Arvedi ESP and WinLink® - Superior efficient flat and long steel production

Gerald Hohenbichler, Principle Senior Expert
19th Metal Bulletin Middle East Iron and Steel Conference - Dubai, Dec. 2015
• Arvedi ESP

• WinLink®
Are there any differences between Arvedi ESP and WinLink beside Flat vs. Long?

**Similar technology, same strengths:**

**Arvedi ESP**
- Energy savers
- Green-tech, saving CO2 emissions
- CAPEX and OPEX saving
- Economic at lower production scales, despite high-level machinery
- Land-efficient due to compact configuration
- Yield-maximizers

**WinLink**

**Both technologies ...**
- Consume less specific labor than conventional
- Use powder casting and high specific secondary cooling flows
- Exploit the casting enthalpy of the cast strand for in-line rolling
- Avoid intermediate stock (slabs, billets) to maximum extent
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- Use the same integrated automation concept to link the caster with the rolling mill
- Take a casting cross section in the midth to generate maximum casting throughput
- Produce almost the whole usual spectrum of steel grades of flat and long, respectively
Design capacity…… 3 x 2.55 Mtpy
BOF-Heat size………… 300 t
Machine radius………… 5 m
Metallurgical length…… 20.2 m
Max. casting speed…… 7.0 m/min
Total length…………… 180 m
Strand Thickness…. 70–110 mm
Strip Thickness…….. 0.8–6 mm
Width range…….. 900–1600 mm
Start-up……………… 2015
Time Schedule

<table>
<thead>
<tr>
<th>Line</th>
<th>Contract Start</th>
<th>Startup Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line 1</td>
<td>11.06.2013</td>
<td>13.02.2015</td>
</tr>
<tr>
<td>Line 2</td>
<td>11.06.2013</td>
<td>18.04.2015</td>
</tr>
<tr>
<td>Line 3</td>
<td>11.06.2014</td>
<td>19.09.2015</td>
</tr>
<tr>
<td>Line 5</td>
<td>11.06.2014</td>
<td>17.04.2016</td>
</tr>
<tr>
<td>Line 4</td>
<td>11.06.2014</td>
<td>17.06.2016</td>
</tr>
</tbody>
</table>

First million ton produced by beginning of Nov. 2015
## Arvedi ESP - the ultimate Technology connecting Casting and Rolling in endless mode

### Actual Production
- 340 t/h
- 193,000 t/m

### Sequence length
- 11 Heats (11x300=3300t)

### Yield
- >98%

### Casting speed
- 6.0 m/min at thickness 80mm

### Breakout rate
- 0.07%
- No breakout for 650,000 t
- 6 breakouts per year

### Cobble rate
- 0.06% @ 43% < 1.6 mm

### Work Roll Lifetime
- >170 km at F5

### Steel grades
- Low & Medium Carbon
- HSLA S500
- API X70
- DP 600 (Rizhao)

> World’s only proven endless casting and rolling technology for strip production

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19th Middle East I&S Conference, Dubai

G. Hohenbichler, Primetals Austria
First 0.8 mm on Rizhao ESP L1

Technical data

<table>
<thead>
<tr>
<th>Date</th>
<th>03.07.2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casting Speed</td>
<td>5.8 m/min</td>
</tr>
<tr>
<td>Strip Width</td>
<td>1250 mm</td>
</tr>
<tr>
<td>Strip Thickness</td>
<td>0.8 mm</td>
</tr>
</tbody>
</table>

Strip Thickness [mm]:
- 2 x 0.9
- 0.87
- 2 x 0.84
- 0.78
- 3 x 0.8
- 0.81
- 0.84
- 0.87
- 2 x 0.9

Coiler:
- Strip to DownCoiler 1
- Strip to DownCoiler 2

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Successful commissioning of the Rizhao ESP lines

Endless Strip Production (Arvedi ESP)

All three ESP lines are already at full monthly productivity in the year of their commissioning.

Revolutionizing the production of hot rolled band

Arvedi Steel, Italy
Operating since 2009, 9 Mt produced

Rizhao Steel, China
5 lines

90–110 mm
70–90 mm
10–20 mm
0.8–12.7 mm
180 m
Real Endless Strip Production
Inductive Heating

- Short 10 m inductive heating leads to **reduced scale losses** compared to 200 m tunnel furnace
- No Energy consumption during idle and maintenance periods
- **Reduced maintenance** costs compared to long tunnel furnaces
- Optimized control of end rolling temperature

Sources: 1) VdEh paper, 2) Attested by TÜV SÜD, 3) SMS paper, 4) Nucor publication
• Cutting endless strips leads to higher yield by avoiding crop losses

• Constant strip quality along entire strip length of endless coils

• No change of thickness, profile or flatness at head and tail of coils!
Real Endless Strip Production
Cutting and Coiling

- 90mm mold thickness leads to stable mold conditions
- Reduced breakout rate compared to thinner molds
- Cutting endless strips leads to higher yield by avoiding crop losses
- Constant strip quality along entire strip length of endless coils
- No change of thickness, profile or flatness at head and tail of coils! Straight cut! No head and tail scrap
Typical general space requirements driving turnkey costs

**ESP**
2,3 Mtpy

**2-Strand Thin Slab Casting and Rolling**
2,8 Mtpy

**Continuous Casting+ Slab yard+ Gas RHF+ Hot Strip Mill**
4 Mtpy

Approximate space requirements and costs:
- **ESP**
  - 20,000 m²
  - 8,7 m² / Ktpy
- **2-Strand Thin Slab Casting and Rolling**
  - 60,000 m²
  - 21,4 m² / Ktpy
- **Continuous Casting+ Slab yard+ Gas RHF+ Hot Strip Mill**
  - 100,000 m²
  - 25 m² / Ktpy
**ESP**

Specific cash conversion costs

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>ESP</th>
<th>Other Thin Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>44,9 €/t</td>
<td>17,5 €/t</td>
<td>28,4 €/t</td>
<td>37,0 €/t *</td>
</tr>
<tr>
<td>16,5 €/t</td>
<td>14,4 €/t</td>
<td>8,3 €/t</td>
<td></td>
</tr>
<tr>
<td>9,0 €/t</td>
<td>6,8 €/t</td>
<td>7,9 €/t</td>
<td></td>
</tr>
<tr>
<td>1,8 €/t</td>
<td>2,2 €/t</td>
<td>2,4 €/t</td>
<td></td>
</tr>
</tbody>
</table>

**Personnel**
- Only one caster operation group
- No slab storage staff

**Other op. Supplies (Maintenance)**
- Minimum maintenance at 10 m inductive heater
- Increased work roll life time due to 2-step rolling

**Energies**
- Use of hot strand internal energy for first rolling step
- No heating during idle times at inductive heater

**Yield losses**
- Minimum scale at 10m inductive heater
- No head and tail losses

*) Compare World Steel Dynamics 2009: Sestao 54 US$/t (37,8 €/t)

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CSM Certificate
API X70

TÜV Green Certificate
PAS 2050 for 2 mm Strip

TÜV Attestation
131.6 kWh/t for 2 mm Strip
### Are there any differences between Arvedi ESP and WinLink beside Flat vs. Long?

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WinLink®
Direct rolling of long products

1. Shorten the time from investment decision till break-even
2. Provide green technologies for new plants
3. Minimize conversion cost
4. Minimize investment cost
5. Shorten the transformation period from scrap to rebar
6. Save energy by process optimization

QUICK EFFICIENT GREEN
We REDUCE the final product cost in a PRODUCT-COST based market by minimizing CAPEX and OPEX through HIGH-LEVEL technological solutions.
WinLink ®
From scrap directly to finished long products

Meltshop is connected directly to rolling mill without any process interruption

Less specific OPEX than the conventional - not directly connected - process route at much lower annual production levels of around 300 ktpy
WinLink®
Process route and configuration

- EAF melting, LF refining, Continuous Casting and Rolling Mill are integrated in a high-level technological solution to ensure a 24 h continuous production

- A high-speed 2-strands caster continuously feeds a rolling mill with high availability

- Billet caster strand #1 directly feeds the rolling mill while strand #2 exploits the longer availability of meltshop, and produces saleable billets. It serves as backup to improve production flexibility requested by the rolling mill in semi-endless operation.

- Inductive temperature adaptation and rolling mill configuration ensure a full day production with no interruption of production.
Continuous casting

2 Strands CCM

to market

to rolling mill
RM capacity can match the CCM capacity for all finished products, ensuring a full utilization of the meltshop capabilities
Benefits

CAPEX benefits
- Smaller footprint
- Less equipment
- Smaller infrastructure (e.g. WTP)
- Less civil works and buildings

OPEX benefits
- Less energy consumption (No fuel for RHF)
- Higher yield (no scale, no short bar, no head & tail crops)
- Less personnel
- Less consumable expenses
- Lower inventory cost and working capital
- Lower fluid consumption

ENVIRONMENTAL benefits
- Less land required
- Lower CO₂ emissions (no fossil fuel furnace)
- Energy saving (utilization of sensible heat of cast billet)
- Reduced specific water consumption
- Soft visual impact (smaller buildings, less equipment)

Conventional vs WinLink in the range 280k to 600k (Casting & Rolling share)

<table>
<thead>
<tr>
<th>Category</th>
<th>Conventional</th>
<th>WinLink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>-40%</td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>-20%</td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>-30%</td>
<td></td>
</tr>
<tr>
<td>Civils</td>
<td>-20%</td>
<td></td>
</tr>
<tr>
<td>Natural Gas Consumption</td>
<td>-70%</td>
<td></td>
</tr>
<tr>
<td>Man power</td>
<td>-40%</td>
<td></td>
</tr>
<tr>
<td>Plant area</td>
<td>-40%</td>
<td></td>
</tr>
<tr>
<td>Material losses</td>
<td>-80%</td>
<td></td>
</tr>
<tr>
<td>Total Energy Consumption</td>
<td>-20%</td>
<td></td>
</tr>
</tbody>
</table>
Competitive production cost

Basis for comparison:
Scrap/DRI based: price 135 EUR/t
Region: CIS countries
Turn Key consideration, without land

Full Production cost (OPEX+CAPEX)

Very low production costs even at moderate capacity

- Conv. EAF 50t + WinLink (300-500ktpy)
- Conv. EAF 60t + WinLink (500-600ktpy)
- Quantum 70t + WINLINK (700-900ktpy b&r)
- Quantum 70t + EBROS (600-900ktpy)
- Quantum 100t + EBROS (900-1,000ktpy)
- Quantum 100t + conv. CC+RM (900-1,200ktpy)
1. WinLink endless mode 160x160 mm
2. Standard hot charge

Up to 60% cost reduction
A comprehensive range of WinLink® Lines

- Three configurations
- Five billet sizes depending on product mix and annual capacity requested
- Semi-endless option to boost the plant productivity → WinLink®Flex

<table>
<thead>
<tr>
<th></th>
<th>Billet size (mm)</th>
<th>Rebar Capacity (ktpy) of a single rolling line</th>
</tr>
</thead>
<tbody>
<tr>
<td>WinLink55</td>
<td>Sq 130 or 140</td>
<td>up to 380</td>
</tr>
<tr>
<td>WinLink70</td>
<td>Sq 150 or 160</td>
<td>380 to 500</td>
</tr>
<tr>
<td>WinLink85</td>
<td>200x150</td>
<td>500 to 600</td>
</tr>
<tr>
<td>WinLink®Flex</td>
<td>all</td>
<td>up to 750</td>
</tr>
</tbody>
</table>
### Configurations

**WinLink® 85**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity range [ktpy]</td>
<td>500 - 600</td>
</tr>
<tr>
<td>Billet size [mm]</td>
<td>bl200x150</td>
</tr>
<tr>
<td>EAF Transformer [MVA]</td>
<td>70</td>
</tr>
<tr>
<td>Tapping weight [t]</td>
<td>70</td>
</tr>
<tr>
<td>Tap-to-tap [min]</td>
<td>31</td>
</tr>
<tr>
<td>CCM capacity (1 strand) [tph]</td>
<td>85</td>
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<tr>
<td>CCM radius [m]</td>
<td>10</td>
</tr>
<tr>
<td>CCM speed [m/min]</td>
<td>6</td>
</tr>
<tr>
<td>Metallurgical length [m]</td>
<td>50</td>
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<tr>
<td>Induction furnace [MW]</td>
<td>2.0</td>
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<tr>
<td>RM total length [m]</td>
<td>260</td>
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<tr>
<td>No. of stands</td>
<td>21</td>
</tr>
<tr>
<td>RM installed power [MW]</td>
<td>7.5</td>
</tr>
<tr>
<td>RM finishing speed [m/s]</td>
<td>14</td>
</tr>
</tbody>
</table>

*Diagram showing IN-LINE STAND and IH.*

*bl 200x150 mm 6.0 m/min*
### Configurations

#### WinLink® FLEX

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Capacity range [ktpy]</td>
<td>380 - 750</td>
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<tr>
<td>Billet size [mm]</td>
<td>sq 150 – bl 150x200</td>
</tr>
<tr>
<td>EAF Transformer [MVA]</td>
<td>60-70</td>
</tr>
<tr>
<td>Tapping weight [t]</td>
<td>60-70</td>
</tr>
<tr>
<td>Tap-to-tap [min]</td>
<td>31-44</td>
</tr>
<tr>
<td>CCM capacity (2 strands) [tph]</td>
<td>&gt;110</td>
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<tr>
<td>CCM radius [m]</td>
<td>9-10</td>
</tr>
<tr>
<td>CCM speed [m/min]</td>
<td>5-6</td>
</tr>
<tr>
<td>Metallurgical length [m]</td>
<td>33 - 50</td>
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<tr>
<td>Induction furnace [MW]</td>
<td>4.0</td>
</tr>
<tr>
<td>RM total length [m]</td>
<td>220-260</td>
</tr>
<tr>
<td>No. of stands</td>
<td>18-21</td>
</tr>
<tr>
<td>RM installed power [MW]</td>
<td>5 - 7.5</td>
</tr>
<tr>
<td>RM finishing speed [m/s]</td>
<td>12 - 20</td>
</tr>
</tbody>
</table>

**Diagram:**
- sq 150 - 160 mm
- 6.0 m/min

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Reduce the final product cost
In a product-cost-based market
By minimizing CAPEX and OPEX
Through high-level technological solutions
- high speed caster
- high efficiency induction furnace
- high efficiency rolling mill
- technological and mechatronic packages
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