Use of Coke Oven Gas in DRI Plant

Mr. Anil M. Mhatre
Making Steel is our Profession ... 

Generating Smile is our Passion...
VISION :
Global recognition for Quality and Efficiency while nurturing Nature and Society.

MISSION :
Supporting India's growth in Steel Domains with speed and innovations.
Sponge Iron Plant

- Technology – MIDREX, Gas based
- Commissioned -1994
- Original capacity-1.0 MTPA
- World’s first mega module DRI plant.
- Current capacity -1.6 MTPA
- Modifications carried out in 2005
- Successfully operated with 100% Iron ore Lump in feed mix.
- Achieved annual production of 1.37 MMT in 2009-10.
- Designed to use only Natural gas as a source of hydrocarbons for Production of Hydrogen & Carbon mono-oxide by catalytic reforming.
Journey of DRI Plant towards Capacity Enhancement
Capacity Enhancement: 1 mtpa to 1.20 mtpa in 1996

- **Main Air Blower**: Impeller replaced with larger diameter to increase flow from 210 KNM3/Hr to 227 KNM3/Hr.

- **Ejector stack fan**: Impeller replaced with larger diameter to increase flow from 335 KNM3/Hr to 420 KNM3/Hr.

- **Process gas compressor**: 2nd Stage Process gas compressor speed increased from 325 rpm to 340 rpm to get the flow of 182 KNM3/Hr from 169 KNM3/Hr.

- **Oxygen Injection**: To enhance reducing gas temperature.
Capacity Enhancement: 1.2 mtpa to 1.6 mtpa in 2005

- **Double Bustle Ports**: For uniform distribution of reducing gas.

- **Oval Shape top gas duct & Thin Wall refractory**: To increase the reduction zone volume from 385 M3 to 406 M3.

- **Reformer catalyst**: Replaced catalyst with high active & low-pressure drop, to increase the reformer capacity.

- **Ejector Stack Motor**: Motor capacity increased from 1000 KW to 1400 kw to handle the additional flue gas volume.
Journey towards Innovation......
Challenges ..... 

- Inadequate supply of Natural gas at affordable price.
- Achieving cost of DRI production comparable to Imported HBI.
- Utilization of DRI plant to its maximum capacity.
- Consistency in plant Operation.
- Shortage of Metallic for Steel melt shop.
Project background

- After commissioning of Coke oven battery (1 MTPA) surplus Coke oven gas availability was anticipated.
- Coke oven gas is having useful components like H2, CO & Methane with small amount of impurities like Benzene, H2S, Tar, CnHm etc.
- Other Plants in Dolvi complex does not have margin to utilize available coke oven gas and hence bound to be vented.
PROCESS OF INNOVATION

- Group discussions & brain storming sessions.
- Number of Laboratory test carried out.
- Linder test with Coke Oven gas.
- Process simulation to anticipate expected Reducing gas quality after COG addition
## Reducing gas Quality after COG mixing

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit</th>
<th>Reducing Gas Before COG addition</th>
<th>COG Composition</th>
<th>Reducing Gas After COG addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4</td>
<td>%</td>
<td>2.80</td>
<td>25</td>
<td>2.80</td>
</tr>
<tr>
<td>CmHn</td>
<td>%</td>
<td>--</td>
<td>2.5</td>
<td>0</td>
</tr>
<tr>
<td>H2</td>
<td>%</td>
<td>61.5</td>
<td>58</td>
<td>61.3</td>
</tr>
<tr>
<td>CO</td>
<td>%</td>
<td>32.4</td>
<td>8</td>
<td>32.5</td>
</tr>
<tr>
<td>CO2</td>
<td>%</td>
<td>2.8</td>
<td>2.50</td>
<td>2.90</td>
</tr>
<tr>
<td>O2</td>
<td>%</td>
<td>--</td>
<td>0.50</td>
<td>--</td>
</tr>
<tr>
<td>N2</td>
<td>%</td>
<td>0.50</td>
<td>4</td>
<td>0.50</td>
</tr>
<tr>
<td>Temp</td>
<td>Deg. C</td>
<td>900</td>
<td>400</td>
<td>900</td>
</tr>
<tr>
<td>Pressure</td>
<td>Barg</td>
<td>@ 1.30 to 1.40</td>
<td>2.0 to 2.50</td>
<td></td>
</tr>
</tbody>
</table>

The preliminary calculations shows no major change in reducing gas quality after adding COG.
## Objective of the Project

<table>
<thead>
<tr>
<th>Objective 1</th>
<th>To reduce the consumption of Natural gas to reduce cost of DRI Production.</th>
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<tbody>
<tr>
<td>Objective 2</td>
<td>Increase the Plant Capacity utilization affected by high priced Natural gas.</td>
</tr>
<tr>
<td>Objective 3</td>
<td>To Utilize the Coke oven gas as Process injection rather than source as Fuel.</td>
</tr>
<tr>
<td>Objective 4</td>
<td>To reduce dependency on natural gas availability to some extent.</td>
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</tbody>
</table>
- Detail discussions & number of meetings with M/s Midrex for finalizing most feasible option.

- Awarding contract to Midrex for Engineering & equipment supply.

- Developing of all DCS graphics, DCS programming, trend pages, PLC programming, process interlocks as per Midrex documents.

- Erection & commissioning of Screw compressor within a seven days by JSW which was appreciated by M/s Aerzner, as per them it was a one month job.

- In continuation COG preheater was installed to heat COG upto 400 °C
PROJECT IMPLEMENTATION

- Hot COG was hooked up with Bustle & Transition zone without plant shutdown.

- Project completed within 16 month from its inception.

- COG compressor started with a flow of 2000 NM3/Hr and gradually increased to its full capacity. Achieved 100% rated capacity within 3 days time.

- For 20000 NM3/Hr COG addition, 10000 NM3/hr reduction in Natural gas was achieved.
COKE OVEN GAS EQUIPMENT LAYOUT

COG pre heater System

COG Screw Compressor

COG Battery

COG to Bustle Zone

COG to Transition zone

Commissioning team with M/s Midrex Engr

COG system commissioned on 23rd Dec’14.
<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1 Natural gas consumption 288 SCM / MT</td>
<td>Natural gas Consumption 217 SCM / MT and COG 114 SCM/MT. Equivalent Natural gas 275 SCM/MT</td>
<td>Approx 25 % replacement of Natural gas by Coke Oven Gas</td>
<td></td>
</tr>
<tr>
<td>2 Cost of Natural gas per ton of DRI USD 131 (Considering NG @ USD 0.46 / SCM)</td>
<td>Cost of Natural gas + COG per ton of DRI is USD 104 Cost Reduced by USD 27 PMT</td>
<td>Approx 20 % Reduction in cost of DRI Production.</td>
<td></td>
</tr>
<tr>
<td>3 Under Capacity utilization @ 80% of rated capacity</td>
<td>Plant capacity utilization increased to 95%.</td>
<td>Approx 15 % increase in plant utilization.</td>
<td></td>
</tr>
<tr>
<td>4 Specific Heat consumption @ 2.45 Gcal/Mt</td>
<td>Specific Heat consumption 2.35 Gcal/Mt</td>
<td>Specific Heat consumption reduced by 4%.</td>
<td></td>
</tr>
</tbody>
</table>
Intangible Benefits of coke oven project

- Reduction in CO2 emission by 0.50% by using coke oven gas in DRI process instead of using as a fuel in other facilities.

- Reduction in Energy to compress the RLNG to 75 ~ 80 bar for transportation to end user.

- Reduction in Energy for LNG transportation by ship to India.

- Saving in Energy to gasify LNG to RLNG at unloading station in India.
# Monetary Benefit

<table>
<thead>
<tr>
<th>Sr</th>
<th>Particulars</th>
<th>UOM</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>COG used in SIP</td>
<td>SCM/Hr</td>
<td>20,000</td>
</tr>
<tr>
<td>2</td>
<td>Equivalent NG saved</td>
<td>SCM/Hr</td>
<td>10,000</td>
</tr>
<tr>
<td>3</td>
<td>Cost of NG/hr @ USD 7.8 /MMBTU (Average Price of Market NG)</td>
<td>USD / Hr</td>
<td>4615</td>
</tr>
<tr>
<td>4</td>
<td>Cost of COG / Hr @ USD 2.5/ MMBTU</td>
<td>USD / Hr</td>
<td>1308</td>
</tr>
<tr>
<td>5</td>
<td>Saving per hour</td>
<td>USD / Hr</td>
<td>3307</td>
</tr>
</tbody>
</table>

## Expenses

<table>
<thead>
<tr>
<th>Sr</th>
<th>Description</th>
<th>UOM</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power cost of compressor (1350 kWh/Hr x USD 0.08 /kWh)</td>
<td>USD /Hr</td>
<td>108</td>
</tr>
<tr>
<td>2</td>
<td>Other Utility cost for Soft Water, Nitrogen etc</td>
<td>USD / Hr</td>
<td>29</td>
</tr>
</tbody>
</table>

**Net Savings**: USD / Hr **3170**
Annual saving from this Project is

26 Million USD

(340 days x 24 hrs/day x USD 3170/Hr )
Way Forward....

We have not stopped by just adding 20,000 NM3/hr COG but in future we will be replacing 100% natural gas with Coke oven gas.
Thank you