Blue Competence in Stainless Steelmaking

Reduction in operational costs through steelmaking process innovation and energy efficiency improvement

13th International Stainless & Special Steels Summit, Istanbul

ECO Solutions - saving resources, creating value
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1. Introduction
   SVAI Life cycle partner for Stainless Industry

2. Energy Saving with Stainless Steelmaking Process Innovation’s

3. Energy Saving with Innovative Casting Technology

4. ECO products and Solutions for performance and Energy improvement

5. Summary
1) Introduction
Metals Technologies
From Ironmaking to the finished product

Siemens VAI Metals Technologies

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- Air
- Energy
- Residuals
- Integrated plants
- Consulting

- Beneficiation
- Agglomeration
- Blast furnace
- Smelting/direct reduction

- Converter plants
- Electric steelmaking
- Long rolling
- Mini mills

- Continuous casting
- Endless strip production
- Hot and cold mills
- Aluminum mills
- Strip processing

Electrics and Automation for:
- Ironmaking
- Steel plants
- Casting
- Rolling
- Modernization-packages and products

- Spares and components
- Electrical and mechanical maintenance and repair services
Life cycle partner for Stainless Industry

- SIMETAL EAF
- SIMETAL AOD
- SIMETAL SecMet
- High performance Caster
- Automation solutions

Innovation driven

Highest performance

Energy efficiency

Intelligent solutions

Environmental Protection

ESP/WinLink

RecoSteel

Services

Consulting

SVAI – the life-cycle Solution partner
Strategic Consulting
Approach to Increase Plant Performance & Energy Efficiency

Energy check

Find

- quick energy benchmark based on installed base, main raw materials

Energy feasibility

Evaluate

- detailed investigation of energy saving potential

Detailed improvement

Elaborate

- plant specific efficiency measures and feasibility

Benchmarking and Definition of Baseline …
… to support quick and proper selection of feasible energy efficiency measures
2) Energy Saving with Stainless Steelmaking Process Innovation’s
mostly applied Process in industry 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
Process route of stainless steel production
Alternative route with Hot Metal via BF / BOF
Capacity: 0.5 to 1.2 mio t/a

- HM after DeP is used for Ferrite grades
- Higher energy efficiency due to hot charging
- Electrical energy saving > 370 kWh/t in comparison to EAF route
- 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
Process route of stainless steel production
Based on integrated Stainless Steel Mill
Capacity: 0.4 to 0.8 mio t/a

- Integrated Process for Stainless Steelmaking for austenite grades
- Higher energy efficiency via Hot charging and waste heat recovery
- Electrical energy saving > 420 kWh/t in comparison to EAF/scrap route (w/o IF)
- Higher metallic yield and Ni-yield by eliminating EAF process
  - AOD process adaption necessary due to high Si and C input
  - Strong dependence on Ni-ore price

Electric energy consumption of RKEF: 3,500 kWh/t
Operational Cost Comparison

Ni-Ore price: Nov. 2013: $30/t
April 2014: $120/t
Siemens VAI References in the Stainless steelmaking since 1994

- **ISCOR**
  - 125 t K-OBM-S
  - 100 t VOD
  - 600,000 t/y

- **Outokumpu**
  - 2x125 t AOD
  - 750,000 t/y
  - 90 t LF
  - Slab Caster
  - 500,000 t/y

- **CARINOX**
  - 160 t EAF
  - 180 t AOD
  - 180 t LF
  - Slab Caster
  - 1,100,000 t/y

- **ALZ**
  - 120 t EAF
  - 120 t AOD
  - Slab Caster
  - 1,200,000 t/y

- **Zhangjiagang ZPSS**
  - 130 t EAF
  - 150 t AOD
  - Slab Caster
  - 800,000 t/y

- **POSCO, Pohang**
  - 85 t EAF
  - 90 t AOD
  - Slab Caster
  - 500,000 t/y

- **KAWASAKI, Chiba**
  - 2x160 t K-OBM-S/KMS-S
  - Patent License
  - 600,000 t/y

- **MICROSTEEL, Durban**
  - 15 t AOD, VOD
  - 1 Strand Billet Caster
  - 100,000 t/y

- **POSCO, Pohang**
  - 2x155 t EAF
  - 2x170 t AOD
  - 2x170 t LF
  - 2x170 t VOD
  - 2,000,000 t/y

- **TISCO Taiyuan**
  - 90 t K-OBM-S
  - 550,000 t/y

- **BÖHLER Uddeholm**
  - Plant Revamping
  - 50 t AOD, 130,000 t/y

- **Acc. di BOLZANO**
  - 55 t AOD
  - 100 t AOD

- **Viraj Profiles**
  - 55 t AOD
  - 200,000 t/y

- **TISCO Taiyuan**
  - 3x45 t AOD
  - 450,000 t/y

- **OUTOKUMPU**
  - 2x125 t AOD
  - 750,000 t/y

- **TISCO Taiyuan**
  - 2x150 t EAF
  - 3x180 t AOD
  - 3x120 t LF
  - 3x Slab Caster
  - 3,000,000 t/y

- **KAWASAKI, Chiba**
  - 2x160 t K-OBM-S/KMS-S
  - Patent License
  - 600,000 t/y

- **TISCO Taiyuan**
  - 3x45 t AOD
  - 450,000 t/y

- **Jiuquan ISCO**
  - 120 t AOD
  - 120 t LF
  - 600,000 t/y

- **Sandvik steel**
  - 3x75 t AOD Vessel mod.
  - 250,000 t/y

- **ALZ**
  - 120 t EAF
  - 120 t AOD
  - Slab Caster
  - 1,200,000 t/y

- **Taiwan**
  - 2x160 t EAF
  - 3x180 t AOD
  - 3x120 t LF
  - 3x Slab Caster
  - 3,000,000 t/y

- **LISCO**
  - 2x155 t EAF
  - 2x170 t AOD
  - 2x170 t LF
  - 170 t VOD
  - 2,000,000 t/y

- **POSCO, Pohang**
  - 2x155 t EAF
  - 2x170 t AOD
  - 2x170 t LF
  - 2x170 t VOD
  - 2,000,000 t/y

- **NANJING**
  - 140 t EAF
  - 150 t AOD
  - 800,000 t/y

- **TISCO Taiyuan**
  - 90 t K-OBM-S
  - 550,000 t/y

- **Viraj Profiles**
  - 55 t AOD
  - 200,000 t/y

- **Outokumpu**
  - 2x125 t AOD
  - 750,000 t/y

- **TISCO Taiyuan**
  - 2x160 t EAF
  - 3x180 t AOD
  - 3x120 t LF
  - 3x Slab Caster
  - 3,000,000 t/y

- **BÖHLER Uddeholm**
  - Plant Revamping
  - 50 t AOD, 130,000 t/y

- **TISCO Taiyuan**
  - 3x45 t AOD
  - 450,000 t/y

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  - 2x150 t EAF
  - 3x180 t AOD
  - 3x120 t LF
  - 3x Slab Caster
  - 3,000,000 t/y

- **KAWASAKI, Chiba**
  - 2x160 t K-OBM-S/KMS-S
  - Patent License
  - 600,000 t/y

- **POSCO, Pohang**
  - 85 t EAF
  - 90 t AOD
  - Slab Caster
  - 500,000 t/y

- **TISCO Taiyuan**
  - 90 t K-OBM-S
  - 550,000 t/y

- **Perkasa**
  - 40 t EAF
  - 40 t VOD
  - 2 Strand Bloom Caster
  - 600,000 t/y

- **Yunnan**
  - 1x120 t AOD
  - 600,000 t/y

- **TISCO Taiyuan**
  - 2x150 t EAF
  - 3x180 t AOD
  - 3x120 t LF
  - 3x Slab Caster
  - 3,000,000 t/y

- **LISCO**
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3) Energy Saving with Innovative Casting Technology
Trends for SS and Special steel Casting

- Higher Quality
- Higher yield
- Lower operational cost
- Better energy efficiency
- Higher production
**Vertical round bloom caster**  
Zhongyuan, China

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production capacity</td>
<td>370,000 tpy</td>
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<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>

**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

New holding force technology
Customer value add – Yield / forging time
(typical data from Siemens VAI customers)

Ingot casting

85% YIELD

3% scale

2% tail 10% head cut

Siemens VAI vertical special steel caster

97.5% YIELD

0.2% scale

0.6% tundish skull

0.7% tail 0.8% cutting 0.2% head cut

12.5% yield improvement with SVAI vertical caster

based on ø400mm / 8 heats per sequence; (ø600mm/8 heats: 11%; ø800mm/8 heats: 9%)

50% reduction of forging process time with SVAI vertical caster

Overall Energy efficiency increase more than 15%
**SVAI Solution:**
Vertical casting for SS and Special Steel (selected references)

**New Slab Vertical Continuous Casting Plant**

Baosteel Special Steel Branch, Shanghai, China

- Production: 267,000 tpy
- Max. Casting Speed: 1.5 m/min
- Number of Strands: 1
- Section Size: 150, 200 x 600-1300 mm
- Heat Size: 36 t

**DynaFlex Oscillator for Vertical Round Bloom Caster**

Nippon Steel & Sumikin Stainless Steel Corp., Hikari, Japan

- Production: 250,000 tpy
- Max. Casting Speed: 0.5 – 2.0 m/min
- Number of Strands: 2
- Section Size: Ø150 – Ø250 mm
- Heat Size: 60 t

**Modernization of 2 Slab Vertical Solid Bending Plants**

Dillinger Hütte, Dillingen Germany

- CC3 / CC4
- Production: 500,000 tpy / 900,000 tpy
- Max. Casting Speed: 0.7 / 0.5 m/min
- Number of Strands: 2 / 2
- Section Size:
  - 200,260, 300 x 1200 – 1650 mm / 200, 250, 300 x 1600 – 2200 mm
- Heat Size: 190 t
4) ECO products and Solutions for performance and Energy improvement
Energy efficiency for stainless steelmaking

Process optimization packages and advanced Automation

- Waste heat recovery off-gas
- AOD Process Optimization
- Variable speed drives (VSD) for pumps and fan
- Precon

Integrated waste heat recovery concept

Waste heat recovery

Steam VOD

Reheating Furnaces

EAF

AOD

accumulator

O₂, N₂, Ar

Ladle furnace

Steam VOD

el. Power

EAF

AOD

accumulator
Fluid Guard ECO
Failsafe leakage detection and energy efficiency

Challenge
A leakage in metallurgic plants is one of the most dangerous hazard sources in the area of liquid metal. Spontaneous evaporation and hydrogen-oxygen reaction occurs by inflowed water and an explosion will inevitably follow. According to new standards and regulations most of the leakage systems are not suitable. Density changes of the water are not considered. Surges causes fail detection.

Solution
The Fluid Guard was primarily developed as a self checking safety solution for failsafe leakage detection. The ECO solution includes a high energy saving potential. The Law of Affinity -> 20% speed reduction leads to 50% energy saving!

Typical customer benefit
- Easy fit into existing systems
- Exact leakage detection
- Self checking system
- Safety system
- Saving Energy for the water pump station

Environmental benefit
- Monitoring of all relevant cooling parameters in one system
- Calculation of heat losses and latent heat energy for optimized cooling performance

\[
\frac{Q_2}{Q_1} = \left(\frac{n_2}{n_1}\right) \quad \frac{P_2}{P_1} = \left(\frac{n_2}{n_1}\right)^3
\]

20% speed reduction leads to 50% energy saving!
Advanced Bag Filter Control

Challenge
- Highest cleaning performance along with low energy consumption
- Determination of defect cleaning valves
- Long lifetime and spare part availability
- Integration in existing plants

Solution
- Dynamic pulse length optimization for highest cleaning results together with lowest air consumption
- Maintenance-free MOSFET technology
- Determination of defect cleaning valves by the system
- Optional filter breakage detection

Environmental benefit
- Reduction of energy consumption
  Highest cleaning performance

Typical customer benefit
- Advanced valve diagnostics for easy maintenance
- State of the art power electronics replaces relay technique
- Lowest operational expenses besides highest cleaning performance
- Easy upgradability due to modular design

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**Dry Mechanical Vacuum Pumps for VD/VOD**

### Solution
- Mechanical vacuum pumps are volume-based: compression of suction chamber
- Standard pumps, compact designed modules,
- Very flexible combinations, depending on specific process demand
- High redundancy ensures high reliability
- Full pressure control by frequency converters

### Environmental benefit
- Reduction of energy consumption
- Lower life cycle energy cost

### Typical customer benefit
- Simple adaption to necessary suction capacity and pump down time
- Minimized energy consumption by demand actuated control
- Maximum flexibility ⇒ Vacuum on demand ⇒ energy consumption only during operation ⇒ no extra personal costs
- Completely dry system ⇒ no sewage
- Low maintenance cost
- Less design height compared to SE pumps

### Cost Saving

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<tr>
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<th>Operating</th>
<th>Steam</th>
<th>Investment</th>
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<tbody>
<tr>
<td>Full Steam</td>
<td>4.00</td>
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<tr>
<td>Hybrid System</td>
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</tr>
<tr>
<td>Mechanical pumps</td>
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- **Specific costs for 140t VOD facility**

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SIMETAL EAF Heatopt
Holistic closed-loop material and energy handling

Your challenge

- Increasing demands to lower conversion costs and higher product quality
- Ever more stringent environmental requirements
- Highest availability with minimum operator personnel

Our solution

- Holistic energy and transparency optimizing system
- Including best available measurement and analyzing technologies from SIEMENS VAI (e.g. LOMAS, FOX, SAM, FSM, CSM)
- Reaction corresponding to the actual process conditions ➔ Significant progress compared to control diagrams
RecoSteel
Recovering the energy of the offgas

Cooling stack and WHR for AOD

WHR for EAF, RKEF
### Variable Speed Drives (VSD)
**Demand controlled drives**

#### Challenge
Drives are often continuously operated without appropriate control:
- Waste of energy
- Low system performance
- High stress on piping and valves

#### Solution
Feasibility study:
- Optimization of the entire drive system
- Demand driven, economic and flexible operation
- Generated energy fed back

#### Environmental benefit
- Energy savings between 60 and 80%, compared to conventional systems (depending on existing system)
- Reduced maintenance costs

#### Typical customer benefit
- Operation of high-voltage motors on low-voltage distribution possible
- Drives can be operated to precise specifications
- Investments normally pay off in less than two years
Process Optimization L2
Steel Expert – online Process control

Challenge
- Process control is done by operators:
  - Low process consistence
  - Quality problems possible
  - Higher operational cost
  - More samples and Long waiting time

Solution
- SVAI developed the state of art process optimization models for all process steps for:
  - Cost optimized charge mix
  - Standardized processes
  - Shorter process time by dynamic control
  - Lower operational cost
  - Quality insurance with data records

Environmental benefit
- Shorter process time and higher output up to 10%
- Energy savings up to 15%
- Lower operational cost

Typical customer benefit
- Use lower cost raw material
- Higher output
- Better quality consistence
- Energy saving and less CO2 feet print
IT4METALS Overview

Liquid Phase
Hot Rolling
Cold Rolling & Processing

BF
LD/EAF
AOD/LF/VD
CC
HRM
CRM+PL

level 3
MES, APS, SILOC, EMS

level 2

level 1

ERP

Siemens Portfolio

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Energy consumption is basically divided in 2 groups:

- Energy consumption during production
- Energy consumption during non-production

**SIROLL GreenButton®** will reduce the energy consumption during the non-production time
Energy management system
Cuts peak loads and energy costs

Challenge
- Optimize complex energy network
- Approx. 25% of total production costs are energy related
- Benefit of the liberalized energy market

Solution
- Flexible energy-management modules:
  - SCADA
  - Energy Data Management
  - Energy prediction and optimization

Environ-
mental
benefit
- Reduction of specific energy demand
- Reduced emissions due to leakage detection

Typical customer benefit
- Identification of energy saving potentials
- Energy demand forecasts
- Reduction of energy load peaks and flaring
- reduce energy costs by ~3% (pipe bound)
5. Summary
Improvement measures and Saving potential

Current Energy cost

- Variable Speed Drive (VSD)
  - Pumps, Fans, ...
- Advanced Basic Automation
  - Green button, fluid guard; Process Models Expert Systems
- Production Planning System (MES)
- Energy Management System (EMS)
- Mechanical pump
  - Mechanical pump for VD/VOD
- Process innovation
  - Flexible raw material, hot charging
- Energy efficiency
  - Efficient Improvement
    - Efficient use of Metallurgical gases at all processes
- Heat Recovery
  - Utilization Waste Energy for Steam and Power
    - Reduce steam extraction → rise power production

Target energy cost: 76 EUR/t_hot coil

8% 6%

76 EUR/t_hot coil

Up to 40%
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