Ore-Based Metallics: Overview

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President
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➢ International Iron Metallics Association

➢ Ore-Based Metallics

➢ USA - Shale Gas Impact

➢ Summary
IIMA - Who We Are

Producers of Merchant Pig Iron (MPI), Hot Briquetted Iron (HBI), Direct Reduced Iron (DRI) and Iron Nuggets

Suppliers of raw materials, logistics, technology, equipment, consultancy, etc.

Traders/Distributors

Consumers of ferrous metallics

100 members in more than 35 countries
Ore-Based Metallics
Steel Production
Metals Sources

Metallic Source

- Scrap
  - New
  - Obsolete
  - Home
  - Prompt

- Iron Ore
  - Reduction Process
  - BF / RH
  - DRI
  - HBI
  - Pig Iron
  - Iron nuggets
OBMs are not SCRAP SUBSTITUTES
What Are Ore-Based Metallics?

- DRI, HBI, iron nuggets & pig iron are ore-based metallics (OBMs), which are manufactured from iron ore.
- OBMs are best used as **SCRAP SUPPLEMENTS** to dilute impurities in ferrous scrap in EAF steelmaking.
- OBMS are **PRODUCTIVITY ENHANCERS** in BF ironmaking and BOF steelmaking.
### Merchant HBI/DRI Sources

**Venezuela**
- Comsigua: 1.3
- Briqven (Matesi): 1.5
- Venprecar: 0.9
- CVG FMO: 1.0
- Orinoco Iron: 2.2
- Total: 6.9

**Libya**
- Lisco: 0.65 (HBI)
- Total: 1.75

**Libya**
- Lisco: 1.1 (DRI)
- Total: 1.75

**Russia**
- Lebedinsky GOK: 2.3

**Russia**
- Total: 17.29 MMT

**India**
- Welspun Maxsteel: 0.9 (HBI/DRI)

**India**
- Total: 17.29 MMT

**Qatar**
- Qatar Steel: 1.5 (HBI/DRI)

**Qatar**
- Total: 17.29 MMT

**Malaysia**
- Antara Steel: 0.9 (HBI)
- Lion DRI: 1.54 (HBI/DRI)
- Total: 2.44

**Malaysia**
- Total: 17.29 MMT

**Total: 17.29 MMT**

**Merchant HBI/DRI Sources**
Merchant Pig Iron Sources

Canada
Brazil
Norway
Ukraine
Russia
China
India
Japan
South Africa

Merchant pig iron producing countries
Main producers
### Merchant Pig Iron Sources

<table>
<thead>
<tr>
<th>State</th>
<th>Furnaces (N°)</th>
<th>Capacity (MMT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maranhão</td>
<td>22</td>
<td>2.7</td>
</tr>
<tr>
<td>Pará</td>
<td>21</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>North System</strong></td>
<td>43</td>
<td>5.5</td>
</tr>
<tr>
<td>Minas Gerais</td>
<td>106</td>
<td>8.5</td>
</tr>
<tr>
<td>Espírito Santo</td>
<td>8</td>
<td>0.8</td>
</tr>
<tr>
<td>Mato Grosso S.</td>
<td>6</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>South System</strong></td>
<td>120</td>
<td>10.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>163</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Main producers

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[Map of Brazil with highlighted states indicating pig iron sources]
## Merchant Pig Iron Sources

<table>
<thead>
<tr>
<th>Place</th>
<th>Capacity/Shipments (MMT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulachermet</td>
<td>3.0</td>
</tr>
<tr>
<td>Kosaya Gora</td>
<td>0.7</td>
</tr>
<tr>
<td>Chusovskoy</td>
<td>0.6</td>
</tr>
<tr>
<td>Ural Steel</td>
<td>0.5</td>
</tr>
<tr>
<td>NMLK Lipetsk</td>
<td>0.5</td>
</tr>
<tr>
<td>Svobodny Sokol</td>
<td>0.8</td>
</tr>
<tr>
<td>Russia</td>
<td>6.1</td>
</tr>
<tr>
<td>Donetsksteel</td>
<td>0.6</td>
</tr>
<tr>
<td>Ukraine</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Main producers

[Map showing Russia and Ukraine with markers indicating major sources of merchant pig iron.]
Where OBM s Are Used

EAF

BF

BOF

Cupola Furnace

Ladle Metallurgy
Benefits of OBMs

- Consistent quality and low residual content
- Controlled C content, consistent C recovery
- Predictable mass and heat balances
- Continuous feeding and high density feedstock
- Application flexibility (Reduces coke rate, Metallic yield similar to hot metal)
- Dilutes impurities in scrap
- Better slag foaming
- Easier on hearth refractory & electrodes
- Year-round production
- Attractive cost structure
- Lower copper content (next slide)
## Steel Grade Specifications & Metallic Feed Quality

<table>
<thead>
<tr>
<th>Metallics Type</th>
<th>Cu Content</th>
<th>Value Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Dealer Bundles</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Bushelling</td>
<td>0.08 - 0.1</td>
<td>0.8</td>
</tr>
<tr>
<td>#1 HMS</td>
<td>0.25 - 0.35</td>
<td>0.3</td>
</tr>
<tr>
<td>#2 HMS</td>
<td>0.4 - 0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>#1 Shredded</td>
<td>0.15 - 0.2</td>
<td>0.17</td>
</tr>
<tr>
<td>#2 Shredded</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>P&amp;S</td>
<td>0.12 - 0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>OBM Types</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HBI/DRI</td>
<td>0.002 (depends on ore)</td>
<td>0.0</td>
</tr>
<tr>
<td>Pig Iron</td>
<td>0.002 (depends on ore)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

The inherent cost of a point (0.01 weight %) of copper in the scrap has been determined to be approx. $2.00

Charging Mix is Determined by Product Quality Requirements

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### Residual limit for:

- Exposed auto sheet
- CQ sheet
- SBQ bar&rod
- Merchant bar

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### Charging Mix

- No.1 Factory Bundles
- No.1 Dealer Bundles
- Busheling Clips
- Plate and Structural
- Railroad Rails, Wheels
- Shredded
- No.1 Heavy Melting
- Cut Structural
- No.2 Heavy Melting
- No.2 Bundles
Shale Gas Will Fuel a U.S. Manufacturing Boom

Chemical producers abandoned the U.S. in droves. Cheap natural gas is luring them back. MIT Technology Review, January 9th 2013

By Kevin Bullis on January 9, 2013

People predicting a manufacturing renaissance in the United States usually imagine whirring robots or advanced factories turning out wind turbines and solar panels. The real American edge might be in something entirely more mundane: cheap starting materials for plastic bottles and plastic bags.

The plummeting price of natural gas, which can be used to make a vast number of products, including tires, carpet, antifreeze, lubricants, cloth, and many types of plastic, is luring key industries to the United States. Just five years ago, natural gas prices were so high that some chemicals manufacturers were shutting down operations here. Now the ability to access natural gas trapped in shale rock formations, using technologies such as hydraulic fracturing and horizontal drilling, has led to a surge in natural gas supplies that have lowered American gas prices to a fraction of prices in other countries (see “King Natural Gas”).

USA – Shale Gas Impact
Opportunities for steelmaking:

- For EAF steelmakers, higher share of electricity from natural gas
- Scope for shift in auxiliary BF fuel [typically 150-200 kg/tonne hot metal] towards natural gas
- Indirect use of natural gas in the BF through use of DRI/HBI as charge material to boost productivity
- Futures contracts enable lock-in of forward gas prices - underpins viability of investment in DR capacity

**Henry Hub Natural Gas Price**

<table>
<thead>
<tr>
<th>Time</th>
<th>Historical spot price</th>
<th>STEO forecast price</th>
<th>NYMEX futures price</th>
<th>95% NYMEX futures upper confidence interval</th>
<th>95% NYMEX futures lower confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2012</td>
<td>2.5</td>
<td>2.6</td>
<td>2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul 2012</td>
<td>3.0</td>
<td>3.1</td>
<td>3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 2013</td>
<td>3.5</td>
<td>3.6</td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul 2013</td>
<td>4.0</td>
<td>4.1</td>
<td>4.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 2014</td>
<td>4.5</td>
<td>4.6</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul 2014</td>
<td>5.0</td>
<td>5.1</td>
<td>5.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Confidence interval derived from options market information for the 5 trading days ending January 3, 2013. Intervals not calculated for months with sparse trading in near-the-money options contracts.*

*Source: Short-Term Energy Outlook, January 2013*
USA – DRI/HBI Plants

- Actual: Nucor Louisiana plant - 2.5 mtpy capacity, due to start up in mid-2013

- Projects: potential second and third modules at Nucor’s Louisiana plant

- Projects: 6-10 companies are actively considering DR plants in North America, some very seriously, with a couple of contracts possible in 6-12 months

- US Steel, Severstal, Northstar BlueScope and ESSAR North America have received press mention

- VoestAlpine Stahl has announced the decision to build an HBI plant in the USA
Problem or Opportunity For Merchant Scrap Supplements?

- Increased production of DRI in the USA can have a significant impact on the metallics supply chain, but is this a problem or an opportunity for merchant suppliers?
  - Some offshore HBI and pig iron supply to the US market may well have to seek alternative markets for displaced US imports
  - But there is scope for increased demand for scrap supplements from steel mills without captive supply and from increased steel production resulting from the development of shale gas

- In any case, offshore suppliers of pig iron offer the US steel and metal casting industries a useful hedge against higher gas prices.
Summary

- OBM Capacity
  - Significant excess Pig Iron capacity in Brazil
  - Ample latent HBI capacity in Venezuela
  - Russia adding 1.8 MMTY of HBI capacity

- Perception of HBI value in use

- Offshore HBI and Pig Iron Producers will remain as a supply source for the US, European Market & Asian markets

- Lack of residual copper in OBM feed stocks for the EAF does demonstrate an intrinsic value

- Steelmakers should look for opportunities to blend lower grade scrap with OBM to achieve the lowest cost/MT of liquid steel.

- Shale gas and low gas prices should boost US manufacturing and increase steel demand.

Cont..
Lower gas prices offer the US steel industry, both the BF/BOF and EAF sectors, the opportunity to reduce costs and increase competitiveness.

There seems to be every prospect that the third wave of direct reduction plants in North America is upon us - the big differentiator from the past being the ability to lock in long term gas prices.

There seems to be significant scope for rationalization of the various projects to ensure maximum efficiency and cost effectiveness across the industry.

OBMs are Not Scrap Substitutes.
Thank you for your attention

Alberto Hassan
Attachments
**Direct Reduced Iron (DRI)**

<table>
<thead>
<tr>
<th>Chemical Characteristics (ranges % by wt.) Based on 65.5-68% Fe iron ore</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metallization</strong></td>
</tr>
<tr>
<td><strong>Fe (Total)</strong></td>
</tr>
<tr>
<td><strong>Fe (Metallic)</strong></td>
</tr>
<tr>
<td><strong>C</strong></td>
</tr>
<tr>
<td><strong>S</strong></td>
</tr>
<tr>
<td><strong>P₂O₅</strong></td>
</tr>
<tr>
<td><strong>Gangue</strong>*</td>
</tr>
<tr>
<td><strong>Mn, Cu, Ni, Cr, Mo, Sn, Pb, Zn</strong></td>
</tr>
<tr>
<td><strong>Size</strong></td>
</tr>
<tr>
<td><strong>Apparent Density</strong></td>
</tr>
<tr>
<td><strong>Bulk Density</strong></td>
</tr>
</tbody>
</table>

*minus S, P₂O₅ & trace elements*
### Hot Briquetted Iron (HBI)

**DRI**

**HBI**

**Iron Nuggets**

**Pig Iron**

#### Chemical Characteristics (ranges % by wt.)

Based on 65.5-68% Fe iron ore

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metallization</td>
<td>94.0%</td>
</tr>
<tr>
<td>Fe (Total)</td>
<td>88.3-94.0%</td>
</tr>
<tr>
<td>Fe (Metallic)</td>
<td>83.0-88.4%</td>
</tr>
<tr>
<td>C</td>
<td>0.5-1.6%</td>
</tr>
<tr>
<td>S</td>
<td>0.001-0.03%</td>
</tr>
<tr>
<td>P$<em>{2}$O$</em>{5}$</td>
<td>0.005-0.09%</td>
</tr>
<tr>
<td>Gangue*</td>
<td>3.9-8.6%</td>
</tr>
<tr>
<td>Mn, Cu, Ni, Cr, Mo, Sn, Pb, Zn</td>
<td>Traces</td>
</tr>
<tr>
<td>Size</td>
<td>30 x 50 x 110 mm</td>
</tr>
<tr>
<td>Apparent Density</td>
<td>5.0 – 5.5 t/m$^3$</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>2.5 – 3.3 t/m$^3$</td>
</tr>
</tbody>
</table>

*minus S, P$_{2}$O$_{5}$ & trace elements*
Iron Nuggets

Chemical Characteristics
(ranges % by wt.)

<table>
<thead>
<tr>
<th>Component</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metallic iron</td>
<td>97.0 %</td>
</tr>
<tr>
<td>Carbon</td>
<td>2.5 - 3.0%</td>
</tr>
<tr>
<td>S</td>
<td>&lt; 0.1%</td>
</tr>
<tr>
<td>Si, Mn, O</td>
<td>Depends on Ore</td>
</tr>
<tr>
<td>Size</td>
<td>80% 6 - 16 mm</td>
</tr>
</tbody>
</table>

Mesabi Nugget
0.5 MMT plant started up in 2010; nuggets used in SDI melt shops
### Pig Iron

#### Chemical Characteristics (ranges % by wt.)

<table>
<thead>
<tr>
<th></th>
<th>Basic</th>
<th>Foundry</th>
<th>Nodular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>94.0 - 95.0%</td>
<td>94.0 - 95.0%</td>
<td>94.0 - 95.0%</td>
</tr>
<tr>
<td>C</td>
<td>3.5 - 4.5%</td>
<td>3.5 - 4.5%</td>
<td>3.5 - 4.5%</td>
</tr>
<tr>
<td>Si</td>
<td>&lt; 1.5%</td>
<td>1.5 - 3.5%</td>
<td>0.05 - 2.0%</td>
</tr>
<tr>
<td>Mn</td>
<td>0.5 - 1.0%</td>
<td>0.5 - 1.0%</td>
<td>&lt; 0.05%</td>
</tr>
<tr>
<td>S</td>
<td>&lt; 0.05%</td>
<td>&lt; 0.05%</td>
<td>0.01%</td>
</tr>
<tr>
<td>P</td>
<td>&lt; 0.12%</td>
<td>&lt; 0.12%</td>
<td>&lt; 0.02%</td>
</tr>
<tr>
<td>Ingot Weight</td>
<td>3.5 - 45.0 kg</td>
<td>3.5 - 45.0 kg</td>
<td>3.5 - 45.0 kg</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>3.7 t/m³</td>
<td>3.7 t/m³</td>
<td>3.7 t/m³</td>
</tr>
</tbody>
</table>
Units: MMT

China MPI, 55.0

Domestic DRI/HBI, 8.0
Cross border DRI/HBI, 6.8
Cross border MPI, 12.5
Domestic MPI, 9.0

Estimates for cross border trade 2012:
Pig iron - 12 mt
DRI/HBI - 8.6 mt

Source: IIMA