papers from Primetals Technologies at the ESTAD Conference 2017 in Vienna covering the topics of long rolling, plate mills, linked casting and rolling, hot-strip rolling, pickling, cold rolling, strip processing and the associated automation and process-optimization systems.
ENDLESS PRODUCTION of high-quality, thin-gauge hot-rolled coils at Rizhao Steel, China
FORGING-LIKE ROLLING WITH HIGH REDUCTION OF SBQ LONG PRODUCTS

Paper number: 98
Principal author: Francesco Toschi

The special bar quality (SBQ) family comprises a wide range of steel grades that are mainly requested by the automotive, energy and engineering sectors. These steels are primarily used for demanding applications where significant performance is required related to high stresses, high temperatures and severe working conditions. To meet the performance demands, it is necessary to achieve precise control of both the mechanical properties and the metallurgical structure of the steel along the entire production route. For semi-products with large dimensions – equivalent to diameters of around 300 mm – the required control is traditionally obtained in a manufacturing route that comprises ingot casting followed by reheating, forging and rolling.

Since 2010, new processes have been investigated and technologies developed to replace the ingot route for the production of special steels with continuous rolling followed by controlled high-reduction rolling. In these processes, the seamless integration of continuous casting and rolling is implemented for the precise control of material flow, the applied deformation forces and rolling temperatures. By using the proper combination of roll diameter, speed and applied reduction forces, excellent control of the metallurgical structure across a complete section can be obtained with the additional benefit that internal material voids generated during continuous casting are eliminated.

These casting-rolling processes, which can be described as “forging-like,” are applicable to several steel grades cast with large semi-product dimensions (300 mm and higher). By dispensing with the ingot route, yield and productivity are increased, which is highly beneficial for the overall economy of a plant. An example of a forging-like process is shown by the high-reduction blooming stand installed by Primetals Technologies at the Camin mill of Acciaierie Venete S.p.A in the Italian province of Padova. This paper reviews the applied rolling concepts, the mill technology and the main process features.

THE PRODUCTION OF RAILWAY RAILS IN MODERN AND EFFICIENT PLANTS – THE NEW ARBZ RAIL MILL

Paper number: 103
Principal author: Francesco Toschi

A growing trend in the production of rails can be noted worldwide as a consequence of the market interest in high-speed and heavy-haul transport. Evidence for this is seen by the updating of the main international rail standards, or their re-issue, in China, Europe, India, Russia and the U.S.A. since 2010. In 2014, global rail production was approximately 12 million tons, of which 8 million tons were produced in plants commissioned after 2010. Head-hardened rails account for some 1.2 million tons, and this growth is expected to be in the double-digit range by 2025.

In order to ensure the required efficiency and flexibility for cost-effective rail production, modern rolling mills for rails and sections must operate at high quality and productivity levels. The latest generation of mill installations incorporate the most recent advances in processing, equipment and control. These mills are comprised of sophisticated mechatronic systems that can consistently replicate the manufacturing processes, and all operations are fully automated throughout the complete production route. This leads to a number of advantages in terms of product quality, productivity, flexibility and conservation of energy and materials.

This paper describes the main innovations introduced by Primetals Technologies for the production of rails, and presents, as an example, the Aktobe Rail and Section Works LLP (ARBZ) in Kazakhstan.
A mill modernization project was undertaken by Kroman Celik Sanayii A.S. in Turkey to improve product quality, consistency and shape of the coil package, as well as to reduce maintenance and production delays in the rod mill in order to increase utilization and productivity. The project, which was executed jointly with Primetals Technologies, included the installation of a new Morgan Intelligent Pinch Roll and High Speed Laying Head, modifications to the existing cooling conveyor, and replacement of the coil-reforming station. The new pinch roll and laying head were provided to ensure better control in forming the ring and consistency of the coil shape on the conveyor, while reducing delays on the conveyor. Changes to the cooling conveyor included the installation of new nozzle decks and an Optimesh air-distribution system in addition to the rearrangement of existing fans to improve both cooling rates and uniformity of cooling. This paper explains details and features of the newly-installed equipment. Resulting product and process improvements are presented, which include increased tensile strength and uniformity of product, reduction in delays on the conveyor and reform tub, and enhanced coil quality.
**ROLLING INTO THE FUTURE BY DIGITALIZATION**

**Paper number: 78**  
**Principal author: Paul Riches**

Today’s steel producers face the dual challenge of ensuring on-time delivery and ever-demanding product requirements while also running a lean operation. Daily management of a long products rolling facility requires continuous optimization of both operating and business practices.

Due to the evolution in technology (data collection, communication, Internet of things, control techniques and intelligent sensors), there is more information available today than at any time before. Using this information and monitoring the performance of a plant will revolutionize the control of rolling mills worldwide. This will lead to the optimization of the entire value chain along with advanced flexible production. New concepts are therefore being developed to improve the operational management of critical areas within a long-products rolling mill. Existing installed technology is being outfitted with smart sensors, such as non-contact measurement devices, vision systems, intelligent temperature measurement and RFID (radio frequency identification), for better product tracking. Such devices will provide real-time data to enable a higher level of automation to be achieved that will substantially improve product quality, rolling processes and flexibility, operating and maintenance costs, operational set up, operator intervention in the rolling process, and product storage and logistics.

This paper describes how the digitalization of information collection and distribution will lead to a revolution in long-product rolling mill control systems. The benefits of adding intelligent sensors are highlighted because they are critical to enhancing mill performance in all areas.

**NEW STRIP-TENSION CONTROL FOR BETTER THICKNESS PERFORMANCE AT FINISHING MILLS**

**Paper number: 79**  
**Principal author: Daniel Kotzian**

The stable and reliable rolling of thin strip in the finishing mill of linked casting and rolling processes such as Arvedi ESP (endless strip production) and Compact Strip Production (CSP), or in conventional hot-strip mills, has increased the requirements for precise mass-flow and thickness control. As an initial step to meet these demands, Primetals Technologies has developed a new control concept for rolling ultra-thin hot-rolled strip in the finishing mill of an ESP line. Referred to as “ultra-thin rolling control,” the system is essentially an adapted control concept that has been successfully applied many times in tandem cold mills. When rolling below a certain strip thickness, the control mode is switched from speed control to roll-gap control while the strip tension is kept constant.

In this solution approach, the looper measures the strip tension between the stands and the looper position remains constant. This type of switchable control is applied at each finishing mill stand. A flexible control approach allows a smooth strip transition between the mill stands. This type of mass-flow control was applied at the No. 3 Arvedi ESP line at Rizhao Steel in China. The required strip tension and thickness reductions are obtained in the endless rolling mode with the use of fast actuators and by compensating for periodic disturbances. Moreover, the control system is linked to the thickness monitor, which regulates the exit thickness at the finishing mill. As the next step, Primetals Technologies is developing an extension of ultra-thin rolling control to roll thin hot strip in a finishing mill of a CSP line and in a conventional hot-strip mill. The goal is to achieve improved strip thickness performance and operational stability.
BROADENING THE STEEL MARKETS BY DIRECT APPLICATION OF HIGH-QUALITY ESP STRIP

Paper number: 33
Principal author: Dr. Bernd Linzer

The steel feed stock for the final fabrication of flat steel products is mainly met by cold-rolled and final-annealed or galvanized strip. Depending on the required strip thickness and surface requirements, conventional batch-production processes account for a certain share of flat-steel production, however, without cold rolling this portion is quite limited. Arvedi ESP (endless strip production) technology, featuring the direct linking of a slab caster and hot-rolling mill in a continuous, uninterrupted production line, is providing new impulses for the flat-steel market. With this game-changing technology, it is now possible to produce hot-rolled feed stock for numerous applications that previously could not be directly met with the hot-rolling step alone. Thinner and at the same time wider steel strip can be produced in an Arvedi ESP line that is able to replace a large portion of previously cold-rolled steel strip. Joint development efforts by Rizhao Steel and Primetals Technologies at recently commissioned ESP lines in China are setting new standards to supply even more demanding products for high-end applications. The paper provides an overview of the products and results achieved with Arvedi ESP technology that allow cold-rolled strip to be directly substituted.

ARVEDI ESP: THE TECHNOLOGICAL CONTRIBUTION FOR PERFORMANCE OPTIMIZATION

Paper number: 34
Principal author: Andreas Jungbauer

For every final product there is a carbon footprint that is primarily determined by the raw materials used and the applied production route. The steel industry is seeking to minimize its carbon footprint not only because of environmental reasons, but also to reduce plant energy costs. Significant improvements have been achieved by optimizing each process step and also by linking individual manufacturing steps. Arvedi ESP technology decisively reduces energy consumption during hot rolling thanks to the advantages offered by a fully endless production process.

Furthermore, it is possible to gain even higher energy reductions through the direct utilization of hot-rolled strip – thereby dispensing with the need for cold rolling and annealing – or by an optimized combination of the rolling and annealing steps. This approach is leading to totally new production possibilities and concepts. This paper provides an overview of different process routes and their respective advantages in the production of final rolled products and their market applications.

Production of ultra-thin hot-rolled strip at low energy costs with Arvedi ESP technology (Rizhao Steel, China)
The current market is seeing an increased demand for value-added products that include high-strength plates. However, because of economic reasons, the use of high-cost alloys must be ideally kept to a minimum. Steel used for applications such as oil and gas pipelines, offshore structures and shipbuilding require good control of both mechanical properties and the final shape of the plates. The production of such plates is more economic with Mulpic (multi-purpose interrupted cooling) plate-cooling technology coupled with advanced process control. This paper describes the recent modernization project implemented at the plate line at China Steel’s Kaohsiung Works, Taiwan. The target was to increase the product mix and improve the quality of the final products. China Steel and Primetals Technology worked closely together to install the Mulpic system upstream of the existing laminar water-flow cooling section to enable higher cooling rates to be applied than is possible with direct-quench cooling technology. The modular design of Mulpic considerably shortened its installation time, and final acceptance was awarded with all guaranteed values met. An overview of this project is presented together with a description of the cooling system. The importance of the associated advanced model-based automation system is highlighted, including its sophisticated adaptation to the mill. Mulpic is designed to provide the high cooling rates and temperature-control precision needed to achieve the combination of high strength and toughness that is essential for plates destined for demanding downstream applications. The required plate-flatness accuracy is regulated by edge masking, crown valves and head and tail masking. The new valve technology from Primetals Technologies is also described, which allows water-flow rates to be precisely controlled in accordance with plate cooling requirements. Typical performance results are presented, which demonstrate the high degree of accuracy attained.
THE MOST UNIQUE HOT-STRIP MILL IN THE WORLD

Primetals Technologies received a contract from Allegheny Technologies Incorporated (ATI) to design, engineer and supply a new, fully integrated hot-rolling mill on a process-turn-key basis. The order also included the installation of a water-treatment plant. ATI had embarked on this strategic investment in order to shut down an old hot-rolling mill that had been operating since the 1950s, to enhance its production capabilities, to strengthen its leading position in the market, and to support future material developments. Primetals Technologies successfully executed this project thanks to the close interaction of different in-house engineering locations for mechanical equipment and fluids (Canonsburg, U.S.A. and Linz, Austria) and electrics and automation (Alpharetta, U.S.A. and Erlangen, Germany). The unique specialty metals hot-rolling and processing facility (HRPF) was jointly put into operation with ATI at Brackenridge, Pennsylvania, U.S.A. in 2014. The mill is capable of rolling a wide range of highly diversified carbon and stainless steels and specialty metals at widths up to 2,083 mm. The rolling forces are the highest ever to be supplied in a hot-strip mill. The HRPF facility is designed to produce an exceptional and highly diverse product mix that includes flat-rolled austenitic, ferritic and martensitic stainless steel alloys; grain-oriented electrical steel; titanium and titanium alloys; nickel-based, corrosion-resistant and high-temperature alloys; zirconium alloys and other specialty metals.

The rolled and processed products are used in the aerospace, automotive, defense, petroleum, chemical, construction, mining and power industries, as well in various medical, food-equipment, machine and cutting-tool applications. The rolling of special carbon steels, for example API pipe grades up to X100 and dual-phase steels, also lies within the overall capability of this remarkable mill.
DEVELOPMENT OF LOOPER SHAPE METER IN HOT ROLLING

Paper number: 106
Principal author: Naoto Migakida

Primetals Technologies has developed a contact-type in-line shape meter for hot-rolled strip, which is known as the Looper Shape Meter (LSM). It is now available for hot-strip mills where continuous in-line strip shape measurements have been long-awaited. The LSM consists of a roll divided into seven segments across the width of the mill. Low hysteresis is obtained by applying torque meters to each segment in combination with internal water cooling of the rolls. Excellent robustness of the LSM has been confirmed as shown by an LSM that has been successfully operating in a hot-strip mill for more than ten years. This paper describes the development details of the LSM.

MILL STABILIZING DEVICE FOR REDUCTION OF MILL VIBRATION IN HOT ROLLING

Paper number: 108
Principal author: Jiro Hasai

As the demand for harder and thinner hot-rolled strip has been increasing, so have the requirements placed on the finishing mill stands to achieve higher reductions, larger rolling forces and higher rolling speeds. With the increase in rolling forces, the impact forces during the threading of the strip front end also increase and mill vibrations can start to occur.

The Mill Stabilizing Device was developed by Primetals Technologies to counter these effects. The device consists of hydraulic cylinders equipped with damping orifices, which are installed between the roll chocks and entry side of the mill housing. These cylinders eliminate the clearances between the roll chocks and housing and provide a damping effect. The device can be installed in new facilities, as well as added to existing mill stands.

This paper presents Mill Stabilizing Device technology and the results achieved toward reducing mill vibration and impact forces in an actual production line.
A PIONEERING HOT-STRIP MILL SIDE-GUIDE SYSTEM THAT ELIMINATES STRIP SURFACE DEFECTS AND OFFERS A CONSIDERABLY EXTENDED SERVICE LIFE

Paper number: 122; Principal author: Friedrich Moser

In the field of downcoiler technology for hot-strip mills, Primetals Technologies has developed innovative products that eliminate mill-operator headaches by simplifying operational and maintenance work with a simultaneous reduction in operational and maintenance costs. Contrary to conventional wear plates where the passing strip always cuts into the plates along the same line, wear on Eco Slide Discs, developed by Primetals Technologies, is distributed across the entire disc surface. This avoids strip edge defects and extends the service life from a few days using conventional wear plates to several weeks without any service requirements. Another key feature of the Eco Slide Discs is their inherent self-cleaning effect, which reduces the risk of material deposits falling onto the strip, and thus eliminates an important cause of surface damage on hot-rolled strip.
The need for more effective and flexible roll-gap lubrication in hot- and cold-rolling mills is steadily increasing due to ever-greater requirements placed on the rolling process and the final products. This paper focuses on two innovative technologies for highly efficient roll-gap lubrication in rolling. For cold-rolling mills, a new generation of roll-gap lubrication technologies called MQL (Minimum Quantity Lubrication) was successfully installed and commissioned at the Tandem Cold Mill No. 1 of the Bruckhausen steelworks of ThyssenKrupp Steel Europe. MQL replaces the conventional roll-gap lubrication system using emulsion in stands 1 and 2 with minimum amounts of pure rolling oil that is finely atomized with pressurized air and directly aimed onto the work-roll surface. As a consequence of the improved lubrication efficiency, the rolling forces, motor torques and energy consumption can be reduced and the strip surface cleanliness significantly improved thanks to reduced strip wear in the first stands of the mill.

A solution concept for removing residual oil from the work-roll surfaces in hot-rolling mills is also presented in this paper. In a typical hot-rolling mill, work-roll lubrication in a specific finishing mill stand is switched on immediately after thread-in of the strip head and switched off before thread-out of the strip tail. This is to prevent insufficient friction during thread-in and contamination of the roll bite during tail-out. Due to the efficient cleaning procedure, a safe strip thread-in is assured that is independent of the lubrication conditions of the previously rolled strip.
HOT-FLAT-PRODUCT SURFACE INSPECTION – LATEST DEVELOPMENTS

Paper number: 117
Principal author: Laurent Dorel

Monitoring surface quality is generally implemented in the final steps of steel manufacturing before shipment to the end user. However, a growing trend is to address quality issues in the upstream stages, such as at the hot-rolling mill. This is being tackled by Primetals Technologies to offer steel producers the possibility to optimize yield management and benefit from “lessons-learned” processes.

Recent developments in the next-generation platform of the SIAS automatic surface-inspection system from Primetals Technologies now include high-resolution and near-infrared vision techniques. This paper discusses site results applying these techniques in highly specific applications and operational constraints such as in Arvedi ESP (endless strip production) lines and plate mills.

THE IBOX PICKLING TANK FOR PRODUCTION IMPROVEMENTS OF ADVANCED HIGH-STRENGTH STEELS – AN UPGRADING SOLUTION FOR DEEP-BATH PICKLING TANKS

Paper number: 114
Principal author: Takafumi Nakaya

The growing demand for advanced high-strength steels (AHSS) means that steel manufacturers are increasingly confronted with capacity bottlenecks of their pickling lines. Primetals Technologies has therefore developed the so-called iBox pickling tank to improve the throughput capacity of pickling plants. This highly advanced solution is particularly characterized by its reduced energy consumption and ease of maintenance.

Since the iBox pickling tank is equipped with storage tanks to drain the acid pickling solution to prevent over-pickling in the case of a line stoppage, a wider line width is necessary. To reduce the required space, a new and uniquely designed iBox pickling tank is offered by Primetals Technologies as a revamp solution for conventional deep-bath pickling tanks.

DEVELOPMENT OF A NEW MASH SEAM WELDER – THE CROSS SEAM WELDER – FOR CARBON STEEL PICKLING LINES

Paper number: 145
Principal author: Takafumi Nakaya

Primetals Technologies had developed a new mash seam welder known as the Cross Seam Welder (CSW). This solution offers the benefits of the mash seam welder, such as low cost and compactness, and it is ideally suited for the joining of strip with thicknesses up to 6.5 mm in continuous rolling mills.

The first and second orders for the CSW were received from JFE Steel Corporation in Japan where the CSWs were installed in a continuous pickling line. As part of revamping projects, the previous flash butt welders were replaced with CSWs. Additionally, a black-scale remover was also developed and installed for use in pickling lines to enable CSW welding after the surface scale has been removed in the vicinity of the weld. This is the first time in the world that this solution has been implemented.

LATEST PL-TCM TECHNOLOGIES FOR ADVANCED HIGH-STRENGTH STEEL APPLICATIONS

Paper number: 115
Principal author: Frank Beddings

Safety and environmental considerations have significantly increased the demand for advanced high-strength steels for automotive applications. Primetals Technologies has incorporated various advanced technologies in the latest supplied continuous pickling lines coupled with tandem cold mills (PL-TCM) to satisfy the increased process demands to produce these harder and thinner steels, achieve the faster rolling speeds required to meet today’s production targets, and provide cost-effective solutions in an extremely competitive market environment. This paper introduces several of these advanced technologies, including highly efficient iBox pickling technology with polypropylene tanks, the 6-high Universal Crown Control Mill (UCM Mill) for unmatched shape-control capability, the Hyper UCM Mill for stable rolling of ultra-high-strength steels, and the flying-width-change (FWC) side trimmer for continuous trimming operations. The advantages of these technologies to produce these difficult steel grades are discussed, as well as the implementation of these solutions in new installations or for the modernization of existing facilities to maintain high availability of the production equipment.
Tangshan Iron and Steel Group Co., Ltd. (Tangshan Steel) and Primetals Technologies achieved a remarkable project execution and fast implementation of Tangshan Steel’s new No. 2 Cold Rolling Mill Complex. The facility is dedicated to the production of high-value-added cold-rolled, annealed and coated coil products. The project scope was not only limited to equipment delivery and line start-up, but also included the commissioning and optimization of the cold rolling, annealing and the strip-galvanizing production steps to ensure that the required plant throughput and product quality fully meets the market demands. The key time-to-market milestone was successfully reached with the first produced coil within the targeted 21-month period following contract effectiveness. Ramp-up of the coupled pickling line and tandem cold mill as well as the continuous annealing line and continuous galvanizing line to commercial production was also accomplished on schedule. A so-called Through-Process Know-How (TPKH) package that extends from the up-stream to the finishing production stages was also supplied to support an optimized and reliable plant production and overall plant coordination. The know-how package additionally aids in the development of new advanced steel grades, in particular, advanced high-strength steels for use primarily in the automotive market. The combination of Tangshan Steel’s experience in steel manufacture with the expertise of Primetals Technologies in steelmaking equipment, process technologies and metallurgical know-how was decisive for the rapid product acceptance and certification on the Chinese market.
Demand for cold-rolled tin-plated and galvanized steel sheet products is rapidly increasing in Turkey as a consequence of the country’s economic expansion. A new cold-rolling complex built at Tosyali-Toyo Celik Anonim Şirketi in Turkey was recently put into operation in response to this trend. Primetals Technologies supplied a pickling line linked to a tandem cold mill (PL-TCM), a tinplate continuous annealing line (Tin-CAL) and a two-stand double-cold-reduction (DCR) temper mill for the rolling complex. This paper introduces the latest technologies installed in these facilities for the production of tin-plated steel sheet. Examples include highly efficient and energy-saving iBox pickling technology for the PL-TCM, the 6-high Universal Crown Control Mill (UCM Mill) for the PL-TCM, the temper DCR mill, and a vertical furnace equipped with tension leveler for the CAL to ensure high-speed and steady operations.

Completed 5-stand 6-high tandem cold mill in the cold-rolling complex of Tosyali Toyo Celik Anonim Şirketi, Turkey

The demand for harder and thinner steels, such as advanced high-strength steel (AHSS) sheet for the automotive industry, tin plate and electrical (silicon) steels, has accelerated rapidly in recent years. Particularly in the field of cold-rolling, new rolling techniques for the production of harder and thinner strip have become urgent requirements that must be dealt with. The Hyper Universal Crown Mill (Hyper UCM) was developed by Primetals Technologies to roll harder and thinner strip to a higher degree of accuracy and quality than previously possible. It features the use of smaller-diameter work rolls that are driven by special highly rigid spindles.

The Hyper UCM is the most advanced version of the 6-high Universal Crown Control Mill (UCM Mill), and it offers an optimal combination of work-roll diameters, intermediate roll diameters and back-up roll diameters to ensure advanced strip shape control and minimized Hertz stress between the rolls. Hyper UCM Mills have work rolls that are 20% to 40% smaller in diameter than in conventional UCM Mills.

Another technological highlight of the Hyper UCM Mill is the high-performance work-roll drive system that consists of a special gear reducer and unique spindles. To drive the smaller work roll, gear reducers and spindles are designed to maintain the required rigidity and stability for high component revolutions.

In this paper, the basic configuration, performance and references of the Hyper UCM Mill for tandem and reversing mills are presented.
Power X-Hi is a specially designed 18-high mill stand that offers considerable flexibility in fully continuous rolling operations and includes specific patents to allow for endless rolling.

DEVELOPMENT OF THE ADVANCED 20-HIGH SPLIT-HOUSING ZR-MILL FOR STAINLESS AND ELECTRICAL STEELS

Paper number: 121
Principal author: Hajime Higuchi

The Advanced 20-high Split-Housing ZR-Mill (HZ-Mill) was developed by Primetals Technologies for the heavy reduction of hard materials such as stainless steel and electrical steel during cold rolling. The mill is designed as a 20-high cluster mill with a split inner housing to replace the conventional mono-block 20-high Sendzimir rolling mill (ZRM). An improved ease of operation of the HZ-Mill is met thanks to an increased roll clearance between the work rolls during threading and an optimized construction that ensures the required equipment rigidity. The mill is additionally equipped with a fast-response hydraulic screw-down system and a double roll-bending (AS-U) mechanism, which further enhances strip thickness and shape control.

STAINLESS STEEL ENDLESS CONTINUOUS COLD ROLLING WITH POWER X-HI STAND TECHNOLOGY

Paper number: 127
Principal author: Sebastien Maillard

Pushing the horizon of cold-rolling mill performance for stainless steel to provide even greater strip quality while maintaining yield and productivity has reached a new milestone with the introduction of Power X-Hi technology by Primetals Technologies. The technology was first installed in a tandem mill at the direct-rolling annealing and pickling line (DRAPL) of Baosteel Desheng Stainless Steel Co., Ltd. and subsequently in a continuous tandem cold mill (CTCM) at Beihai Chengde Stainless Steel Co., Ltd. (both in China). Power X-Hi is a specially designed 18-high mill stand that offers considerable flexibility in fully continuous rolling operations and includes specific patents to allow for endless rolling. Among the various differentiating features of Power X-Hi technology, the specific design, position and control of the rolls are particularly decisive for providing the stability and precision required in order to extend the capabilities of continuous stainless steel mills.

The Beihai Chengde reference is a continuous 5-stand tandem mill that is equipped with mill-entry and mill-exit strip loopers to enable uninterrupted rolling. This significantly decreases out-of-tolerance strip thicknesses and thus increases total mill yield. An innovative solution allows fully automatic roll changes to be carried out while the strip is still traveling through the mill stand. This shortens production downtime by several minutes and also further reduces off-gauge material. When the roll gap is open during roll change, the thickness reduction for that stand is taken over by another active rolling stand. Work-roll changes are possible for stand speeds up to 120 m/min. Roll replacements during production can be carried out for all rolls with the exception of the back-up rolls. This type of operation is a world premiere and offers considerable improvement potential for the rolling of stainless steel and other high-strength steels.
Primetals Technologies has undertaken an important research & development effort in the field of laser welding. The latest step in this program is the further evolution of its laser-welding and -cutting range with the application of solid-state technology to generate the laser beam. A total of 12 welders equipped with this technology have since been manufactured by Primetals Technologies.

After more than six years of industrial feedback, the results demonstrate a high level of performance, reliability and constant cutting and welding quality. A diverse range of steel grades can be welded that extend from silicon steels to high-strength steels, including dual-phase (DP) and transformation-induced plasticity (TRIP) grades. Welding operations based on this technology are highly reliable; allow complete operator control; and ensure high welding quality, excellent weld-geometry control and perfect strip centering. Reduced maintenance is another customer benefit that results from the use of optic fibers, a solid-state laser source and the application of an improved preventive-maintenance system with integrated control monitoring.

Industrial results and the main benefits of this new laser system are discussed in this paper on the basis of recent installations at Chinese continuous processing lines.

**INDUSTRIAL RESULTS OBTAINED WITH THE NEW GENERATION OF LASER WELDERS**

**Paper number: 118; Principal author: Thomas Vallée**

Rolling and Processing Highlights of Primetals Technologies

**Long rolling**
- Up to 10% increased bar mill output with the ETB-EBROS billet-welding system and endless rolling
- Up to 60% savings in operational expenditures with the endless and semi-endless WinLink long product production line
- 300% higher wear resistance with IDRHA+ inline rail-hardening technology
- Up to 60% increased productivity with the Morgan rod reducing/sizing mill

**Flat-product rolling**
- More than 3,350 Morgoil bearings installed in some 1,200 hot-strip and cold-rolling mills worldwide
- 22 Mulpic (multi-purpose interrupted cooling) plate cooling systems installed since 2002 for extended product range, reduced alloying costs and improved plate weldability
- Up to 45% reduced energy consumption with Arvedi ESP endless strip production compared to conventional casting and rolling processes
- Nearly 160 Mill Stabilizing Devices (MSD) installed in the work and backup rolls of Pair Cross mill stands and other types of mill stands since 2000 for reduced impact forces, reduced amplitude of mill vibration and more stable rolling conditions
- More than ten years of operation of Looper Shape Meters (LSM) in hot-strip mills for the accurate measurement of strip shape under tension conditions during rolling
- 80 mm maximum work-roll opening clearance in the Advanced Split-HousingZR-Mill (HZ-Mill) for the production of high-quality stainless and silicon steels

**Strip processing**
- 65% market share of supplied coupled pickling lines and tandem cold mills worldwide
- Development of a new mash seam welder type known as Cross Seam Welder (CSW) for welding steel sheets with thicknesses of up to 6.5 mm for use in pickling lines, tandem cold-rolling mills and reversing mills
- 30% reduced work-roll diameters in 6-high Hyper Universal Crown Control Mills (Hyper UCM) for greater thickness reductions in cold-rolling mills

- 584 strip-processing lines supplied to date
- 25% reduction of heating losses and 30% reduction of pickling time with the iBox pickling tank compared to deep-bath pickling tank
- Zero cutting knives and no wear with the use of a combined laser cutting and welding system
- More than 450 skin-pass mills supplied to date
- 340 tension levelers installed in processing lines throughout the world
- 82 air knives supplied worldwide
- More than 130 SIAS strip surface inspection systems supplied to date
- 100 GB of data converted into meaningful information with the TCOptimizer process expert system for just-in-time warnings to ensure sustained and reliable performance in processing lines