Thin Slab Casting & Rolling technology for hot rolled coil production - Danieli's innovative concepts and experiences

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Thin Slab Casting Rolling: the beginning

First generation of Thin Slab Caster & Rolling

Reduced investment and transformation cost
Target: commercial products segment

Drawbacks of applied technology in “first generation plants”
- Limitation in product mix & steel grades
  - Limitation in production
  - Commercial quality
Considering present market status trends, a flat products minimill conceived to target commercial quality market, with limited productivity (below 1.5 / 1.6mtpy), as given by “first generation technology”, is not economically sustainable.
Thin Slab Casting Rolling: the evolution

Added Value
Production

Productivity

First Generation Technology Plants
Danieli minimill concept: the new generation of minimill for flat products

- Increasing in production level
- Extended product mix
- “Conventional mill style” coil quality
- High value production
- Ultra thin gauges production
The Danielli flexibility concept

1984 first pilot caster plant based on Danielli original technology

- Productivity: increased output to reduce transformation costs
- New steel grades: AHSS, HSLA, Peritectic, Silicon Steels and API grades (including ARCTIC applications)
- New markets: top quality pipe applications and, as goal, automotive exposed
Productivity chart

Yearly Production per Casting Strand

- 1989: 0.8 Mtpy
- 1995: 0.8 Mtpy
- 2000: 1.0 Mtpy
- 2005: 1.5 Mtpy
- 2010: 2.0 Mtpy
Steel grade mix chart

- Commercial grades
- Peritectic grades
- HSLA
- API grades
- Si steel
- Arctic API grades
- AHSS
Thin Slab Casting Rolling: the ultimate goal

**Danieli minimill concept**
the new generation of minimill for flat products.

Close the “vicious gap” between conventional route and TSCR process in production and quality, keeping intact the “virtuous gap” in competitiveness concerning:
- Unbeatable CAPEX (20% advantage) and OPEX (15% advantage)
- Reduced environmental impact and carbon dioxide footprint
State-of-the-art
Tangshan Iron & Steel plant, TISCO (China) has been the first plant in the world able to produce in excess of 3.0mtpy of coils adopting thin slab casting and rolling process.
The evolution
With the new Danieli applications of Ultra High Speed casting consolidated in POSCO it is possible to exceed a plant productivity of 4.0mtpy.
Flexibile minimill for quality

Essar Algoma (Canada)
The first plant in the world to produce peritectic steel grades adopting thin slab casting and rolling process. Danieli Thin Slab Casting process is the only technology that ensures the cast of these steel grades.
“The 12” square by 0.250” was the flatest product we have ever seen. There was significant reduction in our scrap rate and less set up time in our mill. As for the scale, if the product had been oiled, I would have believed that the material had been pickled.”

(Jim Clark, Director of Quality, Sonco Steel Tube Inc., Brampton, Ontario)
“The surface was marvelous, almost like cold rolled.”
(Sue Meagher, Maksteel Inc., Missisagua, Ontario)
Essar Algoma developed HSLA grades with HIGH strength

- DSPC 700B/770B is a superior HSLA light gauge grade with minimum yield strength exceeding 700 MPa, for several applications including automotive, weathering grades, drawing quality.

- Surface quality of these steel grades produced in DSPC are reported to be higher than experienced in conventional Essar Algoma mill.
Flexibile minimill for Quality

Benxi Iron & Steel plant (P.R. China)

- Pioneering silicon steel production in China using Thin Slab Casting technology
- Several Si grades have been successfully cast at over 4 m/min with a Si content up to 3.2%
Flexibile minimill for Quality

Benxi experience: customer reports
Flexibile plant for outstanding performance

OMK plant (Russia)
the first thin slab casting and rolling plant in the world specifically conceived for the production of top quality pipe grades (including arctic applications)
More than 20 steel grades for pipe steel are already in production.

### Steel group | Steel grades
---|---
HSLA MC | 13G1SU, 17G1SU, 20KSX, 22GU, 22GU-1, 22GU-2, 22GU-E, 22GF
MC | ST20, St3sp, S235JR-3, A36, S235JR-1
HSLA LC | K52, K56, K60
PERITECTIC | 09G2S, 09GSF
LC | St08ps, S235JR-2, SAE1006, St1SP
Flexibile minimill for minimized environmental impact

The energetic efficiency embodied in the thin slab casting and rolling process reduces the overall energy consumption and related carbon dioxide footprint to less than 35% compared to conventional process.
“Investment oriented” key design factors:
• Definition of slab thickness
• Definition of mill layout and process
• Modular solutions for future upgrades
Danieli concept: flexibile minimill

Danieli developed a comprehensive portfolio of layouts and technological solutions to get the best transformation cost fitting with:
- Production level according to market request
- Product mix (steel grades and coil dimensions)
- Possible future expansion
ftSC defining features

• Danielli **Vertical Curved** caster design vs. vertical design

• Danielli **High Speed High Quality (H²) Long funnel Mould** vs. conventional funnel mould

• Danielli **Dynamic Soft Reduction** with mathematical model vs. static soft reduction

• Danielli **Air Mist** secondary cooling vs. water only secondary cooling

• Danielli **Independent Machine Cooling** vs. no dedicated machine cooling
<table>
<thead>
<tr>
<th>Specification</th>
<th>Range or Value</th>
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<tbody>
<tr>
<td>Slab thickness</td>
<td>50/70/80 mm</td>
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<td>Slab min max width</td>
<td>800-1600 mm</td>
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<tr>
<td>Strip min max width</td>
<td>800-1600 mm</td>
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<tr>
<td>Max coil sp. weight</td>
<td>20 kg/mm</td>
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<tr>
<td>Coil nominal ID-OD</td>
<td>762-2000 mm</td>
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<tr>
<td>Max coil weight</td>
<td>30 t</td>
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**TSR Technological Layout**

TSR for 1.6/2.0 Mtpy of Hot Rolled Coils with 1 strand caster
fTSR for 1.6/2.0 Mtpy of Hot Rolled Coils with 1 strand caster

<table>
<thead>
<tr>
<th>Slab thickness</th>
<th>50/70/80 mm</th>
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<tbody>
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<td>Max slab length</td>
<td>48 m</td>
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<td>Max slab weight</td>
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<table>
<thead>
<tr>
<th>Strip min max thickness</th>
<th>(0.8) 1.0 - 20 mm</th>
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<tbody>
<tr>
<td>Strip min max width</td>
<td>800-1600 mm</td>
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<tr>
<td>Max coil sp. weight</td>
<td>20 kg/mm</td>
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<tr>
<td>Oil nominal ID-OD</td>
<td>762-2000 mm</td>
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<tr>
<td>Max coil weight</td>
<td>30 t</td>
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TISCO plant (P.R. China)
QSP 90 technological layout

QSP 90 for 1.8/2.2 Mtpy of Hot Rolled Coils with 1 strand caster

<table>
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<th>Value</th>
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<td>Max slab length</td>
<td>30 m</td>
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<tr>
<td>Max slab weight</td>
<td>30 t</td>
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<tr>
<td>Strip min max thickness</td>
<td>1.0 - 20 mm</td>
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<tr>
<td>Strip min max width</td>
<td>800-1600 mm</td>
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<tr>
<td>Max coil sp. weight</td>
<td>20 kg/mm</td>
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<td>Max coil weight</td>
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OMK plant (Russia)
QSP 70 technological layout

QSP 70 for 1.6/2.0 Mtpy of Hot Rolled Coils with 1 strand caster

<table>
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<th>Specification</th>
<th>Details</th>
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<td>Max slab weight</td>
<td>30 t</td>
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<tr>
<td>Strip min max thickness</td>
<td>1.0 - 20 mm</td>
</tr>
<tr>
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<tr>
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<tr>
<td>Coil nominal ID-OD</td>
<td>762-2000 mm</td>
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<tr>
<td>Max coil weight</td>
<td>30 t</td>
</tr>
</tbody>
</table>

Diagram showing the technological layout of QSP 70 for Hot Rolled Coils.
ETR technological layout

ETR for 2,2/2,6 Mtpy of Hot Rolled Coils with 1 strand caster

- Slab thickness: 80 mm
- Slab min max width: 800-1600 mm
- Max slab length: NA
- Max slab weight: 30 t
- Strip min max thickness: (0.8) 1.0 - 20 mm
- Strip min max width: 800-1600 mm
- Max coil sp. weight: 20 kg/mm
- Coil nominal ID-OD: 762-2000 mm
- Max coil weight: 30 t
POSCO plant (Korea)

• The fastest caster in the world: over 7 m/min in steady state operation
• The most productive minimill in the world: 1.8 Mtpy with one casting strand only and 1.3 m max coil width
POSCO plant (Korea)

• The fastest caster in the world: **over 7 m/min** in steady state operation
• The most productive minimill in the world: **1.8 Mtpy** with one casting strand only
  and **1.3 m** max coil width
Conclusions

Productivity
Conclusions

Quality
Conclusions

Modular process and layout solutions, market oriented
Outlook

To suit the specific requirements of the customers, Danieli Minimills have the following flexible solutions for hot rolled coil production:

- **TSR** (Thin Slab Rolling) – coil to coil/semi-continuous rolling

- **fTSR** (flexible Thin Slab Rolling) - coil to coil/semi-continuous rolling

- **QSP** (Quality Strip Production) - coil to coil

- **ETR** (Extra Thin Rolling) - coil to coil/endless rolling

Thanks for your kind attention