Energy Saving & Breakthrough Technologies

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Agenda

- Iron & steel industry overview
- List of energy saving technologies (EST)
  - most implemented EST technologies worldwide
  - results overview
- Most widely implemented EST
- Steel producers experience with EST
- Breakthrough technologies
The iron and steel industry – where we are

- Total world crude steel production in 2012: 1 542 Mt
- Energy costs represent around 20 to 25% of the total input of steel producers and it becomes one of the most important topic of steel producers
- Coking coal accounts for more than 65% of primary source of energy

Average Energy Intensity: 18.2 GJ / t_{CS}

Average CO₂ Intensity: 1.8 t CO₂ / t_{CS}

Production ratio globally
BF / BOF: 69.6%  EAF: 29.3%  OHF: 1.1%

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BF / BOF: 69.6%  EAF: 29.3%  OHF: 1.1%
Global crude steel volumes 1980–2010, potential scenario for 2015–2075*

* Source - 1980 – 2010 data worldsteel, 2015 – 2075 Example based on 9.9 Billion people in 2075 @ 235kg CS/capita
Typical energy intensity of integrated steel plants

<table>
<thead>
<tr>
<th>Process</th>
<th>GJ/t of product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coking</td>
<td>3.9</td>
</tr>
<tr>
<td>Sintering</td>
<td>2.2</td>
</tr>
<tr>
<td>Iron Making (BF)</td>
<td>12.8</td>
</tr>
<tr>
<td>Steelmaking (BOF)</td>
<td>0.7</td>
</tr>
<tr>
<td>Hot Rolling</td>
<td>2.1</td>
</tr>
<tr>
<td>Cold Rolling</td>
<td>0.3</td>
</tr>
<tr>
<td>Finishing</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Energy efficiency improvement:

- Existing widely utilized technologies (BF/BOF, EAF)
- Installation of EST (PCI, CDQ, TRT, etc.), EMS, Freq. Converter.
- Process optimization, M&R, detect losses, etc.
- Future EI of metallurgy processes

New Met. Tech. Corex, Finex, Hlsmara

Worldsteel Association
worldsteel List of Energy Saving Technologies

- A technology questionnaire was developed to analyze the gap between the energy intensity of plants and sites depending on equipment used.

- Contains more than 190 energy efficient techniques and technologies and analyze the impact of the energy efficient technologies on the totally energy intensity of plant.

- Each defined technology must be able to decrease the energy intensity of the steel production process or can increase the productivity or quality of the products.

- Project members analyzed the implemented technologies and determined the reason for implementing these technologies.
## Steel Shop / Basic Oxygen Furnace

List of T&T – part of the steel shop list

<table>
<thead>
<tr>
<th>Name of the Techniques or Technologies</th>
<th>Technology used at participants sites</th>
<th>Average years of experience with technologies.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry gas cleaning system</td>
<td>3.0</td>
<td>13.3</td>
</tr>
<tr>
<td>Ladle temperature management</td>
<td>15.0</td>
<td>17.5</td>
</tr>
<tr>
<td>WHR on close loop cooling system converter</td>
<td>5.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Ladle lids used to reduce heat loss</td>
<td>17.0</td>
<td>14.9</td>
</tr>
<tr>
<td>Single vessel blowing operation</td>
<td>9.0</td>
<td>24.9</td>
</tr>
<tr>
<td>Dust Hot Briquetting and recycling</td>
<td>9.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Recovery of high Zn concentrated pellets</td>
<td>1.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Recycling of BOF slags.</td>
<td>17.0</td>
<td>17.9</td>
</tr>
<tr>
<td>Recycling of BOF dusts.</td>
<td>17.0</td>
<td>10.1</td>
</tr>
<tr>
<td>Heat Recovery from BOF Slag.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regenerative Burners for preheat the ladle</td>
<td>3.0</td>
<td>4.3</td>
</tr>
<tr>
<td>other (ID fan speed control)</td>
<td>1.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

### Bar Charts

- **Ladle lids used to reduce heat loss**
  - Year: 0.5, 6-10, 11-15, 16-20, 21+
  - No.: 3, 3, 1, 4, 3

- **Recycling of BOF slags.**
  - Year: 0.5, 6-10, 11-15, 16-20, 21+
  - No.: 4, 2, 2, 2, 3

- **Recycling of BOF dusts.**
  - Year: 0.5, 6-10, 11-15, 16-20, 21+
  - No.: 5, 4, 2, 2, 1
Most widely implemented EST within Energy use project members
EST implemented at BF plant and BOF Shop

No. of analyzed energy saving technologies: 20

40% of EST are widely implemented at BF plants

No. of analyzed energy saving technologies: 23

30% of EST are widely implemented at BOF plants
Site Energy Intensity vs. No. of Energy Eff. Technologies

BF-BOF and DRI-EAF

Energy intensity of steel production vs No. of implemented technologies

- Energy intensity performance (%)
- No. of implemented ES technologies
Site Energy Intensity vs. No. of Energy Eff. Technologies

EAF and DRI-EAF

Energy intensity of scrap based steel production vs. No. of implemented technologies

- Energy intensity performance (%)
- No. of implemented ES technologies
Steel producers experience with EST
Pulverized Coal Injection to BF
Pulverized coal injection to BF – EST (example)

- 13 metallurgy company implemented PCI injection to BF within 16 worldsteel energy use members BF plants.
- The average PCI injection through a whole year operation is 140 kg / t of hot metal.
- Maximum PCI injection to BF: 280 kg / t HM

worldsteel analyses:

- analyse how steel producers can increase / reach the average PCI injection rate to BF.
- analyse how much energy they can save with this technology.
- Each energy saving technology has some operational and technological limitations due to the specific production site, raw materials quality, operational practices, etc.
PCI injection rate to BF

- PCI injection rate: 250 kg/t HM
- Red line: BF No.6
- Blue Line: BF No.7
- Productivity increased from 2 to 4 t HM / m³ WV.d
Hot Charging Billets
Billet hot charging is a process of charging billets direct from continuous caster to reheating furnace of rolling mill without going through a cooling phase.

The concept is to avoid extreme temperature drops from the billet, which results in energy saving of reheat furnace and productivity improvement.

NatSteel identified an opportunity to achieve significant energy and productivity gains through infrastructure (Billet Conveying System) and process management. User interface screens from BTS (Billet Tracking System) are provided for operators to view/edit/add billet charging information, it also allows operators to monitor and track real time billet information in reheat furnace.
- Typical billet temperature that came out from pinch roll of caster is around 950°C
- Billet is now travelled at a speed of 1.4m/s / around 4 minutes of delivery time.
- Hot charge has been increased from 67% in FY06 to 83% in FY09 and fuel oil consumption reduced from 16.5 lit/t in FY06 to 13.8 lit/t in FY09.
Productivity & hot charge

- if there is no hot charge, maximum productivity can only achieved at about 90t/h,
- with hot charge (let’s say 80%), some product size can rolled to as high as 120t/h.
- As a result of hot charge increase, production output also increased from 0.55MTPY in FY06 to above 0.70MTPY in FY09
Hot DRI Charging
Hot DRI Charging

- Hot DRI is produced from shaft furnace (DR Plant).
- Conveyor is covered and insulated to minimize temperature loss and prevent oxidation of Hot DRI during transportation.
- The main benefit of Hot DRI charging was increased productivity and reduced electricity consumption.

Advantages compared to cold DRI usage,

- Energy saving of approximately 10-15% of energy consumption compared to Cold DRI.
- EAF electrode consumption was observed to be lowered compared to Cold DRI.
Hot DRI charging to EAF

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilization of the sensible heat from the DRI</td>
<td>Hot transport by sealed special bucket-type conveyors to storage bin</td>
</tr>
</tbody>
</table>

**Environmental benefit**
- Increased productivity determined to be 15-20%
- Electrode savings of 0.5-0.6 kg/t liquid steel
- Power savings of ~0.5 GJ/t liquid steel

**Typical customer benefit**
- Reduce alloying material costs up to 5%
- Elimination of return heats
Energy saving

The comparison of Energy saving for last 3 years (2009, 2010 & 2011) of both cold and hot DRI with 500º C usage in EAF is illustrated in following chart:
Energy saving technology list – main outcomes

- 25 from the 190 listed energy saving technologies have newer been implemented at the Energy use project members site.

- only 1/3 of energy saving technologies is widely implemented within worldsteel energy use project members.

- Big variation of energy efficiency were discovered by EST implementation within energy use project members.

- Need to analyze possibilities for further improvement of developed energy saving technologies.

- Need to analyze possibilities for further improvement of existing implemented energy saving technologies within metallurgy sites.
Breakthrough Technologies
Programme Status / Update reports

- **AISI**: Hydrogen Flash Melting
- **ULCOS**: TGR – BF, HIshape, ULCORED, ULCOWIN, ULCOLYSIS
- **Australian Program**: Heat Recovery of Molten Slag, Extend Biomass Use
- **China Steel Corporation**: CO₂ capturing technologies (including adsorption, absorption, etc.)
- **JISF Course 50**: Development of technologies to reduce CO₂ emissions from Blast Furnaces
  Development of technologies to capture CO₂ from Blast Furnace Gas.
- **POSCO CO₂**: Carbon-lean Steelmaking
  Carbon Capture & Storage of Steelmaking
# ULCOS Projects

<table>
<thead>
<tr>
<th>Coal &amp; sustainable biomass</th>
<th>Natural gas</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revamping BF</td>
<td>Brownfield</td>
<td>Revamping DR</td>
</tr>
<tr>
<td>TGR-BF</td>
<td>Hilsarna</td>
<td>ULCORED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pilot tests (1.5 t/h)  
Demo phase launched  
Pilot plant (8 t/h)  
start-up 2010  
Pilot plant (1 t/h)  
to be erected in 2011?  
Laboratory pilot
Projects potential impact

Key activities high impact

-30% - 50% CO2
Charcoal Biowaste Paired Straight Hearth with smelter

H2-Enrichment (Reforming) Course 50 Posco

-10% to-20% CO2
CH4, H2 Australia, Posco

Waste Heat Usage Australia Course 50 Posco

CC&S CSC, Course 50 POSCO, ULCOS

TGRBF HISARNA ULCOS

> 80% CO2 with CCS

Key activities with lesser impact

-20 % alone

Suspension H2-Technology AISI

Electrolysis AISI, ULCOS

CO2 Utilization (Algaes) CSC

Longer term projects

L Likely hood of early success H

L Level of impact H
Potential Development Timeline

- **2010**
  - Ulcos phase II
  - TGR-BF -2015
  - Hisarna 2013

- **2020**
  - ULCOS
  - Hisarna commercial size
  - Ongoing development
  - And up-scaling

- **2025**
  - CCS
  - Policy and test sites
  - Infrastructure
  - Sites established

- **2030**
  - Charcoal
  - Bio-Mass development

- **2040**
  - H2-Enrichment

- **2050**
  - Waste heat recovery
  - CH4, H2 & Ethanol
  - Suspension H2 Technology
  - Electrolysis
  - Clean electricity required
  - CO2 utilisation
  - Grow Algae

Thank you for your attention

Questions??
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