Status and Future of FINEX® Process for Reducing CO₂ Emissions

5 November 2013

posco
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2. Direct Reduction of CO₂ Emissions
3. Indirect Reduction of CO₂ Emissions
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   - FINEX® Process Flow
   - Characteristics of FINEX® Process

2. Direct Reduction of CO₂ Emissions

3. Indirect Reduction of CO₂ Emissions

4. Future of FINEX® Process
Scale-up History

- Jun. 2003 0.6 MTPA FINEX® (Demo.)
- Apr. 2007 1.5 MTPA FINEX®
- Dec. 2013 2.0 MTPA FINEX®

FINEX® R&D Kick-off
Model Plant (15t/d)
Pilot Plant (150t/d)
No.1 FINEX® (0.6 MTPA)
No.2 FINEX® (1.5 MTPA)
No.3 FINEX® (2.0 MTPA) (Construction Site)

Annual Production (MTPA)

0.0 0.5 1.0 1.5 2.0
Panoramic Views

No. 1 FINEX® (0.6 MTPA)

No. 2 FINEX® (1.5 MTPA)

No. 3 FINEX® (2.0 MTPA)

Fluidized bed Reactor

Melter-gasifier
FINEX® Process Flow

- Ore Fine
- Non-Coking Coal
- Scrubber
- Coal Briquetter
- Hot DRI Compactor
- Fluidized Bed Reactors
- Melter Gasifier
- CO₂ Removal (PSA)
- Power Plant
- Oxygen Plant

Innovate Steel, Design Future
Characteristics of FINEX® Process

- No pretreatment plants
- Flexibility of raw materials in use
- Environmentally-friendly process
- Flexibility of hot metal production
Contents

1. Introduction of FINEX® Process

2. Direct Reduction of CO$_2$ Emissions
   - Coal Briquette
   - CO$_2$ Removal Process
   - Pulverized Coal Injection

3. Indirect Reduction of CO$_2$ Emissions

4. Future of FINEX® Process
Coal Briquette

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CO₂ Removal Process

Off Gas Recycling

Gas
Coal
Heat
DRI

Coal Consumption Rate (kg/tHM)

Before CO₂ Removal

After CO₂ Removal

Production (t/d)
Pulverized Coal Injection

<table>
<thead>
<tr>
<th>Coal Bq.</th>
<th>Coal</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrolysis, Dust loss</td>
<td>Dome, Char Bed</td>
<td>-</td>
</tr>
<tr>
<td>56%</td>
<td>Raceway</td>
<td>100%</td>
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</tbody>
</table>

Fluidized Bed Reactor Availability

Continuous Operation (days)

<table>
<thead>
<tr>
<th>Reduction Degree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
</tr>
<tr>
<td>83</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>300</td>
</tr>
</tbody>
</table>

Coal Briquettes
Gas + Dust
Gas
Coal Pyrolysis
Carbon solution loss
Combustion
Hot Metal
Pulverized Coal

Pyrolysis, Dust loss

Carbon solution loss
Combustion
Gas + Dust
Gas
Coal Briquettes
FINEX® Demo Plant Operational Performance

Production (T/D)

Coal Briq. CO₂ Rmv. PCI

Coal Rate (kg/t)

2003 2004 2005 2006 2007
7 9 11 1 3 5 7 9 11 1 3 5 7 9 11 1 2 3 4

COREX FINEX

1,800 T/D (0.6MT)
## Operating Parameters of No. 2 FINEX®

<table>
<thead>
<tr>
<th>Indices</th>
<th>Target (designed)</th>
<th>Operation (2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt/y</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>t/d</td>
<td>≥ 4,200</td>
<td>4,300</td>
</tr>
<tr>
<td>Coal Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coke kg/t-HM</td>
<td>≤ 730</td>
<td>720</td>
</tr>
<tr>
<td>PCR</td>
<td>≥ 140</td>
<td>150</td>
</tr>
<tr>
<td>Hot Metal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[S] %</td>
<td>≤ 0.030</td>
<td>0.027</td>
</tr>
<tr>
<td>[Si] %</td>
<td>≤ 0.80</td>
<td>0.81</td>
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</tbody>
</table>
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2. Direct Reduction of CO₂ Emissions

3. Indirect Reduction of CO₂ Emissions
   - Heat Recovery System
   - Dry Dust Collectors
   - Recycling of By-products

4. Future of FINEX® Process
Heat Recovery System

Demineralized water

Steam
40 t/hr
260 ºC
13.5 bar

Off gas
300 kNm³/h,
380 ºC

230 ºC

Scrubber

Reducing Gas

Water Treatment System

Heat Recovery System

Heat Recovery System
Dry Dust Collectors

Bag Filter (Pilot Stage)

380 °C → 230 °C → Ceramic Filter (Commercial Stage) → 700 °C

DRI Feed Bin

Fluidized Bed Reactors

700 °C → Multi-Cyclone (Commercial Stage) → Bag Filter (Commercial Stage)
Recycling of By-products

<table>
<thead>
<tr>
<th>Composition(%)</th>
<th>Total Fe</th>
<th>RD</th>
<th>C</th>
<th>SiO₂</th>
<th>CaO</th>
<th>Al₂O₃</th>
<th>MgO</th>
</tr>
</thead>
<tbody>
<tr>
<td>By-products</td>
<td>50~55</td>
<td>15~20</td>
<td>5~10</td>
<td>4~6</td>
<td>3~4</td>
<td>3~4</td>
<td>~ 1</td>
</tr>
</tbody>
</table>
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2. Direct Reduction of CO₂ Emissions
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4. Future of FINEX® Process
• After starting R&D activities of FINEX® in 1992, it is being scaled up to 2.0 Mt/y

• CO₂ emissions from FINEX® drastically fell down because POSCO has developed coal briquetting process and has optimized the FINEX process by adopting CO₂ removal system and pulverized coal injection

• A series of technical developments such as heat recovery system, dry dust collectors and recycling by-products could reduce CO₂ emissions furthermore

• FINEX® has lots of potential for lowering coal consumption rate and saving energy as a developing process
Thank You