EXTRACTS
FROM VARIOUS NEWSLETTERS

MODERNIZATION
OF HOT STRIP MILLS

Solution to meet market demands
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SMS Siemag is the right partner for modernizations of hot rolling mills. This has been proven by numerous references during the last few years, some of them are shown in this magazine.

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ArcelorMittal Dunkirk chose SMS Demag to supply new main gear units for the roughing stands of its hot strip mill. The modernization aims to expand the product spectrum and cut the maintenance cost of the mill. Based on a study worked out by SMS Demag on the drives of the roughing mill, ArcelorMittal decided to replace the motors and the main gear units of the roughing stands R2 to R5 and contracted us to do the job. By 2011, all main gear units will be replaced by new SMS Demag drives. The gears weigh between 65 and 125 t and supply fatigue-resistant drive torques of 3.1 to 5.7 MNm. Revamping will start in mid-2010 with the drive of stand R5. The conversion jobs for R2/R3 and R4 will each follow one year later.

**OVER 30 YEARS OF SERVICE**

The hot strip mill of ArcelorMittal's Dunkirk operations went on stream in the 1960s. It operates three-quarter continuously; stands R2 to R5 of the roughing mill are non-reversing stands. Maintenance of the drive trains, which have been replaced repeatedly, requires a large effort.

**EXAMINATION OF ROUGHING MILL**

Since the company is additionally planning to expand the proportion of high-strength materials in its product spectrum, it was doubtful whether the drive units would be able to withstand the higher loads involved. To answer this question, we investigated in detail all...
operating conditions in ArcelorMittal’s roughing mill over a period of almost one year.

**EXTENSIVE STUDY**
The study included exhaustive pass-schedule calculations for the current and future product spectrum. This provided accurate information on the force and torque requirements for which the previously used drives trains had not been rated. Another part of the study comprised simulation calculations on the dynamic behavior of the whole drive train, extending from the motor via the couplings and gear units to the spindles and work rolls. These calculations yielded information about the proportion of shock loads and were incorporated in the subsequent rating of the load-bearing capacity of the new gear units and coupling components.

Further considerations detailed in our study confirmed the commercial basic concept employed so far for the roughing mill as compared to other concept options.

ArcelorMittal Dunkirk, France

New gear unit installed in rougher R5

On September 1, 2010, we concluded the installation of a new gear unit for the roughing stand R5 of ArcelorMittal’s Dunkirk hot strip mill. This modernization measure ensures the operational reliability of the drive train, prepares the mill for a future extension and reduces mill maintenance.

The rougher R5 is the last of four non-reversing stands in the five-stand roughing mill of ArcelorMittal’s hot strip mill in Dunkirk, France. After many years of service, the old gear unit of the stand required an immense amount of maintenance and no longer met today’s high load requirements.

**REPLACEMENT OF THE COMPLETE DRIVE TRAIN.** In July and August 2010, we replaced the complete drive train of this stand, including motor and gear. Owing to the extensive foundation work required for the new motor, the revamping work took a total of 36 days, half of which were part of the annual mill shutdown. In the remaining days, the hot strip mill was operated without roughing stand R5.

**HIGHER OUTPUT TORQUE.** The new single-stage gear unit of R5 is able to permanently transmit a significantly higher output torque than the old gear. It was completely manufactured, assembled and aligned in our Hilchenbach shops and has a total weight of 90 t. The large wheel alone with the coupling weighs over 50 t and has a diameter of 3.8 m.

**COMPLETELY ANALYZED.** Prior to modernization, we carried out an extensive study to analyze all mechanical and electrical drive components of the roughing mill. Based on the future product mix and the associated pass schedules, we determined the required powers and torques, and dimensioned all components accordingly. In addition, we ran simulations to investigate into and optimize the dynamic behavior of the drive trains.
Responding to an order received from ArcelorMittal, SMS Siemag will further modernize the drive equipment in the customer’s works in Dunkirk, France. The order comprises the supply of new reduction gear units and couplings for stands F2 to F5. Taking into account the previously placed orders for stands R2 to R5 and for the finishing stand F1, the complete hot strip mill is now provided with new main gear units by SMS Siemag.

**GRADUAL MODERNIZATION.** The revamp will be carried through step by step in the next few years. As early as August 2012, SMS Siemag will install the main gear units for stands R2 and R3. The gear for F1 will follow in December 2012 and the revamp of R4 and F2 in August 2013. The modernization will be completed in 2014 by installing the main gear units for stands F4 and F5. The conversion measures had been started in 2010 with a new reduction gear unit for stand R5. The ex-
cellent cooperation between Arcelor-Mittal and SMS Siemag under this contract was a reason why the orders for further modernizations were awarded to SMS Siemag as well.

**STUDY SERVED AS BASIS.**
The basis of all modernization activities was a study by SMS Siemag on the present and future product mix of ArcelorMittal’s plant in Dunkirk. Pass schedule calculations with exact power and torque specifications showed that the drive trains would have to be strengthened to meet future requirements. Additionally, simulations of the dynamic behavior of the entire drive train from the motor to the work rolls provided valuable information on the dynamic share of loads and were incorporated into the design of the new components.

**GEAR UNIT MANUFACTURE IN THE SMS WORKSHOP.**
The new order once again demonstrates the expertise of SMS Siemag in the sector of drive engineering. All gear units will be manufactured in the company’s own workshop in Hilchenbach. The large wheel of the main gear unit for R3, which has a diameter of almost 4,500 millimeters, a width of 1,300 millimeters and a weight of 40 tons, is the largest case-hardened wheel SMS Siemag has ever made in its workshop. The main gear unit of F1 will be of single-stage design with intermediate wheel. All gear units will completely be pre-assembled by SMS Siemag in its workshop and, with preset contact pattern, be delivered to the customer’s Dunkirk works.

**40 TONS OF HIGH-TECH**

Largest case-hardened wheel

From September 2011 until August 2012, a workpiece of a size that even the SMS Siemag workshop had never seen before passed the manufacturing process in Hilchenbach.

The large wheel for stand R3 in the hot strip mill of ArcelorMittal, Dunkirk, with a diameter of nearly 4,500 millimeters, a width of 1,300 millimeters, and a weight of 40 tons, is the largest case-hardened wheel in the long history of SMS Siemag so far.

Scan the QR code with your smartphone or watch the video at www.sms-siemag.com/qr/duengear
Each individual step of manufacture reflects the special expertise of SMS Siemag in the field of drive technology.

The total duration of the project from order placement by ArcelorMittal to delivery was about twelve months. The procurement of the forged and ring-rolled rim raw material alone took about half a year.

To ensure the high quality of the raw material, SMS Siemag cooperates with especially certified subcontractors that satisfy highest demands in respect of the manufacturing process and material qualities.

All further manufacturing steps of the large-size wheel – welding, turning, milling, gear cutting, grinding, and pre-assembly – were carried out in the Hilchenbach workshop. The wheel only left the workshop for hardening in Europe’s largest gas carburizing plant.

Further steps of manufacture included case-hardening of the tooth flanks as well as precision-machining by means of a profile grinding machine.

In September 2012 at last, it was put on stream in ArcelorMittal’s works in Dunkirk.
Adjustment of the eccentric is calculated in advance and the pattern tested by means of contact color.

During the case-hardening process, the tooth flanks are carburized at more than 900 degrees Celsius.

For presetting the contact pattern, the gear unit is pre-assembled and the wheel set including eccentrics adjusted in the optimum position.

Precision machining on a modern profile grinding machine. The final geometry achieves accuracies to the micrometer.

After a throughput time of just one year, the wheel is transported to its destination, the works of ArcelorMittal in Dunkirk, France.
ArcelorMittal has awarded SMS Siemag (www.sms-siemag.com) the order to upgrade the seven-stand hot-wide-strip mill in Gent, Belgium. The order comprises the installation of new finishing stands F1 and F2 as well as modifications to stands F3 and F4. Additionally, the SMS group will support ArcelorMittal in optimizing the rolling process for its third-generation UHSS and AHSS grades.

By this upgrading project, ArcelorMittal is making its Gent hot strip mill fit for future market requirements. With the new equipment, modern actuators and higher rolling forces, ArcelorMittal intends to further improve the quality of its products and expand the portfolio, especially of high-strength and multi-phase grades.

This project continues the close partnership between ArcelorMittal Gent and SMS Siemag. Between 2012 and 2014, SMS Siemag already upgraded the drive trains of finishing stands F1 through F3. That project included the installation of more powerful main and pinion gears as well as SIEFLEX®-HT high-performance spindles. SMS Siemag also supplied a new profile, contour and flatness control system [PCFC] for the mill.

The installation work for this most recent project will take place in two steps during two short mill shutdowns. The modernization concept developed by SMS Siemag will minimize the impact on the running production and the need to adapt the existing equipment. During the first phase, which is scheduled for the end of 2015, stands F3 and F4 will receive new hydraulic screwdown systems, new oil film bearings and additional components that will provide for an increase in rolling forces.
The main project phase in December 2016 will see the installation of the new rolling stands F1 and F2, which will be equipped with high-capacity actuating systems with hydraulic screwdown systems and CVC® plus technology with work-roll shifting and bending. The first stands will feature high rolling forces and torques enabling them to achieve high reduction rates also when rolling high-strength grades. As part of the modernization, the entire finishing mill will receive new loopers.

In order to ensure minimal shutdown times and a fast ramp-up, the two new rolling stands will be pre-assembled and tested in the SMS Siemag workshop in Hilchenbach. On-site erection in Gent will then take place during running production alongside the rolling mill. During the subsequent mill shutdown, the existing stands F1 and F2 will be disassembled and the new, pre-assembled stands will be shifted into the finishing mill in place of the old ones.

The project will involve the installation of new finishing stands F1 and F2, modifications to stands F3 and F4, and new loopers (shown in red).
SALZGITTER HOT STRIP MILL: MAJOR REVAMPING MEASURE COMPLETED

As-rolled width up from 1,880 to 2,000 mm

Built in 1963, but incorporating cutting-edge technology thanks to constant modernization: The hot strip mill of Salzgitter Flachstahl, Germany.
In June 2010, we revamped three areas of Salzgitter Flachstahl’s hot strip mill at the same time: We completed the modernization of the finishing mill, installed the main gear unit of F1 and started up the new coil transport system. In total, we installed more than 650 t of new equipment during the 12-day shutdown.

**INSTALLATION OF THE MAIN GEAR UNIT ON F1**
As part of the revamp, Salzgitter’s finishing mill will receive a completely new drive system. Following renewal of the drive train of F3 in December 2009, we installed the new 150-t main gear unit of finishing stand F1 in June 2010. Until mid-2011, we will additionally supply the two speed reducers for F2 and F4 as well as new intermediate couplings for F5 to F7. After the revamp, Salzgitter Flachstahl’s finishing mill will be one of the most powerful worldwide.
REVAMPING OF THE FINISHING STANDS

One goal of this modernization job was to increase the width of the finished strip from 1,880 to 2,000 mm. To this end, we made the opening gaps of the finishing stands wider and renewed all equipment in the interstand area. For stands F2 to F5, these measures had already been carried out in previous revamping stages, and so we used the recent phase to modernize stands F1, F6 and F7. Moreover, F1 was equipped with our CVC® plus system so that all of the stands now use this modern adjusting element or actuator for profile, contour and flatness control.
Revamping began during ongoing production with the dismantling of the tilting chair at coiler No. 1.

After modernization, a coil car carries the coils from all three coilers to the walking-beam conveyor system.

On September 9, 2010, the first 2,000-mm-wide strip was rolled.

COIL HANDLING SYSTEM

During the mill stoppage in June 2010, our subsidiary SMS Logistiksysteme connected the new coil handling system to coilers Nos. 1 and 2. Now a system comprising coil cars, walking beams and a transport chain conveys the coils with their axes in horizontal position, substantially replacing the previous chain-type conveyor system. Starting with coiler No. 3, the new coil handling system had been installed and operated in parallel with the old system for a few months. This ensured that the new system was perfectly functional by the time it took over the entire coil transport function. Following shutdown of the old transport system, SMS Logistiksysteme installed a new inspection line in the place of the old chain-type conveyor.
An innovative device pushes protruding strip wraps back into the ideal contour.

The very part of the old plate-type chain conveyor, which leads to the existing material store, was maintained. A new tilting chair transfers the coils from the walking-beam to the chain-type conveyor.

The new equipment was installed in large pre-assembled units.

The new walking-beam conveyor transports the coils with their eyes in horizontal position, partly underpassing tracks and roads.

Inspection line with roller table and strip turner.
Following revamping of the coilers and the coil handling system, all key components of Salzgitter Flachstahl’s hot strip mill use automation equipment made by SMS Siemag.

**ELECTRICAL AND AUTOMATION EQUIPMENT**

On the E&A side, the revamping concept included several measures to safeguard mill availability and full productivity after commissioning of the new equipment. For instance: during start-up of the automation system of coilers Nos. 1 and 2, switchover was possible between the old and the new system. The control systems of the finishing mill were pre-tested up to the hydraulic blocks. The pre-assembled elements of the coil handling system were cabled and tested prior to the standstill; so all that had to be done during revamping was to install them in the desired location, and to connect them. The result: smooth re-start.
CONVERSION IN RECORD TIME
It took a stoppage time of just 18 days for SMS Siemag AG to install new plant components in the roughing and finishing trains as well as a new automation system, until the hot strip rolling mill at Salzgitter Flachstahl GmbH in Salzgitter, Germany, resumed production at 23.00 hrs. on May 19, 2003.

This meant the first finished strip was rolled twelve hours before the agreed deadline. Following the third strip, regular production got underway again, and after the first week some 80% of normal production was achieved – well ahead of target.

Never before has such an extensive hot strip mill revamp been completed with such a short shutdown time. What made it possible was complete pre-assembly of the largest single component – a heavy roughing stand with edger (the world’s most powerful) – right next to the rolling mill during ongoing production. Included here were functional testing and a spectacular installation procedure that finally saw the 850 t giant pushed into the rolling line.

INTEGRAL MODERNIZATION CONCEPT
The smallest possible production loss due to plant stoppage along with our technical expertise as a system supplier were the vital factors in our favor when Salzgitter AG issued its modernization orders in the year 2000. The full package entailed a slab sizing press, a roughing stand with edger as well as bending and shifting systems for the F2 to F5 finishing stands with CVC plus technology. Operating as a system supplier, SMS Siemag supplied an integral concept that covered not only the mechanical equipment but also the entire automation for the hot strip mill.

INSTALLATION AND COMMISSIONING IN STAGES
Commissioning the equipment and systems took place in two stages. First, in September 2001, we installed and started up the slab sizing press. Then the other facilities followed in May 2003.

HIGHER OUTPUT CAPACITY, BETTER PRODUCTS
This extensive modernization of its hot strip mill dating from the 1960’s gives Salzgitter AG the means to substantially improve the product quality especially of its high-
strength strip grades as well as to increase cost-effectiveness and productivity. Furthermore, the sizing press increases the utilization factors of the steelworks and the continuous casting plant.

GROUNDBREAKING AUTOMATION CONCEPT
Here is a list of the automation functions for Level 1 and 2 supplied and successfully put into operation for the plant areas slab sizing press, roller tables, descaler in the roughing and finishing trains, reversing roughing stand with edger and 7-stand finishing train.

PROCESS CONTROL COMPUTER WITH PROCESS MODELS
- Pass schedule calculation for roughing stand with edger and finishing train with material model and a newly developed grain model
- Profile, contour and flatness model with CVC plus
- Rolling sequence control for production optimization
- Integrated width control for slab/finished strip

SEQUENCE CONTROLS FOR ALL PLANT PARTS
- Material tracking system/speed guides
- Roll changing
- Control of cooling equipment and auxiliaries
- Extensive linking to existing components

TECHNOLOGICAL CONTROL SYSTEMS
- Roughing stand: horizontal and vertical adjustment as control elements of the thickness and width control
- Finishing train: adjustment, shifting, bending and loop control as well as speed guide as control elements for strip thickness, profile, flatness, temperature, strip running control

MEASURING DEVICES IN THE AREA OF THE ROUGHING STAND
- Laser speed measurement, width measurement, temperature measurement and X-ray material detector

The technological control systems and sequence controls were implemented on the proven ProBAS platform.

Added to this was a switch-over concept we developed for the automation upgrade of the roughing and finishing lines that made it possible to change over from the existing to the new automation in a very short time. Parallel switching of all signals to the new automation system enabled us to carry out intensive testing in “eavesdropping” mode.

We performed initial functional testing of the new plant parts such as sizing press and roughing stand in our Hilchenbach workshop, jointly testing the mechanics, hydraulics and automation systems. Moreover, we set up the new roughing stand on site during ongoing operation and carried out a full functional test. Then we inserted it into the rolling line and applied a special cabling concept that provided for full connection to the rolling mill plus signal testing within 48 hours.

What the new automation system means for Salzgitter Flachstahl GmbH is a stable platform and stabilization of the production process especially for rolling sophisticated and new products.

Slab sizing press.

Gerhard Kusche
Gerhard.Kusche@sms-siemag.com
Modernization | Benxi Iron & Steel, China, boosted the cooling performance of its laminar cooling system by installing the SMS Siemag-made super-reinforced cooling units. This step will enable the Chinese steelmaker to enhance its product portfolio especially in the field of tube and pipe steels.

In the course of this modernization, SMS Siemag replaced the first five of a total of 20 cooling groups by super-reinforced cooling units which can apply an almost three times higher specific water volume as compared to the remaining groups. At low investment costs, Benxi Iron & Steel is now able to attain, in particular for tube or pipe steels, the high cooling rates that are needed to set the desired metallurgical structure with corresponding properties on the basis of economic alloying concepts.

The new cooling system can be controlled in a very flexible way since each individual cooling header within any one group can be separately switched on or off. This enables Benxi to vary the cooling rates within a wide range and to employ super-reinforced cooling for steels without particular demands, too. Furthermore, water volume distribution to top and bottom headers was adjusted to attain good strip flatness even in the case of very high cooling rates. With an annual capacity of more than five million tons, the hot strip mill supplied to Benxi by SMS Siemag in 2008 is a real high-performance plant and designed for carbon as well as stainless steel grades.
In the summer and fall of 2010, we carried out two important revamping steps in the hot strip mill 2000 of the Lipetsk Metallurgical Combine (NLMK). The four forward finishing stands were equipped with hydraulic adjusting systems, and F2 received a new mill pinion gear and new Sieflex® gear-type drive self-aligning spindles.

The finishing mill is modernized in several steps with the main goal of improving the tolerances of the hot strip. This will make it possible for the Russian company to expand its position as a supplier to the automotive industry.

We are using the current modernization phase to install hydraulic adjusting systems on stands F1 to F4 as well as CVC® plus systems on stands F2, F6 and F7. The finishing train was partly modernized already in the 1990s so that, after completion of the ongoing revamping work, all of the finishing stands will incorporate hydraulic adjusting systems and work-roll bending systems and, with the exception of F1, CVC® plus.

The ongoing modernization phase is divided into three steps. In the first step in June 2010, we equipped stands F1 to F4 with the new hydraulic adjusting systems to enable quick and precise roll-gap setting and correction. It took merely seven days to mount the systems and to connect them to the previously installed new hydraulic station. The new equipment performed flawlessly right from production start, and was instantaneously accepted by the customer.

Next, in October 2010, we carried out the second revamping step which comprised the installation of a new mill pinion gear and new Sieflex® gear-type self-aligning spindles on finishing stand F2. Also during this revamping stoppage we did the required milling work on stands F2, F6 and F7 for accommodation of the CVC® plus shifting systems which we will install in the third revamping step in October 2011.

In the future, the new hydraulic station will feed the complete finishing mill with hydraulic oil.
Coilers are pre-assembled in the manufacturing shop of SMS.

Shougang Iron & Steel, China

First coil

The objective of the revamp was to extend the range of products of Shougang Iron & Steel in the field of high-strength and pipe steel grades. After the modification of the No. 3 coiler, pipe grades of the strength category X100 with a thickness of up to 22 millimeters can be coiled today.

“We are very satisfied with the new UNI plus-coiler performance and the wider production range will help us to strengthen our market position in China,” says the project manager in charge at Jingtang, Wang Wenzhong.

Ralf Setzer
ralf.setzer@sms-group.com
Chinese steelmaker Taiyuan Iron & Steel has placed an order with SMS Siemag for the supply of a UNI plus coiler which was specially designed to wind strip of high-strength tube grades at low strip temperatures. The new coiler of Taiyuan Iron & Steel will be one of the most powerful in China.

The compact hot strip mill made by SMS Siemag went on stream in Taiyuan in the Chinese province of Shanxi in June 2006. Taiyuan Iron & Steel uses the mill to produce strip of carbon steels and a wide spectrum of stainless steel grades. In the future, the company wants to focus on the growing market for high-strength steels. To ensure reliable coiling of these materials, Taiyuan Iron & Steel commissioned us to extend the mill by installing a UNI plus coiler. The new equipment is scheduled to start up in November 2011.

**TUBE STEELS AT LOW STRIP TEMPERATURES**

Based on the results of extensive investigations, the UNI plus coiler was specially developed to coil extra-thick strip of high-strength materials. The coiler for Taiyuan will be extremely strong and powerful to be able to coil strip of tube grades up to the X100 strength class at strip temperatures of around 400 °C. In addition, it will be able to handle direct-hardened strip up to a thickness of 10 mm.

The fully hydraulic UNI plus coiler is of 3-roller design and comes with our Automatic Step Control system to ensure material-friendly and equipment-protecting coiling of the initial windings. For reliable removal and processing of the coils it is equipped with an enhanced coil car and an optimized coil strapping machine.

Mill extension by a third coiler had already been planned in the first construction stage. The new coiler of Taiyuan Iron & Steel will be the twelfth UNI plus coiler worldwide.
HOT STRIP MILLS

Specially developed for coiling high-strength, thick tube grades: the UNI plus coiler.

Designed for an annual production of 4.0 million t: the compact hot strip mill of Taiyuan Iron & Steel.
TAIYUAN, CHINA: LAMINAR COOLING SYSTEM WITH STRONGER COOLING GROUPS

NEW ORDER | New on our books is an order from Taiyuan Iron & Steel Company, China, covering the supply of a laminar cooling system for the compact hot strip mill which went on stream in August 2006 and likewise came from SMS Siemag. The cooling line will be equipped with more-intensive cooling groups enabling steep cooling curves and different cooling strategies and, hence, an expansion of the product spectrum.

In the future, Taiyuan Iron & Steel wants to concentrate more on the production of hot strip of high-strength steels and, for this purpose, had already contracted us in 2010 to supply a new UNI plus coiler for winding these strips. Revamping of the cooling line will take place in H1 2012.

Higher cooling capacity. Over its full length, the new cooling line will be fitted with higher-capacity cooling groups to achieve an increased water flow. Only the trimming zones at the end of the line will remain unchanged. The new cooling groups will make it possible for Taiyuan Iron & Steel to apply larger amounts of water to the strip to thereby achieve higher cooling rates as required, for example, for the production of high-strength grades or DP steels (Dual Phase).

Precise setting of cooling rates. The new cooling system will permit to operate and control each cooling-pipe row separately. This will give our customer great flexibility in implementing an array of different cooling strategies.
HIGH-STRENGTH STEELS THROUGH REINFORCED COILER

Tata Steel IJmuiden

Due to the reinforcement of coiler No. 3, Tata Steel is now able to roll strips of higher strengths in its works in IJmuiden, Netherlands.

The modernization of the coiler by SMS Siemag covered the installation of new and stronger gear units for the pinch roll set and the coiler mandrel drive, new hydraulic valve stands, and the reinforcement of the existing coiler drive. A new hydraulically controlled chute roll supports the coiling of high-strength steel grades. “Thanks to the reinforcement of the coiler, Tata Steel is now able to coil higher-strength strips of greater thicknesses,” says Project Manager Ulrich Cramer. These include, for instance, direct-quenched (DQ) grades having yield strengths of up to 650 megapascals (referred to coiling temperature) and a thickness of up to 16 millimeters.

All existing coiler mandrels will be reinforced in the workshop of SMS Siemag until the end of 2013.

Modern oil film bearings for Tata Steel.

Since the installation of hot rolling mill 2 in 1968, there has been strong cooperation between Tata Steel Europe, domiciled in IJmuiden, the Netherlands, and SMS. Service experts from SMS examined the more than 45-year-old bearing systems with the objective of making sure the bearings operate without trouble and of reducing operating expenses. Since 2012, the bearings have been revamped with the modifications including changes to the design of the bearing seals, the bearing and neck bushes as well as the axial positioning elements. In addition, the backup roll chocks were repaired in the Hilchenbach workshops. These measures were supported by training courses held by SMS experts. The result: Oil losses reduced by 70 percent, water penetration to a specified volume and bearing damage minimized considerably.
MODERNIZATION
SMS Siemag revamped the finishing mill and the cooling line in the Bochum works, Germany, of Thyssen Krupp Steel Europe (TKSE). This step enables TKSE to attain closer hot strip tolerances and, due to amended cooling strategies and higher cooling rates, to keep on broadening its product portfolio.

The hot strip mill in Bochum was put on stream in 1966 and focuses, within the group, on the production of stainless and special steel grades, among other things. In the last few years, SMS Siemag has equipped the plant with a new edger and a new flying crop shear. Following completion of the modernization of the finishing mill and the strip cooling line in mid-2012, TKSE has been able to improve the strip quality in respect of thickness, profile, and flatness, and to enhance its range of products thanks to the new cooling line.

Revamp of the finishing mill. Stands F1 to F4 of the finishing mill were fitted with new hydraulic adjusting systems; the maximum rolling force was raised to 45 MN. To absorb the increased rolling forces, the stands were equipped with new Morgoil® bearings of the KLX® series.

While the new hydraulic adjusting systems serve to set the strip thickness more precisely, the installation of CVC® plus systems and stronger work-roll bending systems in stands F3 to F5 permits TKSE to attain closer strip contour, profile, and flatness tolerances. These stands were furthermore fitted with Sieflex® gear-type self-aligning spindles which, due to their internal continuous circulating oil lubrication, are easy to maintain and feature a long life cycle. In the course of the conversion, SMS Siemag additionally replaced the interstand equipment and modernized the roll changing devices.

Changeover operation of the automation system for rapid ramp-up. On the electrics and automation side, SMS Siemag supplied a new level-2 automation system for the finishing mill including profile and flatness model. The new automation system was initially operated parallel to the existing system. Thanks to the option of running the system in the shadow.
mode and of changing between the old and new systems, it was possible to test and ensure full functional performance of the new automation system. During this phase, the operating personnel had the opportunity of becoming familiar with the new system under production conditions. The SMS Siemag specialists instructed the TKSE operators in parallel training courses and provided assistance as part of production support at the plant. The positive effect of this concept was apparent after the revamp. The plant could be ramped up to its nominal capacity within a very short time.

To implement the complex modifications in the stands within the shortest possible time, SMS Siemag carried out comprehensive pre-assembly work in its Hilchenbach workshops, comprising CVC® shifting systems, work-roll bending systems, entry and exit guides, lifting rails, loopers, and even the work rolls.

Cooling line modernized. SMS Siemag replaced the complete old spray cooling by a modern laminar cooling system with intensive cooling groups at its starting end. As the strip is applied with higher water volumes there, TKSE can achieve steep cooling ramps as are required for special grades. In the so-called trimming zone at the exit end of the strip cooling section, the coiling temperature can be set precisely. The optimum cooling strategy is preset by SMS Siemag’s new X-Pact® cooling model. It is based on the description of the decisive physical processes such as the thermal conductivity in strip thickness direction, heat transfer in air and water zones, and the forming behavior of the material during the cooling process, and it calculates the suitable cooling curve for each strip.

Following the order for the modernization of the Bochum hot-strip finishing mill, ThyssenKrupp Steel Europe recently contracted SMS Siemag to also renew the cooling facilities of this mill. So we will install a state-of-the-art laminar cooling line to replace the existing cooling equipment which comprises a combination of spray cooling system and laminar cooling headers. Installation of the new line will take place concurrently with the revamp of the finishing mill in March 2012.

At its starting end, the new cooling line is equipped with intensive cooling groups. By increasing the amount of water applied to the strip ThyssenKrupp Steel achieves steep cooling ramps there as required for special grades. To ensure precise setting of the coiling temperature, the cooling line has a so-called trimming zone in its exit section.

The new cooling line likewise will incorporate all of these features and functions, and will additionally make it possible for ThyssenKrupp Steel to implement cooling strategies that are needed for the production of a whole range of modern materials. The optimal cooling strategy in each case is preset by SMS Siemag’s X-Pact® cooling model which takes into account the decisive physical processes such as the thermal conductivity in strip thickness direction, the heat transfer in air and water zones as well as the transformation behavior of the material during the cooling process. Based on this data, the X-Pact® cooling model calculates the suitable cooling curve for each strip and presets it to the cooling equipment.
Since the summer of 2011, the hot strip mill of SSAB in the Swedish town of Borlänge, has been operating with a new laminar cooling system and a new water treatment plant supplied by SMS Siemag. By these measures, SSAB is able to expand its portfolio of high-strength and wear-resistant hot strip. The characteristic features of laminar cooling are high cooling rates, sensitive control, and a cooling model that is perfectly adapted to the products of SSAB.

Besides precise control of the cooling line, the production of high-strength and wear-resistant grades on a hot strip mill requires very high cooling rates. This is the reason why the Swedish company commissioned SMS Siemag with the modernization of its laminar cooling line and its water treatment plant. The old systems had not been designed to handle the great water volumes needed. Both orders covered the mechanical equipment as well as X-Pact® electrics and automation.

Cooling line for DQ grades. The production of Direct Quenched grades (DQ) up to a thickness of 10 mm on a hot strip mill involves new challenges to the design of the cooling system. The laminar cooling line of SSAB attains the high cooling rates needed for DQ grades by applying a clearly higher specific water volume as compared to conventional cooling. In order to implement the strategies for the production of standard steel grades, too, SSAB’s cooling system can be adjusted in a particularly sensitive way.

Six valves are available in each cooling group to control the water volume. In the first four groups, the water flow can be infinitely adapted by means of control valves. This permits very precise setting of the cooling rate. Fine tuning of the coiling temperature is done in the trimming zone at the end of the cooling section.
Cooling model determines appropriate water volume. To attain an exact coiling temperature, the SMS cooling model calculates the water volume to be applied in accordance with a given cooling strategy. The cooling model is based on physical-mathematic calculations that describe the structure as a function of the chemical composition at different temperatures, grain size, and cooling rates. Modifications incorporated in the model permit, in the first place, a more precise description of phase transformation.

Pre-assembly of complete cooling equipment. The new cooling equipment was installed in July and August 2011, within a mere three weeks. The complete laminar cooling system had previously been pre-assembled in an adjacent bay and was integrated into the hot strip line section by section during the conversion phase.

Production of Hardox on hot strip mill. At commissioning start, the strategies for standard steels as stored in the cooling model were examined and adapted to the new cooling line. Three weeks later, SSAB started to produce direct-quenched grades. When it came to Hardox 400 and 450 grades, the cooling line proved its efficiency. Both, the granted cooling rates and the desired mechanical properties of the strip had definitely been achieved. Although coiling temperature was clearly below 100 °C, no problems were incurred regarding flatness.

SSAB was satisfied. Irina Karlström, SSAB Area Sales Manager for South Eastern Europe says: “With this line, SSAB will have one of the broadest portfolios of wear-resistant and high-strength plates and sheets on the market. Our customers are already looking forward to the first deliveries this fall.”

Closed-circuit cooling system with heat exchangers. The water treatment plant has a capacity of 15,500 m³ per hour and went on stream in June 2011. The water coming from the cooling line flows into an entry basin via a scale flume. From this basin, it is pumped into a sedimentation basin for scale particles to settle there. Oils, greases, and other floating matter are removed there as well. Coarse particles are already retained at the front side of the entry basin by means of a rake which can be cleaned during ongoing production. Part of the water is then subjected to further purification in a sand filter system.

Water cooling in the plant of SSAB is achieved by heat exchangers. So, the water resource can be used in a closed circuit in a highly efficient way.

The purified and cooled water is then pumped into an elevated tank and can be re-used for strip cooling.

Modernization of hot strip mill continued. With the commissioning of the laminar cooling system, SMS Siemag has modernized the complete exit section of the hot strip mill in Borlänge. In the years 2006 and 2010, SMS Siemag had supplied two coilers for reeling high-strength strips. In 2010, SMS Logistiksysteme had also modified the complete coil transport line and installed a modern walking-beam system.

Börje Sundell, Technical Manager at SSAB, summarizes the benefits to the customers resulting from the modernization: “We will be able to produce products (for heavy vehicles) with better load capacity and higher wear resistance than with our previous cooling section. This will give the end user a lower overall cost and will have less impact on the environment.”

Helmut Metz
Helmut.Metz@sms-siemag.com
SSAB: REVAMPING FOR STRIP OF DIRECT-HARDENED STEELS IN FULL SWING

Totally new: From laminar cooling system to coil transport equipment

**BROADENING OF PRODUCT RANGE TO MEET CUSTOMER NEEDS**

In the second half of 2010, we started up a new coiler and a coil transport system in the hot strip mill of SSAB Tunnplåt in Borlänge, Sweden. This represented an important milestone in the modernization of the hot strip mill. The next steps in the months to come include the replacement of the laminar cooling line and the installation of a new water treatment plant. Once these measures are completed, SSAB will be able to expand its product spectrum even further.

**More strips of direct-hardened steels.** The primary goal SSAB is pursuing with the modernization of the hot strip mill from the laminar cooling system up to the coil handling equipment is to strengthen its performance and capability in the segment of strips made of direct-hardened steels. There is a huge demand for these materials mainly in the construction-machinery industry and in mechanical engineering because they feature great hardness and excellent wear resistance.

**Step-by-step renewal of coiler station.** For reliable and top-quality winding of direct-hardened hot strip, SSAB has renewed its coiler station in several steps over the past few years. The new coiler No. 5 and coiler No. 4 which we supplied in 2006 are designed to wind strips of high-strength
Coil transfer from the coil car to the walking-beam transport system.

The new inspection line.

steels up to a thickness of 12.7 mm. Strips of softer grades can be coiled up to a thickness of 25.4 mm.

The new coiler No. 5 went into operation on October 22, 2010. And shortly afterwards, SSAB could use the coiler to full capacity, winding strips of all the dimensions and grades produced on the hot strip mill.

Renewal of coil transport system finalized in August 2010. Before the new coiler was started up, SMS Logistiksysteme had already revamped the complete coil transport system in July and August 2010. The old system using a transport chain was removed for a modern walking-beam transport system to take its place. It allows SSAB to transport coils with their axis in horizontal position from the coilers to the storage area.

Alongside the new transport system, SMS Logistiksysteme installed an offline inspection station to allow SSAB to inspect strip sections up to 7 m length on both sides. The station can also be used to correct or “repair” defective strip ends.

Installation of water treatment plant underway. In January 2011, we began to install the new water treatment plant which will supply water to the new laminar strip cooling line. The key components of the WTP include a sedimentation basin, a sand filter system and a heat exchanger to cool the water coming from the rolling mill. The new water treatment plant will be put into service at the end of May 2011.

Mounting of cooling line in summer 2011. We will install the new laminar strip cooling line during the scheduled mill shutdown in summer 2011. Being the decisive metallurgical tool for the production of direct-hardened steel strips, the new cooling line will be equipped with more powerful cooling groups over its full length. In addition, it features high-precision control of the individual cooling groups. In the first four cooling groups, the water flow can be infinitely set or adapted with the aid of control valves so that a variety of different cooling strategies can be implemented.

The new cooling model with X-Pact® automation was extended specially for the production of direct-hardened materials. For each steel grade, it ascertains the transformed shares of ferrite, pearlite, bainite and martensite as a function of the cooling rate. This permits to determine the correct cooling strategy required to set the desired mixed structure.

Helmut Metz
Helmut.Metz@sms-siemag.com

The new coiler No. 5 was installed at back of coiler No. 4. This ensured safe installation during ongoing production.
"The information provided in this brochure contains a general description of the performance characteristics of the products concerned. The actual products may not always have these characteristics as described and, in particular, these may change as a result of further developments of the products. The provision of this information is not intended to have and will not have legal effect. An obligation to deliver products having particular characteristics shall only exist if expressly agreed in the terms of the contract."

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