Circular Pelletizing Technology
A smart combination

Christoph Aichinger, Siemens VAI

We didn’t invent Pelletizing.
We just made it better...
Trends in Iron Ore Mining
Why Pelletizing?

- **Global Decrease of Lump and Sinter Feed Ores**
  This tendency makes the utilisation of fine and ultra fine ores more and more important in next decades, for which pelletizing is the only industrial scale proven process.

- **Good Bed Permeability and Reducilbility**
  Due to the spherical shapes and the high porosity of the pellets a high bed permeability and a high reducibility of pellets is achieved, which is leading to less energy consumption in the downstream processes.

- **Uniform chemical analysis**
  By beneficiating of ultrafines a very constant quality is achieved leading to constant operation conditions.

- **Easy handling and transportation**
  By induration an excellent strength of pellets for further handling and processing is achieved.
From Ore to Iron
Process Routes in Ironmaking

Ore with high iron content

- Screening
  - Lump ore
  - Fines
  - Sintering

- Blast furnace
- FINEX plant

Ore with low iron content

- Beneficiation
  - Concentrate
  - Pelletizing

- DR plant
- COREX plant
A Long History in Pelletizing Business
Siemens VAI – 40 years experience in straight grate pelletizing

**Milestones**

1966 Siemens VAI enters pelletizing business (VOEST-Alpine)

1969 Tubarao 1 Vale, Brazil 2.0 Mt/a Hematite

1970 Siemens VAI enters pelletizing business (VOEST-Alpine)

1973 Tubarao 2 Vale, Brazil 3.0 Mt/a Hematite

1977 License Agreement with LURGI (today Outotec)

1978 Mandovi Pellets India 1.8 Mt/a Limonite

1978 SIDOR Venezuela 2 x 3.3 Mt/a Limonite

1979 Acquisition of Circular Pelletizing Technology

1981 Delta Steel Nigeria 1.5 Mt/a Hematite

1983 Primary focus on Sinter Plants

1984 Pelletizing Plant modernization studies

1990

2000

2004 LURGI Pelletizing License terminated

2005

2010 Acquisition of Circular Pelletizing Technology

2011 First Circular Pelletizing Plant implemented in India

2015

**References**

2011

2001 Pelletizing Plant modernization studies

1976-2011 Primary focus on Sinter Plants

2000

1979 Acquisition of Circular Pelletizing Technology

1978 Mandovi Pellets India 1.8 Mt/a Limonite

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1966 Siemens VAI enters pelletizing business (VOEST-Alpine)
Circular Pelletizing Technology

A smart combination
The Challenge of making iron ore pellets
Typical Flow Sheet of a Pelletizing Plant
Straight Grate Pelletizing Technology
Induration Process
Siemens VAI Sintering Technology
Mechanical design of a circular dip rail cooler
Circular Pelletizing Technology
A SMART combination

Siemens VAI combines the well-proven travelling grate process with the simple and robust mechanical design of a circular dip rail cooler. The result is the revolutionary Circular Pelletizing Technology.
Circular Pelletizing Technology
The Induration Process in Circular Arrangement

Induration Zones:
1. Up-draft drying
2. Down-draft drying
3. Preheating
4. Firing
5. After-firing
6. First cooling
7. Second cooling

Process Gas System in a typical Straight grate Furnace
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Characteristics and Design Criteria

CPT combines proven process with reliable mechanical system

Design Criteria

- **Simple and robust design** of equipment and gas flow
- **Circular design and small footprint** of induration furnace with efficient and optimized equipment utilization
- Location of Circular Pelletizing Plant not necessarily at mine site, but also at steel works or direct reduction plants
- Induration furnaces for capacities between 0.6 and 3.0 mt/a considered
- Production of high quality **Blast Furnace** and **Direct Reduction Grade** pellets as well as Manganese pellets
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Temperature and Processing Zones

Indurating Furnace Temperatures and Seven Processing Zones

- Drying Section
  - Updraft Drying
  - Downdraft Drying
  - Pre-heating

- Heating Section
  - Firing
  - After-firing

- Heat Recovery Section
  - First Cooling
  - Second Cooling
By careful design of the pallet cars and the drive system combined with a detailed stress analysis of the complete system a reliable and easy maintainable indurating machine could be realized.
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Induration Furnace - Cross Section - Firing Zone
By simulating the process gas flows inside the indurating hood the optimum arrangement and specific power of the burners could be defined.
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Layout, Plant Features
Circular Pelletizing Technology (CPT)
Standard Plant Layout CPT 1.2M

1. Raw material dosing & balling
2. Mixing station
3. Induration furnace
4. Product classification
5. Product storage pile
6. Process gas cleaning
7. Coal gasification plant
8. Additive storage & grinding
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Impressions
Circular Pelletizing Technology
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Circular Pelletizing Technology
Impressions
Circular Pelletizing Technology
Top View of a CPT 1.2M in a Steelworks

1 Iron ore grinding
2 Dosing & mixing
3 Green balling
4 Additive storage & grinding
5 Induration furnace
6 Product classification
7 Product intermediate bin
8 Process gas cleaning
Advantages of this Direct Coal Gasification Technology:

• Several small and independent units enable high flexibility in operation

• Efficiency of energy output is very high as tar is not removed

• Stable operation of this type of gasifiers results in high plant availability
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Dual Fuel Burner Principle Scheme

Fuels can be mixed in every ratio.
CPT Plant Combinations:

By the production of DR-grade pellets the next generation module size of CPT plants is the ideal basis for a MIDREX® 1.7 Mtpa DRI plant.

The new module can also be combined with a 1.5 Mtpa COREX® plant for the production of hot metal.

The complete combined plant solutions can be offered by Siemens VAI.
Siemens’ Hybrid Flotation addresses the challenges by differing from conventional technologies

Why Hybrid Flotation?

First stage (upper section): **Pneumatic** principle with 3-phase-ejectors; especially capable to recover “fines” and achieve high enrichment factors

The circular movement in the upper section together with the conical intersection between upper and lower section leads to a centrifugal effect

Second stage (lower section): **Column** principle with bigger gas bubbles; catch coarse particles not attached in first stage at lower enrichment factors, but increasing total recovery significantly

Adjustability of the lower aerators ensures best possible positioning for optimization of bubble-particle contact

Short retention times lead to a quick discharge of the froth product

No stirring device means no energy required for it and no wear at an agitator system

... because it's two principles in one machine!
Advanced Level 2 Automation System
Optimized Process Control for Pellet Production

Main Aspects
- Fully integrated system comprising all elements of CPT
- Stable and standardized (shift independent) operation
- Process insight through visualization and reporting

Main Benefits
- Improved Quality and Capacity
- Safe operation
- Reduced Energy Consumption
- Increased Plant Availability
- Transparent and regular management reporting
CPT in Figures
## Circular Pelletizing Technology
### Production Figures

<table>
<thead>
<tr>
<th>Productivity</th>
<th>0.6 – 3.0 Mtpa</th>
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<tbody>
<tr>
<td>Product Size &lt; 5 mm</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td>Product Size &gt; 16 mm</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>CCS (Cold Crushing Strength)</td>
<td>Av. 2,500 N/Pe</td>
</tr>
<tr>
<td>TI (Tumble Index) &gt; 6.3 mm</td>
<td>&gt; 92%</td>
</tr>
<tr>
<td>Reducibility (ISO 7215)</td>
<td>&gt; 70%</td>
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<tr>
<td>Swelling Index</td>
<td>&lt; 15%</td>
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## Consumption Figures

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Less Than</th>
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<tbody>
<tr>
<td>Electr. energy requirement</td>
<td>&lt; 40 kWh / t&lt;sub&gt;pe&lt;/sub&gt;</td>
</tr>
<tr>
<td>Heat energy requirement</td>
<td>&lt; 250 Mcal / t&lt;sub&gt;pe&lt;/sub&gt;</td>
</tr>
<tr>
<td>Water requirement</td>
<td>&lt; 0.2 m³ / t&lt;sub&gt;pe&lt;/sub&gt;</td>
</tr>
<tr>
<td>Compressed air</td>
<td>&lt; 25 m³ / t&lt;sub&gt;pe&lt;/sub&gt;</td>
</tr>
<tr>
<td>Bentonite</td>
<td>&lt; 7 kg / t&lt;sub&gt;pe&lt;/sub&gt;</td>
</tr>
<tr>
<td>Coke</td>
<td>&lt; 11 kg / t&lt;sub&gt;pe&lt;/sub&gt;</td>
</tr>
<tr>
<td>Limestone</td>
<td>&lt; 11 kg / t&lt;sub&gt;pe&lt;/sub&gt;</td>
</tr>
<tr>
<td>Refractories</td>
<td>&lt; 0.1 kg / t&lt;sub&gt;pe&lt;/sub&gt;</td>
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## Circular Pelletizing Technology

### Environmental Figures

<table>
<thead>
<tr>
<th>Environmental Parameter</th>
<th>Limit</th>
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<tbody>
<tr>
<td>Dust in waste gas ($mg_{dry} / Nm^3$)</td>
<td>&lt; 50</td>
</tr>
<tr>
<td>Work zone dust content ($mg_{dry} / Nm^3$)</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Noise level (dB(A))</td>
<td>&lt; 85 (at 1 m from source)</td>
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Advantages of CPT
### Advantages of CPT

<table>
<thead>
<tr>
<th>Benefit</th>
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<tr>
<td><strong>Compact plant layout</strong>, low building profile, short process air ducts, completely standardized equipment</td>
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<tr>
<td><strong>Lowest weight</strong> of equipment and structural steel compared to straight grate and rotary kiln pelletizing plants of similar capacity</td>
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<td><strong>Low overall CAPEX</strong>, specific investment costs comparable with large pellet plants</td>
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<tr>
<td><strong>Modular CPT concept</strong> for larger pellet capacities allows the flexibility of producing different pellet qualities and quantities specifically to the market and customer requirements</td>
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<tr>
<td><strong>Integrated combination</strong> with MIDREX DRI or COREX plant</td>
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Advantages of CPT

Benefits of CPT

- **Flexibility** in plant location: at mine or in steel plant site due to low space requirement
- **Iron Ore Beneficiation Plant** as integrated component of a CPT plant based on **Siemens Hybrid Flotation Cell** for DR grade pellet production
- **Low OPEX** due to the compact layout (e.g. short process ducts)
- Flexibility to use **various energy source** for firing process (e.g. indigenous coal via direct gasification)
- **Environmental compatibility**: lowest emissions, 100% recycling of by-products, processing of in-plant waste materials
- **Fully automated** process control and plant operation based on Siemens VAI Level 2 Automation System
Circular Pelletizing Technology
“Small is beautiful!”

CPT
It is round
It is compact
It is very cost efficient

Christoph Aichinger, Siemens VAI
Contact:
Christoph Aichinger
Vice President
Head of Agglomeration
+43 664 615 3004

Siemens VAI
Metals Technologies GmbH
Turmstr. 44, P.O. Box 4,
A 4031 Linz - Austria
Tel: +43 (0) 70 6592-74495
Fax: +43(0) 70 6980-5772
E-mail: christoph.aichinger@siemens.com

www.siemens-vai.com