Modernization at the state-of-the-art

As part of the modernization of a 4-Stand Tandem Cold Rolling Mill of Arcelor Eisenhüttenstadt GmbH, ABB replaced the drive and automation equipment as well as the process control computer for production management and presetting.

In addition to new technological controls for roll gap, bending systems, thickness, tension and flatness, the rolling mill received a new basic automation for the open- and closed-loop control of the main drives.

The objectives of the modernization were to obtain an improvement in the productivity and product quality as well as an increase in the availability of the electrical equipment.

The revamping took place step-by-step from the end of 2005 to the beginning of 2006. The commissioning time could be considerably shortened by means of a hardware-in-the-loop simulation in real time.

ABB had already carried out a partial modernization in the rolling mill in 1995/96, when the existing DC drives were modified and the mill equipped with a system for automatic thickness control.

As a result of the new developments of ABB in the field of automation, technological controls as well as modeling and presetting, the customer has got an optimized technical overall solution. The basic requirement of the customer, uniformity of the control system, was guaranteed by using ABB’s latest automation platform, which implements all the functionalities of the complete plant by only one type of controller device.

The off-gauge length could be reduced by approx. 60% and the strip quality significantly increased as a result of the modernization measures.
Arcelor Eisenhüttenstadt GmbH

Arcelor Eisenhüttenstadt GmbH is a member of the Arcelor Mittal group, the world's largest steel producer with approx. 3 million tons of hot-rolled strip and flat steel per year.

Plant data
Material: Steel
Capacity: approx. 1.4 mio t/a
Strip width max.: 1650 mm
Coil weight max.: 34 t
Coil diameter max.: 2200 mm
Entry thickness: 1.5 - 6.0 mm
Exit thickness: 0.4 - 3.0 mm
Rolling speed: max. 1200 m/min
Strip tension entry: 120 kN
Strip tension exit: 120 kN
Start up: 01/2006

The latest automation technology - AC800PEC controller as the core

The new automation technology is based on the 800xA concept and, in addition to the peripheral units, I/O and communication modules, includes a total of five high-tech controllers of the type AC800PEC.

This controller is used for all applications for cold rolling mills - the technological controls, the drive controls, the plant control functions and the auxiliaries. A client/server system with eight operator terminals was installed for visualization and plant operation.

Technological controls

The following technologies are used for the Quarto-Tandem Mill:
- Thickness control based on mass flow and speed/tension feed forward control
- Roll gap control
- Roll eccentricity compensation
- Direct tension control and coil eccentricity compensation
- Flatness control (skewing, bending, partial cooling)

Mathematical process models and simulation

An ABB in-house non-linear mathematical model was used for the pre-commissioning of the rolling mill. This consists of modular structures for 1- to n-stand rolling mills.

The model was used to simulate the plant in respect of the normal rolling mill practice, for the strip threading and tailing-out as well as the dynamic program change (DPC) for the technological functions such as reference generation, drives, roll gap positioning and thickness and tension control.

Ghost Rolling with the AC800PEC controller

The software integration test was performed as a hardware-in-the-loop simulation, i.e. by using the original process controllers with the associated application software, and tested versus a highly dynamic process model.

Ghost rolling enables the optimization and test run of the controller-application software as well as access to internal process signals.

By means of the dynamic simulation, a wide range of tests can be performed without the need for the actual rolling process and therefore without running the risk of damaging the plant in any way. Commissioning can be considerably shortened as a result. Plant operators can realistically familiarize themselves with the equipment and control action of the new plant before modernization.
Production management

The following functions were implemented by the process computer with four operator terminals:

- Order management
- Material tracking
- Quality data management
- Strip defect tracking
- Roll management
- Product and production reports
- Model-based pass scheduling and set-point calculation

The pass scheduling and set-point calculation for all rolling phases will be initiated automatically on the basis of the latest coil, roll and adaptation data as well as the operator trimming values and a product dependent rolling specification.

Adaptive models for roll force, torque, forward slip, roll and strip temperature, thermal crown, mill stand module, roll bending and wear are used to predict the expected process behavior in all phases of rolling. More than 300 set-points and control parameters are preset by the model for each coil.

Modernization of the drive system

The modernization of the main drives included the replacement of the excitation converter system while maintaining the motor-generator sets with a high-speed optical fiber connection to the new centralized process control equipment.

For the drives of the coilers, the existing technology was replaced by a new motor-generator controller for the tension reel, and a completely new drive converter for the uncoiler. All the drive products for field excitation and armature circuits are based on the compact ABB DCS600 Multidrive series.

Each stand of the 4-Stand Tandem Mill is driven by two respective four DC motors. The DC drives are supplied via two motor-generator sets, each consisting of a 19.5 MW synchronous motor and four generators. Each generator supplies the armature circuits of two or three main motors. The load is balanced via the field supply.

Results

The following features are provided by the integration of all closed-loop controls and the ABB automation concept:

- The tightest tolerances for all products
- Reproducible qualities
- Minimal off-gauge length
- Higher productivity thanks to a higher rolling speed and improved availability
**ABB scope of supply**

ABB designed and delivered the following equipment and was responsible for project management, engineering, training, erection and commissioning:

**Power systems**
- Digital excitation converters for the motor-generator sets of the stand drives and the tension reels
- DCS600 Multidrive for the flatness measuring roll and the uncoiler

**Data of the main drives**
- Mill stand 1 2 x 2800 kW (140/240 min⁻¹)
- Mill stand 2 4 x 2800 kW (235/400 min⁻¹)
- Mill stand 3 4 x 2800 kW (300/500 min⁻¹)
- Mill stand 4 4 x 2800 kW (385/600 min⁻¹)
- Uncoiler 2 x 400 kW (300/1100 min⁻¹)
- Tension reel 3 x 1000 kW (210/800 min⁻¹)

**Automation system**
Total integration of the automation functions in the ABB 800xA control system based on AC800PEC controllers.
- Drive control
- Pilot control
- Technological controls
- Uniform for human-system-interface
- Interfaces to the existing PLC e.g. for auxiliaries

**Technological controls**
- Thickness control
- Direct tension control
- Roll gap control
- Flatness control
- Coil eccentricity compensation
- Roll eccentricity compensation

**Process control computer**
- Order management
- Material tracking
- Quality data management
- Product and production reports
- Roll management
- Set-point management
- Adaptive rolling model for pass scheduling and set-point calculation

**Instrumentation**
- X-ray thickness gauges
- Laser-based velocity measuring instruments
- Tensiometer devices
- Flatness measuring roll