High Capacity Iron Making with Large, Modern Blast Furnaces

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EPC and Technology

DANIELI 50% 50% TATA STEEL

DANIELI 50% 50% CORUS

India 50% 50% Netherlands China
Technology Based on International Operational Experience
Danieli Corus Technology in India

- 1,681 m³ Blast Furnace for JSW
- 1,681 m³ Blast Furnace for JSPL
- 1,681 m³ Blast Furnace for BSL
- Rebuild of 2,250 m³ Blast Furnace No 7 for SAIL, Bhilai
- Rebuild of 1,860 m³ Blast Furnace “F” for Tata Steel
- Rebuild of 1,700 m³ Blast Furnace No 1 for SAIL, Rourkela
- 4,060 m³ Blast Furnace for SAIL, Rourkela
- 4,506 m³ Blast Furnace for NMDC (largest in India)

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- Chilled hearth recovery on 4,019 m³ BF No 3 for JSW
- Chilled hearth recovery on 4,019 m³ BF No 4 for JSW
- Blowing down / Blowing in of 2,800 m³ of BF “G” Tata Steel
- Coal Injection Ramp up on 1,681 m³ BF for JSPL
NMDC Nagarnar BF1

- Inner Volume: 4,506 m³
- Hearth Diameter: 14.2 m
- Annual Production: 4.0 MT
- Commissioning: 2016
Blast Furnace Classification

Medium & Classical Blast Furnace
• Campaign Life < 5-7 Years
• Operations is an Art
• Coke > 500 kg/THM
• Low Grade Lump Ore / Sinter
• Human Labour

Large & Modern Blast Furnace
• Campaign Life > 20 Years
• Operations is a Science
• Coke < 350 kg/THM
• High Grade Pellets & Sinter
• Mechanisation and Automation
<table>
<thead>
<tr>
<th></th>
<th>Tata Steel IJmuiden BF6</th>
<th>Tata Steel IJmuiden BF7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Volume</td>
<td>2,678</td>
<td>4,450</td>
</tr>
<tr>
<td>Average Production</td>
<td>8,000</td>
<td>11,000</td>
</tr>
<tr>
<td>Average PCI Rate</td>
<td>250</td>
<td>250</td>
</tr>
</tbody>
</table>

Record Efficiency and Campaign Life
## Blast Furnace
- Record 4 t/m³ WV/24 h
- 98% availability
- Campaign Life - 28 years

## PCI
- Record 270 kg/THM
- 100% availability
- Flexible injection rates

## Automation Level 2
- Effective Process Control
- Efficient Process Optimization

<table>
<thead>
<tr>
<th>Blast Furnace</th>
<th>PCI</th>
<th>Automation Level 2</th>
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<td>Record 4 t/m³ WV/24 h</td>
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<td>Campaign Life - 28 years</td>
<td>Flexible injection rates</td>
<td></td>
</tr>
<tr>
<td>122 Reference Plants</td>
<td>66 Reference Plants</td>
<td>19 Reference Plants</td>
</tr>
</tbody>
</table>
Furnace Process and Technology

Challenges for Operator

• Low Coke rate
• High PCI rate
• Burden Distribution
• Gas Flow Control
• Process Data
• Hearth Liquid Management
• Raw Material Logistics

Requirement of Operator

• Good Blast Furnace Design
• Data Management & Analysis
• Consistent Raw Material

Large Blast Furnaces increase the risks & effects of process upsets
Large Blast Furnace - Raceway penetration

- Large furnaces have a relatively higher inactive zone for gas due to larger belly diameter.
- Raceways depth limited due to coke degradation and pressure drop.

- Leads to less stable operation
  - Channeling and scabs
  - Higher fluctuations in heat loads
- Penalty in efficiency and production
• Fines do not spread across large belly of large furnace, but descend vertically
  – Makes gas flow more difficult to control

• Large belly diameter leads to thinner coke slits, limiting PCI and difficulties with burden descent and flooding

• Large throat diameters make fines distribution more difficult due to very high volume required in outer rings close to each other

  ➢ Leads to less stable operation
    ➢ Channeling and scabs
    ➢ Higher fluctuations in heat loads
  ➢ Penalty in efficiency and production
Pulverised Coal Injection

Effects of High Coal Injection

• Increases Ore / Coke Ratio
• Increases Burden Resistance
• Decreases Flame Temperature
• Increases Gas per THM
• Changes Slag Composition
• Changes Gas Distribution
• Increases Top Temperature

To achieve high PCI, the operator has to critically analyse operation and follow a step by step approach
Corus IJmuiden results, 30 years

With Danieli Corus support

Achieved Coal Injection Results:
- Corus IJmuiden: 270 kg/t
- Baosteel: 220 kg/t
- Taiyuan: 200 kg/t
- Masteel: 200 kg/t
- Shougang: 200 kg/t
- Severstal NA: 190 kg/t
- Jindal Steel & Power: 180 kg/t
Instrumentation & Control

Burden
• Size
• Weights
• Coke moisture gauges

Above Burden Probe

Hot Blast
• Flow Rate
• Temperature
• Tuyere input (H₂0, O₂, Fuel…)

In-burden Probe

Hot Metal and Slag
• Casting Times
• Weights
• Temperature
• Analysis

Top Gas
• Analysis
• Temperature
• Pressure

Stock Rod
Radar Profile Meter

Skin flow thermocouple
• Intermediate Pressure Taps
• Lining Thermocouple
• Heat Loss Measurements
Instrumentation & Automation

- Large & Modern Blast Furnace generates significant amounts of data
- Management and analysis of data is critical for operating and control of large & modern blast furnace
- Automation Level 2 is required for management and analysis of these data
- This is essential for process optimization to achieve world class performance
Instrumentation & Automation

Raw Materials Quality and Logistics
- Stockhouse Supervisory
- Burden Calculation

Blast Furnace Efficiency
- Operator Advisory System
- Mass & Energy Balance
- Burden Tracking Monitoring
  - Process Support
  - Burden Distribution
  - Heat Flux

Liquids Management
- Hearth Liquid Level
- Casthouse Operations
- Torpedo Logistics
Modern Bosh & Stack Designs

Copper Stave Coolers

Copper Plate Coolers
Machined Graphite + SiC
Copper Stave Coolers Erosion

- Belgium
- Korea
- Australia
- Argentina
- Japan
- Chile
- India
Copper Stave Coolers Performance

Erosion rate up to 10 mm / month
Copper stave coolers are sensitive to erosion
High Efficiency increases erosion rate
Replacement time

Hoogovens Design
4 - 8 Hours

Copper Stave Coolers
30 – 60 Days
Danieli Corus Bosh and Stack Design

Erosion stabilization due to scab anchoring and SiC
Tata Steel IJmuiden BF7

On-Going Bosh and Stack Campaign since 1991
Conclusions

• Large Blast Furnaces require modern technology, for example good raw material quality & logistics, efficient Blast Furnace operation and process and liquids management

• This introduces many new challenges and demands greater control over burden distribution, gas flow control, etc

• Optimising the operation of large Blast Furnaces requires time, commitment and persistence

• State-of-the-Art instrumentation and automation enables management & analysis of operating data and is a pre-requisite for operating large Blast Furnaces

• Efficient Blast Furnace operation requires a low coke rate and high PCI

• Long campaign life requires the Danieli Corus bosh and stack design

• Danieli Corus technology has been demonstrated at new Blast Furnace plants and campaign extension repairs and includes successful training and operational assistance
Thank You For Your Attention