Modernization of a 2-stand temper mill
at U.S. Steel Košice s.r.o., Slovakian Republic

Based on ABB IndustrialIT for Cold Rolling Mills, ABB has supplied a complete solution for the modernization of the two-stand rolling mill at U.S. Steel in Košice.

The ABB scope of supply included the operator concept, pre-studies and simulations, engineering and commissioning. The complete delivery comprised a process control and optimization system, including the technological control and adaptive model for the DCR mode, the manufacturing execution system as well as the main drive system with ABB AC technology, instrumentation and power supply.

Significant improvements were achieved through the modernization of the rolling mill: A remarkable increase in production capacity thanks to lower rate of downgrades was achieved through the optimized operation. The use of the DCR concept with two rolling modes led to higher production flexibility. The use of preset models enabled the production of various end products with optimum quality – also in smaller lots. A better, constant material quality was achieved through the IndustrialIT strip thickness and tempering technology used.

- Tolerance of thickness control < 1%
- Tolerance of elongation control < 0.1%
- Flatness control, better than 10 l units
U.S. Steel Košice

U.S. Steel Košice is one of the largest European manufacturers of flat products from hot as well as cold rolling processes. The two-stand cold rolling mill was mainly used for wet tempering. Rolling was done at constant roll force using a mill set-up based on operator experience. There was no complete automation system available and what did exist was made up from various systems. The objective of the modernization of this plant was more flexible production, the production of various materials, constant and better product quality and higher productivity. The result of this was the conversion of the plant to a DCR (Double Cold Reduction) rolling mill, for which ABB was awarded the electrical equipment. High-quality strip material is now made in the new plant for the automotive industry as well as for can-making material.

ABB IndustrialIT for U.S. Steel Košice

The ABB IndustrialIT solutions for Cold Rolling Mills cover all the needs of rolling mills, from auto adaptive mathematical models for the optimum set-up of the DCR rolling mill with the different operating modes up to real time process and drives control. These solutions have been successfully used at U.S. Steel.

Solutions pre-study

The mill performance was analyzed by the use of advanced simulation models, in order to optimize the mechanical and electrical components, to define the best control strategy and to calculate the preset values and parameters for the mill.

Systems configurations

An integrated automation system was used for the control, sequencing, drive control as well as technology with a close link to the manufacturing execution system (material tracking, quality data management, roll pass scheduling and reporting) and take place within the same controller family. The automation platform fulfills the highest performance requirements such as high speed communication with the drives and integration of the technological control.
Technological controls and preset mathematical models

The solution package for Double Cold Reduction (DCR) Mills consists of the technological control for a combination of thickness and elongation control and an adaptive preset model to determine the setpoints of the rolling mill for the two operating modes. Operating mode A permits a reduction in the first stand and a finishing operation in the second. Operating mode B permits a double finishing operation in both stands. During shifting between these two operating modes the models and the technological controls automatically adapt themselves to the new operation mode. This package, with its simple operation, provides the customer with more flexible production options in just one plant, whilst maintaining the optimum tolerances.

The use of mathematical models for the preset calculation permits accurate specification of the setpoints for the rolling mill on the basis of the current process conditions and the properties of the incoming material. The calculations are based on models, which take into account the varying physical conditions of the operating modes during reduction or elongation, so that the highest level of accuracy is achieved for the setpoints of the mill. Feedback of the measured values during operation adapts the model to the short-term (changes in material types) or long-term changes (process changes).

The integration of the technological concept into ABB’s well proven and robust control system, permits in particular the relationships between strip thickness, tension, rolling speed and flatness to be taken into consideration.

Advanced drives control

ABB drives control is based on the patented Direct Torque Control (DTC) concept, providing dynamic performance in terms of torque and speed accuracy. The superior performance of the drives has a direct impact on the process performance, since the drives are one of the main actuators for strip tension and strip speed. The fast reaction on torque variation allows a better accuracy in the strip tension control of the tension reel as well as between the stands.

The high torque accuracy and dynamics of the drives used in combination with mass flow control leads to extremely fast correction times of process disturbances and hence to exceptional thickness quality.

The tight integration of the control functions, as well as the ABB automation concept assures the following properties:

- Close process tolerances for all types of production
- Constant quality
- Increased mill productivity, thanks to higher rolling speed and faster acceleration and deceleration.

Plant data

<table>
<thead>
<tr>
<th>Materials</th>
<th>Steel, tin plates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>420,000 t/a</td>
</tr>
<tr>
<td>Strip width</td>
<td>700 – 1020 mm</td>
</tr>
<tr>
<td>Coil weight</td>
<td>max. 15 t</td>
</tr>
<tr>
<td>Coil diameter</td>
<td>900 – 1,800 mm</td>
</tr>
<tr>
<td>Entry thickness</td>
<td>0.15 – 1.00 mm</td>
</tr>
<tr>
<td>Exit thickness</td>
<td>0.14 – 0.35 mm</td>
</tr>
<tr>
<td>Rolling speed</td>
<td>max. 2,200 m/min</td>
</tr>
<tr>
<td>Tempering degree</td>
<td>5 %</td>
</tr>
<tr>
<td>Max. reduction</td>
<td>35 %</td>
</tr>
<tr>
<td>Start up</td>
<td>01 / 2001</td>
</tr>
</tbody>
</table>
ABB Scope of performance

For U.S. Steel in Košice, ABB has designed and delivered the following equipment, supervised the erection and carried out the commissioning work:

Power systems
- AC motors and MultiDrives-frequency converters for all main drives such as uncoilers, tension reels, S-bridles and mill stand drives 1 and 2
- AC motors and MCCs for auxiliary drives
- Main control pulpit and local operator panels
- Uninterruptible power supply (UPS)
  for automation system and process computer

Automation systems
Total integration of control functions in the ABB IndustrialIT Control System with:
- Plant control, basic automation
- Mill drive control for coilers, S-bridles and stand 1 and 2
- Speed reference generation and monitoring
- Technological control for stands 1 and 2:
  - Roll gap and roll bending
  - Thickness and elongation control
  - Tension control
  - Flatness control
- Process control computer with:
  - Production order management
  - Setpoint generation
  - Material tracking
  - Adaptive rolling model
  - Quality data management
- Instrumentation:
  - Thickness control based on 2 thickness measuring devices
  - Mass flow control based on 2 laser-type velocity measuring instruments
  - Tensiometer devices
- Remote I/O units, connected via Fieldbus
- Uniform design of process operator stations

Data of the AC main drives:

<table>
<thead>
<tr>
<th>Uncoiler and tension reel (each)</th>
<th>1 x 950 kW, 1 x 950 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>425 / 1220 rpm</td>
</tr>
<tr>
<td>Entry and exit bridle pairs</td>
<td>1 x 700 kW, 1 x 450 kW</td>
</tr>
<tr>
<td>(top and bottom bridle roll, each)</td>
<td>775 / 1500 rpm</td>
</tr>
<tr>
<td>Mill stand No. 1:</td>
<td>2 x 950 kW, 2 x 950 kW,</td>
</tr>
<tr>
<td>(for each upper and lower working roll)</td>
<td>775 / 1500 rpm</td>
</tr>
<tr>
<td>Mill stand No. 2:</td>
<td>1 x 950 kW, 1 x 950 kW,</td>
</tr>
<tr>
<td>(each upper and lower working roll)</td>
<td>775 / 1500 rpm</td>
</tr>
</tbody>
</table>