Practice of HBIS HYMEX demonstration project

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01 Low-carbon strategy of HBIS Group
**HBIS Group: Being the most competitive steel enterprise**

- Crude steel: 41 Mt
- Total asset: 539.6 bn¥
- Revenue: 400.7 bn¥
- Social contribution: 49.5 bn¥
- Employees: 100,000+
- Brand value: 143.6 bn¥

- China's largest manufacturer of home appliances steel and second largest of automotive steel
- The world's second largest manufacturer of vanadium and titanium materials
- Leading enterprise in steel for ocean engineering and construction

Rank 229 among Chinese Steel Industry

Rank 2 among Chinese Steel Industry
Systematic green and low-carbon development strategy

- From comprehensive environmental governance of factory areas and creation of the world's cleanest factory, to adjustment of plants location,
- from ultra-low emission transformation and the first release of low-carbon development action plans, to the formation of the "6+2" low-carbon development technology roadmap,
- from the completion of the HYMEX project to the release of the "6+6+5" low-carbon emission product development plan,
- a systematic green and low-carbon strategy of energy conservation, pollution abatement, carbon reduction, circulation, and coordination has been formed.

### Phase I: 2008 – 2015

The path of clean production

### Phase II: 2016 – 2020

The path of green development

### Phase III: 2021 - present

The path of low-carbon development
Focus on three major innovations, implement the "6+2" low-carbon roadmap

- **Process structure**
- **Energy structure**
- **Material technology**

**Implementation approach**
- Implementing six technical paths and building two carbon platforms

**Development goals**
- Achieve a 10% reduction in carbon emissions from peaking year in 2025, a 30% reduction in 2030, and strive to achieve carbon neutrality by 2050

**Three major innovations**
- Focus on process structure, energy structure and material technology.
The "6+2" low-carbon technical roadmap

Six technical paths

1. Optimization of iron resources
2. Process optimization and reconstruction
3. Energy structure optimization
4. Low-carbon breakthrough technologies
5. System energy efficiency improvement
6. Industrial collaborative carbon reduction

Two carbon platforms

1. Product LCA platform
2. Carbon data management platform
02 The HYMEX project of HBIS

- COG zero-reforming based DRI-EAF
Currently, about 90% of the steel in China is produced by BF-BOF processes.
- Lack of scrap steel resources in China.
- The DRI - EAF process is an optional path, but the lack of gas resources (natural gas) and higher cost are limiting factors in China.
- However, nearly 190 billion cubic meters of coke oven gas (COG) are produced each year.
- COG contains over 60% H₂, which makes it a good choice for being used as reducing gas.

Typical composition of COG:

- H₂: ~62%
- CO: ~7%
- CO₂: ~2%
- CH₄: ~20%
- N₂: ~5%
- C₂H₄+C₂H₆: ~2.5%
- rest: trace

EAF production ratio (2022):

- China: 9.7%
- Germany: ~20%
- Japan: ~25%
- South Korea: ~27%
- India: ~30%
- USA: ~40%

World average: 28.2%
Construction of the HYMEX project

- Making full use of the rich COG resources of China steel industry, HBIS built the world’s first COG zero-reforming technology based DRI project, located in Xuanhua, Hebei, China.
- A CONSTEEL EAF steelmaking line has been constructed simultaneously.

Hydrogen Metallurgy - EAF, Xuanhua
Main facilities

- DR shaft furnace ironmaking facilities
- Gas process facilities
- Auxiliary facilities

- Charging
- Reactor
- Cooling
- Discharging
Technical principles

- COG contains over 60% H₂, after self-reforming, the H₂: CO can reach 8:1.

- The DR process using COG as the gas source mainly includes two routes, i.e. solid flow and gas flow, namely the pellet-DRI transportation and processing system, and the COG supply-tail gas recovery processing system.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Typical value</th>
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<tbody>
<tr>
<td>TFe</td>
<td>~90%</td>
</tr>
<tr>
<td>MFe</td>
<td>~85%</td>
</tr>
<tr>
<td>Metallization ratio</td>
<td>≥94%</td>
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<tr>
<td>C</td>
<td>2.5-4.5%</td>
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<tr>
<td>S</td>
<td>≤0.004%</td>
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<tr>
<td>Volume density</td>
<td>1600 ~ 1900kg/m³</td>
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<tr>
<td>Apparent density</td>
<td>3.4 ~ 3.6g/cm³</td>
</tr>
</tbody>
</table>

Chemical reactions:
- \( \text{CH}_4(g) + \text{H}_2\text{O}(g) \rightarrow \text{CO}(g) + 3\text{H}_2(g) \)
- \( \text{CH}_4(g) + \text{CO}_2(g) \rightarrow 2\text{CO}(g) + 2\text{H}_2(g) \)
- \( \text{Fe}_2\text{O}_3(s) + 3\text{H}_2(g) \rightarrow 2\text{Fe}(s) + 3\text{H}_2\text{O}(g) \)
- \( \text{Fe}_2\text{O}_3(s) + 3\text{CO}(g) \rightarrow 2\text{Fe}(s) + 3\text{CO}_2(g) \)
- \( 3\text{Fe}(s) + \text{CH}_4(g) \rightarrow \text{Fe}_3\text{C}(s) + 2\text{H}_2(g) \)
Use of DRI in the EAF

- CH$_4$ reacts with the reduced metal iron in the shaft furnace to form cementite, achieving carburization of DRI and generating H$_2$. Carbon-containing DRI is also beneficial for EAF smelting.
- Good for the slag forming in the early stage of EAF smelting, to promote De-P.
- DRI is pure, suitable for high quality steel production
Carbon emission reduction

- Organizational Level Carbon Emission Analysis
  - worldsteel CO₂ Data Collection Methodology
  - the carbon emission intensity per ton of crude steel was reduced by 65% to 70%.

- LCA Based Carbon Footprint Assessment
  - worldsteel Life Cycle Inventory Methodology
  - it was estimated that the carbon footprint of the slab using COG DRI could be between 0.50 tCO₂/t and 0.84 tCO₂/t. When green hydrogen is available, it could be reduced to as low as 0.10 tCO₂/t.

High purity DRI is a good raw material for the production of high-quality steel, e.g. automotive sheet.
Future of HYMEX

- DRI-EAF based near zero carbon emission technology and products
2023
Excellence in low-carbon steel production
Thanks!