Integrated Plant Solutions for Stainless & Special Steelmaking

Operational excellence through integrated process innovation

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1. The steel industry challenge
2. Solutions for stainless & special steelmaking
3. Innovative casting and rolling technologies
4. Environmental & energy efficiency
5. Through-Process Quality Control
6. Conclusion
Creating the future of metals as one

Siemens VAI Metals Technologies
- More than 60 years of metallurgical, engineering and plant-building experience
- Strong emphasis on R&D and introduction of numerous innovations
- Worldwide sales organization and global engineering

Mitsubishi-Hitachi Metals Machinery (MHMM)
- More than 2,200 plants installed worldwide with proven record of reliability and cost-effectiveness
- In-house manufacturing expertise
- Strong sales setup and engineering competence, particularly in growing Asian countries

Ownership
51% Mitsubishi-Hitachi Metals Machinery Inc.¹
49% Siemens

Global Business Focus
Supplier of advanced processes, technologies, plants, products and services for the iron, steel and nonferrous industries

Comprehensive Technology and Product Portfolio
for totally optimized and integrated processes along the entire metals value chain

1) a Mitsubishi Heavy Industries consolidated group company with equity participation by Hitachi, Ltd. and IHI Corporation.
World-class portfolio and organization structured to customer needs and fast response
1. The steel industry challenge
2. Solutions for stainless & special steelmaking
3. Innovative casting and rolling technologies
4. Environmental & energy efficiency
5. Through-Process Quality Control
6. Conclusion
### The Steel Industry Challenge

<table>
<thead>
<tr>
<th>Raw Materials</th>
<th>Market</th>
<th>Operational Excellence</th>
</tr>
</thead>
</table>
| • Availability (Scrap, NPI, DRI, HBI)  
• Volatility management (pricing, volume)  
• Quality vs. Price trade-offs (value in use) | • China is struggling  
• Automotive market will grow  
• Pricing - Nickel | • Cost position improvement  
• Best technology choices  
• Quality Control  
• War for talent |

<table>
<thead>
<tr>
<th>Product innovation</th>
<th>Marketing &amp; Sales excellence</th>
<th>Regulation</th>
</tr>
</thead>
</table>
| • Close collaboration with customers  
• R&D&I  
• Expansion of services offered | • Innovative contract design  
• Risk management  
• Pricing | • Climate change  
• Other regulatory actions |

<table>
<thead>
<tr>
<th>Growth</th>
<th>Capital expenditures</th>
</tr>
</thead>
</table>
| • Internationalization  
• Global and regional industry consolidation  
• Global and regional footprint | • Technology choices  
• Projects prioritization  
• Large capital projects management |
Recent investment criteria for stainless & special steel integrated plant solutions

<table>
<thead>
<tr>
<th>Major criteria</th>
<th>China</th>
<th>Asia w/o China</th>
<th>Europe</th>
<th>Americas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental &amp; Energy Efficiency</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Product Quality</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Plant Productivity</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Raw Material and Production Flex.</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Through-Process Know-How</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
<td>![Bar Chart]</td>
</tr>
</tbody>
</table>
Presentation outline

1. The steel industry challenge
2. **Solutions for stainless & special steel making**
3. Innovative casting and rolling technologies
4. Environmental & energy efficiency
5. Through-Process Quality Control
6. Conclusion
Process route of stainless steel production
Raw Material based on scrap (capacity: 0.4 to 1 mio t/a)

Scrap, HBI, DRI
FeCrHC
Nickel

- EAF (EBT)
- Deslagging stand

Optional

- Duplex (Stainless Steel)
- Triplex (Stainless Steel)
- Carbon Steel
- All Steel Grades

HCCr =>
Approx. 15% of TW

- Induction furnace
- AOD converter
- Deslagging stand

- Ladle furnace
- Slab caster
- VOD

- Duplex (Stainless Steel)
- Triplex (Stainless Steel)
- Carbon Steel
- All Steel Grades

- Mostlly applied process in developed countries based on available stainless steel scrap
- Induction furnace (IF) can be used for HCCr-melting to ensure high metallic yield and for smooth EAF operation
- Triplex for higher production and grades with low N+C
One of the biggest stainless steelmaking plants
Outokumpu Stainless USA in Calvert/Alabama, USA

Scope of supply
160 t electric arc furnace (EAF)
180 t AOD converter
Ladle treatment station
180 t slab caster
Dedusting systems for EAF, AOD and continuous casting

Order in force 28.05.2008
Start-up 16.11.2012

Production 1,000,000 t/y slabs
HM w/o Ni  DeSi / DeP

- HM after DeP is used for ferritic grades
- Higher quality due to less trace elements
- IF can be used to improve energy balance of the AOD process
- Triplex for higher production and grades with low N+C
EAF for stainless steel
Optimized design and process technology

All features and design elements as outlined for AC or DC EAF’s

Power input up to 120 MW

Large furnace volume with consideration of low density of stainless steel scrap (200 m³ and more)

Tight furnace with minimum shell and roof openings

Special spout design to enable fast tapping

Special furnace design to allow tilting angle of up to 40°
EAF steelmaking
Smart packages for intelligent production

ECO Solutions
Comprehensive portfolio for environmental solutions (wet-, dry dedusting, by-products, energy recovery...)

Power Supply
Reliable power distribution and power quality systems, from substation down to the furnace switchgear.

Furnace Transformer
Robust, reliable and efficient design

Foaming Slag Management
For each application and furnace type the optimum solution for foaming slag management is selected, based on structure-borne sound, optical or current harmonics evaluation.

Chargeopt
Automated EAF scrap charging procedure and crane handling

Process Control
Basic automation and technological control functions

Electrode Control
The next generation of electrode control system to reduce energy consumption and increase melting efficiency

EAF Optimization
Level 2 automation system for process optimization (e.g. setpoint calculation, prediction of process results)

Lomas
Off-gas analysis for accurate determination of CO, CO2, H2, O2 and CH4 as well as water leakages

Heatopt
Holistic, closed loop process optimization, minimizing consumables, saving energy and increasing furnace efficiency

RCB Temp
Three functions in one device: Burner Mode – Lance Mode and Temperature Mode

Ladle Tracking
Full tracking and monitoring of steel ladles during the entire process – increases safety, reduces refractory costs

Fluid Guard
Leakage detection and condition monitoring of cooling system

Car
Robust, modular design, proven in numerous applications

CMS
One platform for monitoring of the entire plant. CMS increases the plant availability and reduces maintenance costs considerably

Wiplant
Wireless data transfer designed for harsh steel plant environment. Ideal of moving objects or areas hard to reach with cables
Solutions for secondary metallurgy

Your challenge

- Rising demand for clean and vacuum treated steel qualities
- Extending your product portfolio to advanced market requirements
- Fulfilling customer demands by state-of-the-art technology

Our solution

- Added value through secondary metallurgy plants
- Trend setting technologies for LF, VD; VOD and RH aggregates e.g. new COB-lance ignition system, efficient steam ejector and dry mechanical pump system, ladle lifting by hydraulic or winch systems, copper cladded water cooled roof and powerful automation solutions
Logistics evaluation
Layout and production planning

• Identification and elimination of bottlenecks
• Ideal utilization of resources (materials, equipment, personnel)
• Optimized production planning and scheduling
• Improved material flow
• Higher plant productivity
• Investment savings
• Reduced inventories

Simulation of short-term Steel Plant Schedule

• Maximum achievable production
• Bottleneck identification
• Lead time through the system

Basis for layout and investment decisions
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2-strand vertical round bloom caster
Zhongyuan, China

Steel grades
- Tool and die steel
- Stainless steel (non-magnetic, dual phase, forging)
- Heat resistant steel, Ni-based alloys
- Structural steel
- Bearing steel
- Ultra-high strength steel

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production capacity:</td>
<td>370,000 tpy</td>
</tr>
<tr>
<td>Heat size:</td>
<td>60 t</td>
</tr>
<tr>
<td>Metallurgical length:</td>
<td>23 m</td>
</tr>
<tr>
<td>Bloom dimensions:</td>
<td>ø400, ø600, ø800 mm</td>
</tr>
<tr>
<td>Max. casting speed:</td>
<td>0.55 m/min</td>
</tr>
<tr>
<td>Cut length:</td>
<td>2.5 – 6 m</td>
</tr>
<tr>
<td>Strand center distance:</td>
<td>3,500 mm</td>
</tr>
</tbody>
</table>
Multi roller vs. two roller system
Theoretical and practical comparison

<table>
<thead>
<tr>
<th>2 roller drive unit</th>
<th>3 roller drive unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Image of 2 roller drive unit" /></td>
<td><img src="image2" alt="Image of 3 roller drive unit" /></td>
</tr>
<tr>
<td>High Tensile Stresses over the whole cross section lead to appearance of cracks</td>
<td>No cracks because of compression stresses only</td>
</tr>
</tbody>
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Rolling & Processing Technology
### DRAPL & CTCM
- Black coil rolling line
- White coil rolling line
- Coupled to A&P line (DRAPL)
- Power X-HI mills

### Anneal and Pickle line
- Hot A&P line or Cold A&P line
- Combination A&P line
- Water or Alkaly cleaning
- CMI-UVK pickling section

### Power X-HI mill
- Up to 30% reduction per stand
- Continuous adjustable offset
- Fully automatic roll change
- Neat oil or emulsion based roll cooling system

### Skin Pass Mills
- Skin Pass Mill: 2-Hi, 4-Hi
- Dry operation
- In-line or stand alone
- On line roll polishing
- Quick roll change

### Latest References
- **Black coil rolling line**
  - Beihai Chengde Stainless Steel
  - Baosteel Desheng
  - LISCO
  - Aperam Ugine
- **Hot A&P line or Cold A&P line**
  - Guanghan Tiancheng Stainless Steel
  - Jiuquan Iron & Steel Co.
  - Posco Iron & Steel Co.
  - Columbus
- **Combination A&P line**
- **Water or Alkaly cleaning**
- **CMI-UVK pickling section**
- **Up to 30% reduction per stand**
- **Continuous adjustable offset**
- **Fully automatic roll change**
- **Neat oil or emulsion based roll cooling system**
- **Skin Pass Mill: 2-Hi, 4-Hi**
- **Dry operation**
- **In-line or stand alone**
- **On line roll polishing**
- **Quick roll change**

**Latest References**
- **Guanghan Tiancheng Stainless Steel**
- **Jiuquan Iron & Steel Co.**
- **Posco Iron & Steel Co.**
- **Columbus**
- **Beihai Chengde I&S**
- **Baosteel Desheng**

**Latest References**
- **Guanghan Tiancheng Stainless Steel**
- **Jiuquan Iron & Steel Co.**
- **Posco Iron & Steel Co.**
- **Columbus**

**Design and Manufacturing of All Key Equipment (Welders, stand clusters, shears, levellers …) in Our Montbrison Workshop - France**
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Electric steelmaking
Waste heat recovery for EAF

EAF WHR System:
• Simple & reliable hot water technology
• Modular concept
  – Stage 1 = replacement of water cooled hot gas line
  – Stage 2 = replacement of quenching tower
• Steam generation from hot water
  (no steam production within steel plant)
• Waste heat utilization for heating, steam production for processing (e.g.: pickling lines) and electric power generation
• Substitution of natural gas (gas-fired boilers)

Key Performance Indicators:

| Steam production (kgsteam/tLS) | 100 – 200* |
| CO₂ savings per year (kgCO₂/tLS) | 170 – 340* |

*) depending on furnace type and heat recovery stage
Slag valorization and handling

Slag Valorization

I. Metal recovery
   • Treatment of liquid slag is reducing atmosphere
     \[ \text{FeO} \rightarrow \text{Fe} \]

II. Slag modification and valorization
   • Stabilization and usage as aggregate
   • Fertilizer production by P-enrichment
   • Lime adjustment for cement clinker production

Slag Handling

I. Closed processes with minimum foot print
   • BSSF with drum and short flow route

II. Heat recovery and emission control
   • Dry slag granulation with rotating cup
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Through-Process Quality Control (TPQC) Overview

Enterprise Resource Planning (ERP)

Manufacturing Execution System (MES)

Through-Process Quality Control (TPQC)

Level 3

Level 2

Level 1

Liquid Phase

Hot Rolling

Cold Rolling & Processing
Process and quality know-how

**Inline** Trough-Process Quality Control System (TPQC)

Know how rule based
**Inline** Quality Control System covers:

- Quality monitoring functionality
- Defect Classification & Corrective Actions (feed forward & feedback)
- Data Warehouse for analysis
- Know How documentation

High Quality Production – Through Process Control support & implement Quality Culture
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Making metals more competitive – Profit from experience

COMPREHENSIVE TECHNOLOGY AND PRODUCT PORTFOLIO
For totally optimized and integrated processes along the entire metals value chain

OPERATIONAL KNOW-HOW
To ensure best process performance and technological properties

ENGINEERING EXCELLENCE
As the basis for perfectly designed and cost-optimized plants and equipment

WEALTH OF EXPERIENCE
For fast project completion and plant start-ups
THANK YOU
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