High-class continuous annealing and hot-dip galvanizing lines for a growing market

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Growing market

Steel consumption in India will increase enormously

- Consumption per capita in India only 10% compared to China
- Estimations forecast an increase of India’s steel consumption by 14% compared to a global increase of 5% (Source: FAZ, 01.02.2011)

Steel consumption per capita (in kg/capita)

Total production of crude steel (in mio. t)

Source: Worldsteel Association, Steel Statistical Yearbook 2010
High-strength steels are required for modern small and light vehicles

### Use of high-strength steel grades in compact cars

![Car diagram showing use of high-strength steels](image)

### Percentage of steel grades in the overall weight of a vehicle

<table>
<thead>
<tr>
<th>Year</th>
<th>Steel Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>Ultra-high strength steels</td>
<td>94%</td>
</tr>
<tr>
<td>1990</td>
<td>Ultra-high strength steels</td>
<td>90%</td>
</tr>
<tr>
<td>2000</td>
<td>Ultra-high strength steels</td>
<td>74%</td>
</tr>
<tr>
<td>2005</td>
<td>Ultra-high strength steels</td>
<td>50%</td>
</tr>
</tbody>
</table>

- **Punto 176**
- **Punto 188**
- **Punto 199**

<table>
<thead>
<tr>
<th>Year</th>
<th>Low-carbon steels</th>
<th>High-strength steels</th>
<th>Ultra-high strength steels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>6%</td>
<td>33%</td>
<td>94%</td>
</tr>
<tr>
<td>1990</td>
<td>10%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>2000</td>
<td>22%</td>
<td>74%</td>
<td>74%</td>
</tr>
<tr>
<td>2005</td>
<td>17%</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

- **6%** Ultra-high strength steels
- **33%** High-strength steels
- **94%** Low-carbon steels

Rising demand of high strength steel
High-class processing lines for a growing market

Different line types for galvanizing and annealing

- Continuous Annealing Lines
- CombinedAnnealing or Galvanizing Lines
- Hot-dip Galvanizing Lines
- Hot-strip Continuous Galvanizing Lines (Heat-to-Coat)
Galvanized and Annealed steel strip

Important process steps for manufacturing high-quality steel strip

Cleaning
Annealing
Galvanizing
Post-treatment

Comprehensive production know-how
New developments & optimized concepts

Cleaning
- Cleaning section
- DFI Oxyfuel

Annealing
- Ultra Fast Cooling
- Water-Quench

Galvanizing
- Air-knife
- Strip Stabilization

Post Treatment
- Nickel-Flash
- Roll-Coater

Comprehensive production know-how
Efficient cleaning section vertical spray and electrolytic cleaning cells, horizontal brush cleaning and cascade rinsing

- Simple roll change possible during production
- Energy saved through low evaporation losses
- Heated by exhaust gas of furnace section
Installation of a REBOX® DFI oxyfuel system in a continuous annealing line

Process
- Gaseous fuel is burnt with pure oxygen
- To preheat the strip, the flame is directed specifically at the steel strip.
- DFI = Direct Flame Impingement

Advantages when used in processing lines
- Extremely efficient heat transfer
  → Reduction in furnace length
  → Increase in furnace output for modernization projects
- Residual oils and solid particles are removed from the strip
  → Simplification of the pre-cleaning

SMS Siemag and the Linde Group have signed a cooperation agreement on the exclusive marketing of the process developed by Linde.
Effects on the design of a continuous annealing line

- Thanks to REBOX® DFI, a strip processing line can be set up much more economically.
- Lower investment and operating costs
  - In the furnace, the preheating zone and a part of the heating zone can be replaced.
  - In the cleaning zone, certain sections can be removed (electrolytic cleaning, brushes).
- Nitrogen oxide emissions are reduced through combustion with pure oxygen.
- The production capacity can be increased by 30% if the plant is modernized.
Producing high-strength steel grades with high cooling rates

- Production of high-strength steel grades up to 980 MPa (TRIP & DP)
- Cooling rates of up to 130 K/s/mm are attained
- Direct supply of hydrogen into the cooling chamber enables a hydrogen content of 20 to 30% in the cooling area without increased hydrogen consumption
- Natural diffusion of hydrogen in the adjoining furnace sections
  - No complicated separation between cooling zone and neighboring zones
  - No additional hydrogen consumption compared to the traditional operation with 5% hydrogen in the shielding gas (forming gas)
The only possibility of producing ultra-high strength steel grades in an annealing line

- Cooling rates of up to 1,000 K/s/mm possible
- Required for martensitic steel grades with yield strengths of more than 1000 MPa
- Manufacturing of ultra-high strength steel grades with yield strengths of up to 1550 MPa

Modern nozzle design

- Slot-nozzle configuration with uniform cooling capacity over the strip width
  - No strip distortions
  - Prevention of flatness deviations
- Anticrimping rolls upstream of the nozzle chamber for strip shape monitoring
After slow cooling there are two options available:

- Ultra Fast Cooling system with cooling rates of up to 130 K/mm/s
- Water-quench system for cooling rates of up to 1,000 K/mm/s with following flash pickling
Optimizations of the FOEN Air-knife system

- Laser controlled air knife parallelism to strip
- Variable nozzle gap width adjustment
- Touch less edge coating control device
- Model based coating weight controller
- Each air-knife can be upgraded with latest features
Electromagnetic strip stabilizer “DEMCO” for reduction of over coating

Zinc savings due to reduction of strip vibration and strip shape control

More uniform coatings due to improving of strip shape at air-knife → result in more uniform coatings

The outer pairs of magnets are positioned at the strip edge, the inner pairs are adjusted to the problematic zones, while the center pair is fixed to the strip centre
Roll-Coater technology for passivation

Extreme precisely and reliable coating thickness

- Separate circulation systems for different coating types
- Shuttle coater system for quick product change
- Motor system holds both rolls in an optimal position for even coating – a controlled electric drive unit ensures the rolls turn in unison
- High efficiency and eco-friendliness, no waste water, no vapor
Production Know-how

Customer benefit of comprehensive operation and process know-how

- Correct layout of the line according to requirements of European, Japanese, Korean or Chinese steel composition philosophy
- Entering the market for highly profitable steel grades
- Fast start up leads to earlier cash flow → saves time and money for own developments
- Advanced steel grades ease saleability of commodity grades by selling packages
Know-how package

Steel treatment process
• Basic production parameters
• Process description
• Technical consulting
• Energy management
• Environmental protection

Operation of equipment
• Start-up and process optimization
• Operational assistance and technical support
• Classroom training of customer personnel
• Management training
• Practical training at SMS cooperation partners site
• On-the-job training of customer personnel

Quality control
• Plant descriptions
• Process parameters
• Failure management
• Process requirements
• Quality control/ assurance
• Maintenance requirements
• Job description
• Sample selection and management