KOBELCO Group’s CO₂ Reduction Solution for Blast Furnace Ironmaking
Today's Agenda

1. Introduction

2. KOBELCO Group’s CO$_2$ Reduction Solution for Blast Furnace Ironmaking
Introduction
Addressing social issues both aggressively (in value creation area) and defensively (in management foundation area)
Initiatives & Topics in Management Foundation Area

**Until 2018**
- Establishes Group Corporate Philosophy (2017)

**2019**
- Integrated Report 2019
- Declares Basic Human Rights Policy
- Receives Platinum Kurumin
- Integrates Environmental Management Committee into CSR Committee
- Establishes CO2 Reduction Promotion Subcommittee

**2020**
- Formulates new Group Corporate Philosophy
- Announces framework for sustainability management
- Integrated Report 2020
- Declares Basic Procurement Policy
- Recognized as a “White 500” organization.
- Announces CO2 reduction targets 2030
- Declares support for TCFD
- Receives “A-” from CDP

**2021 and beyond**

**Organizational development**
- Establishes Meetings of Independent Directors (from 2015)
- Undergoes transition to a company with Audit & Supervisory Committee (from 2016)
- Amends framework for remuneration of directors /Introduces stock compensation (from 2016)
- Introduces evaluation system of the Board of Directors (from 2016)
- Ensures that at least one-third of the members are Independent Directors (from 2018)
- Appoints first female Director (from 2019)
- Establishes Nomination & Compensation Committee (from 2018)
- Changes structure of the Board of Directors (from 2018)
Initiatives & Topics in Value Creation Area
– Contribution to Creating a Green Society –

- CO₂ Reduction through Utilization of DRI
  MIDREX® Process

- Solutions for automotive weight reduction & Electrification

- Promoting ICT Technology in Construction Machinery

- Water Treatment & Waste Processing Technologies

- Energy Conservation at Production Sites (Industrial Machinery)
KOBELCO Group’s Sustainability Management

Achieving new development and providing solutions for social issues through the combination of our diverse products and technologies.

KOBELCO’s View of the Future

Today’s topic

External evaluation of the Company’s efforts for the environment, society, and governance

Core Values of KOBELCO

Solving social issues

Six Pledges of KOBELCO Men and Women

Steel & Aluminum

Advanced Materials

Welding

Machinery

Construction Machinery

Electric Power

KOBELCO’s Mission

Creating new value

SUSTAINABLE DEVELOPMENT GOALS

KOBELCO’s Mission

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KOBELEC Group’s CO$_2$ Reduction Solution for Blast Furnace Ironmaking

Innovative technology to reduce CO$_2$ emissions from blast furnace operations successfully verified
Kobe Steel, Ltd. has successfully demonstrated the technology* that can significantly reduce CO₂ emissions from blast furnace (BF) operations, combining the technologies in the engineering business and in the iron and steel business.

This achievement is a result of the integrated efforts of the Kobe Steel Group (also known as the KOBELCO Group) leveraging its diverse businesses.

* Verified at the No. 3 blast furnace (4,844 m³) of the Kakogawa Works in Hyogo Prefecture, Japan in October 2020
Overview of the Technology Demonstrated

1. CO$_2$ emissions significantly reduced from BF operations
   (Verified: CO$_2$ emissions reduced by approx. 20% compared to FY2013)

☆ Successfully reduced CO$_2$ emissions from BFs
   by charging a large amount of HBI$^{*1}$ produced by
   Midrex® Process$^{*2}$ with a significant decrease in RAR$^{*3}$.

* 1) HBI (hot briquetted iron): direct reduced iron (DRI) in a briquetted form
* 2) MIDREX® Process: the leading direct reduced iron (DRI) making process developed
   by Midrex Technologies, Inc., a Kobe Steel’s wholly owned subsidiary in the U.S.
* 3) RAR (reducing agent rate): the amount of carbon fuels used as the reductant such as
   coke and pulverized coal
2. A low-cost CO$_2$ reduction solution
(Lower additional costs for reducing CO$_2$ emissions)

☆ Successfully reduced the use of expensive coke*4) to the world's lowest level by KOBELCO's BF operation technologies.

* 4) Coke: a carbon fuel made from coal (Coal processing requires a lot of equipment and costs)
About the Technology Demonstrated  
— CO₂ Reduction Ratio in BF Operations —

1. Reduced CO₂ emissions from BFs significantly by charging a large amount of HBI produced by Midrex® Process

2. Successfully reduced CO₂ emissions by approx. 20% with a stable decrease in RAR from 518 to 415 kg/tHM* by charging 305 kg/tHM of HBI

3. Achieved roughly twice the CO₂ reduction effect of previous attempts to reduce CO₂ emissions from BFs with HBI

* tHM: ton hot metal
CO₂ Reduction Cost

\[
\text{CO₂ Reduction Cost} = \left( \text{The quantity of HBI used} \times \text{HBI unit price} \right) + \left( \text{The quantity of iron ore reduced} \times \text{iron ore unit price} \right) + \left( \text{The quantity of reductant reduced} \times \text{reductant unit price}^{*} \right) + \text{Equipment cost} + \text{Other costs}
\]

\* The quantity of CO₂ reduced

\(= \text{The quantity of reductant reduced} \times \text{CO₂ emission factor}\)

1. The quantity of reductant reduced \(\times\) reductant unit price

\[= \text{the quantity of coke reduced} \times \text{coke unit price} + \text{the quantity of pulverized coal reduced} \times \text{pulverized coal unit price}\]

(Typical raw material unit prices are: HBI > Coke > Iron ore > Pulverized coal)

CO₂ reduction costs can be minimized by:
- Increasing the quantity of HBI charged in BF operations, and
- Reducing the use of reductant (expensive coke) in large quantity.
About the Technology Demonstrated — CO₂ Reduction Cost (2) —

The key to lowering the CO₂ reduction cost is **how much expensive coke can be reduced by HBI charging**

**Results of the demonstration test**

<table>
<thead>
<tr>
<th></th>
<th>Quantity of HBI charged (kg/tHM)</th>
<th>Coke rate (kg/tHM)</th>
<th>Coke rate reduced (kg/tHM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kobe Steel</td>
<td>305</td>
<td>239</td>
<td>85</td>
</tr>
<tr>
<td>Previous</td>
<td>250</td>
<td>290</td>
<td>34</td>
</tr>
</tbody>
</table>

Note: The figures above are based on Kobe Steel's research results.

The coke rate reduced by 2.5 times compared with the conventional method.
About Blast Furnace Ironmaking

Blast furnace (sectional view)

Blast furnace gas
CO : 21-25%
CO₂ : 20-23%
N₂ : approx. 50%

Functions of the Blast Furnace

(1) Reduction of iron ore
Iron ore (iron oxide) + C = Iron + CO
Iron ore (iron oxide) + CO = Iron + CO₂

(2) Melting of iron (solid ➔ liquid)
Using combustion heat generated from C+O₂ = CO

Note: Approx. 80 to 90% of CO₂ emissions from steel production is generated in BF operations.
**MIDREX® Process and HBI**

- **MIDREX® Process**: Direct reduction of ore pellets (lump ore) to produce reduced iron (DRI, HBI) with reducing gas (H₂ ~55%, CO ~36%), obtained from reforming natural gas.
  - **DRI (Direct Reduced Iron)**: Clean iron source (Fe ~90%, low impurities), widely used and substituting high-grade scrap and pig iron in EAF, BF and BOF.
  - **HBI (Hot Briquetted Iron)**: Compacted & Briquetted DRI for long distance transport such as shipping.
- **MIDREX/EAF route** with 20–40% less CO₂ emissions than BF/BOF route.
- More than 90 MIDREX modules worldwide, producing about 80% of the world’s natural gas-based DRI/HBI.

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**Midrex-NG (Natural Gas)**

1. **Reducing Gas**
   - H₂ 55%, CO 36%
   - H₂/CO = ~1.5

2. **Top gas**
   - (containing CO, H₂, CO₂, H₂O)

- **Shaft furnace**
  - Fe₂O₃ + 3H₂ → 2Fe + 3H₂O
  - Fe₂O₃ + 3CO → 2Fe + 3CO₂

- **Key Points of Low-CO₂ Reduced Iron Production**
  1. Use of hydrogen-rich reducing gas
  2. Effective use of top gas (recycled to the reformer feed and fuel, with no necessity of CO₂ separation)
Concept of CO₂ Reduction Solution

Conventional reduction method in BF route is partly replaced by MIDREX® Process utilizing hydrogen rich gas

**Conventional**

- Iron ore
- Coke

1.8 \((t-\text{CO}_2/tHM)\)

**Kobe Steel’s technology (SCOPE 1+2)**

- Iron ore
- Coke
- HBI

Largely reduced

1.4 \((t-\text{CO}_2/tHM)\)

Reduced by approx. 20%

**Kobe Steel’s technology (SCOPE 3)**

- MIDREX HBI plant

Low-CO₂ HBI production using hydrogen-rich gas

0.68 \((t-\text{CO}_2/t-HBI)\)

CO₂ addition by charging HBI up to 30%

+0.68×30%=+0.2 \((t-\text{CO}_2/tHM)\)

Reduced by approx. 12%
Key Technologies for CO₂ Reduction Solution

Technological Challenge: Essential to eliminate instability of BF conditions with the HBI charging in large quantity and the reduction of coke used.

KOBELCO Group’s technologies

- HBI manufacturing technology
- HBI charging technology
- BF operation technology utilizing AI
- Advanced pellet production technology

Low-CO₂ BF Operation Technology

- About 20% lower CO₂ emissions
- Low CO₂ reduction costs
- Technology readily available
KOBELECO Group’s CO\textsubscript{2} Reduction Solution will:

(1) Reduce CO\textsubscript{2} emissions from BF operations in large quantity and at low additional cost

(2) Provide a new option that could become readily available for a wide range of applications as a promising addition to other advanced technologies being developed by steelmakers around the world
Future Perspectives for KOBELCO Group’s CO₂ Reduction Solution

KOBELCO Group’s Low-CO₂ BF Operation Technology

Further reduction of CO₂ emissions

Lower CO₂ reduction cost

Further improvement of low-CO₂ BF operation technology

Contributing to the reduction of CO₂ emissions from BFs worldwide based on this technology

Establishing and promoting production and sales systems for low-CO₂ steel products (with new added value and differentiated features) and setting the terms and condition for sales

KOBELCO Group's mission

Reduce CO₂ emissions from the steel industry as quickly as possible and at the lowest possible cost
KOBELEC Group’s Mission
—Promoting the Transition toward Carbon Neutrality—

KOBELEC Group’s Corporate Philosophy

For details, please see the Next 100 Project page on the Kobe Steel’s website.
https://www.kobelco.co.jp/english/about_kobelco/outline/next100/
References
World crude steel production (= demand for steel) continues to increase with population growth.

Scrap is mainly used in EAFs. With the increase in steel production, BF s will remain indispensable to cover the entire demand.

Efforts toward achieving carbon neutrality by 2050 are essential in the steelmaking business.

Kobe Steel has been contributing to the reduction of CO₂ emissions around the world through MIDREX® process technologies mainly for EAFs. Going forward, we will also work on to provide CO₂ reduction solutions for BF s.
» Related link

KOBELCO Group’s Integrated Report 2020 is available on our website. Please use the QR code for easy access to the URL below.
URL: https://www.kobelco.co.jp/english/about_kobelco/outline/integrated-reports/

Note: QR code is a registered trademark of Denso Wave Incorporated.
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