
<tr>
<td>Pneumatic valves testing</td>
<td>Fort Night</td>
</tr>
<tr>
<td>Damper &amp; Pressure transmitter condition</td>
<td>Monthly</td>
</tr>
<tr>
<td>NG leakage test</td>
<td>Monthly</td>
</tr>
</tbody>
</table>
PROPER PLANNING

Planning of Sequential Heats
- Saves fuel(NG) due to already hot furnaces.
- Reduced cycle time.

Utilization of Idle time for maintenance
- Prior information of idle time to maintenance.
- Checking leakages and burner fine tuning also included.

Hourly Consumption monitoring in furnaces
- Online system for monitoring NG in each furnace.
- Helps in real time analysis of any higher consumption in case of any abnormality

Furnace allocation according to job sizes
- No need to change furnace throughout forging operation.
ENERGY SAVING DATA
NG SAVING-REGENERATIVE BURNER SAVING

45% of Natural gas saving compared to conventional burners.

Implemented in Project stage

NG Savings-277 SCM / MT
Cost Savings- ₹10000/MT

Cost Saving – 9.9 Cr
NG SAVING-BY GOOD OPERATIONAL PRACTICES

NG Consumption (SCM/MT)

- **2013-14**: 338
- **2014-15**: 301 (11% reduction)
- **2015-16**: 245 (18.6% reduction)

**NG SA VING**

- By good operational practices
# COST SAVINGS

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (MT)</th>
<th>Saving/MT</th>
<th>NG saving (SCM)</th>
<th>₹ /SCM</th>
<th>Savings (₹ Crs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013-14</td>
<td>9016</td>
<td>277</td>
<td>2497432</td>
<td>40</td>
<td>9.9</td>
</tr>
<tr>
<td>2014-15</td>
<td>6552</td>
<td>37</td>
<td>242424</td>
<td>51</td>
<td>1.2</td>
</tr>
<tr>
<td>2015-16</td>
<td>4869</td>
<td>56</td>
<td>272664</td>
<td>34</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Total Savings = ₹ 12.6 Crores
2nd Prize in National Energy Conservation Award for financial year 2014-15 in General Category by Govt. of India
Awarded for being “Excellent Energy Efficient Unit” award at CII Hyderabad 2015
“Golden Jubilee Award 2013-14 award for outstanding performance in Energy Conservation” from SGCCI on 16.05.2015.

“Sri Nimish Vashi Award for Outstanding Performance in Energy Conservation & Pollution Control” by SGCCI for 2012-13.

Trophy handed over to CE – by Mr Dilip Ommen - MD & CE Essar Steel.
“Earth provides enough to satisfy every man's needs, but not every man's greed.”

Thank you!

“The greatest threat to our planet is the belief that someone else will save it.”
1st - While one burner fires, the hot products of combustion enter the burner port of the other.

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