

LATEST SOLUTIONS IN COLD ROLLING WHICH COUNT¹

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Abstract

Everywhere in the world, operators of cold rolling mills are interested in increased yields, better product quality and economic operation of the facility. Therefore they continuously optimize the process, adapt it to the requirements of new products and maintain the equipment. SMS Siemag as full line supplier supports steel producers through innovative technologies, well-proven equipment, up-to-date electrical and automation systems and through a wide range of related services. A new service approach by SMS Siemag is Concept Engineering. It has been developed to support steel producers during all phases of optimization of plant and production. The new service approach comprises technical assistance to introduce best operation and maintenance praxis, includes analysis of bottlenecks and modernization concepts. The close liaison with the customer over a longer period results in comprehensive understanding of the potentials of the facility on the customer's and on SMS Siemag's side. This allows elaborating solutions by considering targets and requirements of the customer in a unique way. The paper will discuss Concept Engineering in a more detailed way and will give an insight in the toolbox, illustrating recent developments and the modular approach to delicately structured solutions. Examples to be mentioned are advanced rolling assistance systems, X-Shape flatness measuring system, CVC® plus M18/4 multipurpose mill and the new high capacity spindle.

Keywords: Cold rolling mills; Concept engineering; Rolling assistance systems; High capacity spindle; Hydraulic gap control.

¹ *Technical contribution to the 50th Rolling Seminar – Processes, Rolled and Coated Products, November, 18th to 21st, 2013, Ouro Preto, MG, Brasil.*

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1 INTRODUCTION

In America as well as everywhere in the world, operators of cold rolling mills are interested in more economic operation of their facilities, which goes along with increased yield, better product quality, large product spectrum and higher plant availability. Therefore they continuously optimize the process, adapt it to the requirements of new products and maintain the equipment.

SMS Siemag as full line supplier supports steel producers through innovative technologies, well-proven equipment, up-to-date electrical and automation systems and through a wide range of related services, covering the whole life circle of the production plant. In times of high competitive pressure new service approaches have to be found, which are adoptable to the particular situation of the steel supplier in all the different phases of optimization of plant and production.

These new service approaches comprise technical assistance to introduce best operation and maintenance praxis, includes analysis of bottlenecks and elaboration of modernization concepts. The continuous cooperation with steel producers results in a comprehensive understanding of the potentials of the facility on both sides. Based on this, innovative solutions can be elaborated, considering targets and requirements of the customer in a unique way.

2 CONCEPT ENGINEERING – A SMART WAY TO CREATE SOLUTIONS THAT COUNT

The success in technical consulting is rooted in the knowledge of the technical condition of the rolling mill and the understanding of the customer demands and constraints. First step is the analysis of the current state and basic condition of the rolling mill. The results will be recorded in a study, including a number of recommendations for improvement of equipment and/or process. Among these very often there are little things to be altered, like e.g. in terms of material handling or routine procedures that lead to reasonable improvement or savings of operational costs.

Furthermore the study provides comprehensive solutions, meeting the vision and future related concepts of the operating company. The study contains detailed proposals for solutions and measures, classified by various criteria. That means the measures are labelled as to be realized in short-term or long-term or if they are of strategic importance. In combination with a tailored and intelligent modernization concept, the customer gets a maximum boost of yield by keeping expenses low at the same time.

Cold strip producers are interested in a better utilization of the potentials of their rolling mills. The primary purposes are manifold. Typical problems to be solved or purposes to be achieved by mill upgrade and revamp are:

- Strip quality has to be improved
- Product mix has to be enlarged
- Mechanical equipment has to be replaced
- Environmental requirements have to be complied with
- Discontinuously mill operation has to be optimized

Referring to these tasks, measures have to be defined according to the basic cold rolling topics, shown in Figure 1.

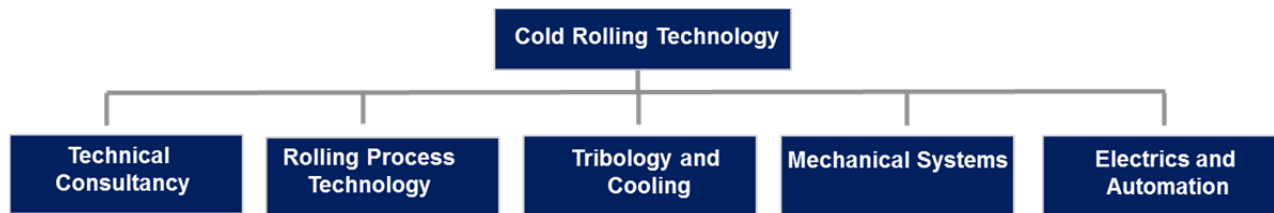


Figure 1: Basic cold rolling topics to be considered in the modernization concept.

The latest revamp project of SMS Siemag gives proof of this. In October 2012, Finnish steel producer Ruukki contracted SMS Siemag to revamp the tandem cold mill at the Haameelinna works. The four-stand tandem cold mill was erected in 1972 and is the “heart” of Ruukki’s cold strip production. A conceptual study by SMS Siemag was preceding the order. As a result, measures for a stepwise improvement of quality, yield and economic efficiency of the mill have been defined. In addition, Ruukki intends to enlarge the portion of high strength grades in the product mix. Based on this, a modernization concept consisting of several modules was elaborated in close cooperation with the customer.

The mill stands three and four will be equipped with a latest generation high-precision hydraulic gap control system. All quality determinant components will be manufactured and comprehensively tested in the workshops of SMS Siemag in Hilchenbach. For this reason an efficient assembly at Ruukki is ensured, so that the tandem mill will be able to start operations after one short downtime in summer 2013 again.

As shown by the way of example Ruukki, the paper puts a focus on short-time measures which count.

3 MEASURES FOR IMPROVEMENT OF STRIP QUALITY

3.1 Improvement of Flatness

The technological control function basically comprises fast control loops for the actuators and superordinate process. One part of these process control loops is flatness controls. Tailored to the mill and the product range to be rolled, the flatness control system by SMS Siemag controls all the actuators influencing flatness, like work and intermediate roll bending, CVC[®] plus shifting system, leveling and multi-zone cooling. An integral part of the level-1 technological control system within the X-Pact[®] electrics and automation package for cold rolling mills, supplied by SMS Siemag, is the X-Shape flatness measurement system.

The core component of the X-Shape flatness measurement system is the X-Shape flatness measuring roll which was newly designed by SMS Siemag. The X-Shape system cannot only be installed in new plants; it can also be retrofitted in existing facilities. Its outer appearance can hardly be distinguished from a conventional deflector roll, but it is the sophisticated technology inside that makes the difference.

The centerpiece of the X-Shape measurement system is a state-of-the-art, four-hole measuring roll based on the BFI Principle. Fitted in the axial boreholes of the roll body are tapered sleeves with Piezo sensors. This way, the roll surface remains closed, and the material flatness is measured without leaving any marks. The position of the sensors within the roll and the size of the measuring zones can individually be selected depending on the maximum and minimum product widths of the plant. Signal transmission is free of maintenance and effected by means of a so-called rotary transmitter consisting of a rotor and a stator. The rotor is mounted

directly at the roll front side and, jointly with the roll, forms a compact, dust-proof unit. Inside the rotor, the sensor signals are digitalized, transmitted to the stator via an optical path, amplified, and then passed on to the control cabinet. This means that signal transmission and the measuring roll are extremely robust and require little maintenance. To check and ensure the measuring accuracy of the roll under operating conditions, SMS Siemag has developed special tests.

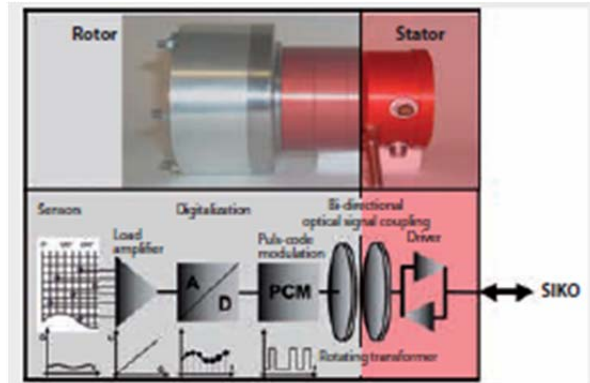


Figure 2: Latest generation X-Shape flatness measuring roll as developed by SMS Siemag (l). Design of the rotary transmitter and signal processing (r)

Unlike other products available on the market, the X-Shape roll features the advantage of a 24-channel transmission technology. Thus it is possible to cover a very wide measuring range of up to 3,000 millimeters.

The raw signals coming from the sensors are evaluated by model-based software, the X-Shape analyzer, newly developed by SMS Siemag. This analyzer precisely filters out the usable portion from the sensor signals and prepares them for visualization and control purposes.

The roll surface may be covered by a number of different coatings, either standard hardened, chromium-plated, or tungsten carbide, depending on the application in each case. Within a very short time, SMS Siemag received numerous references from the steel and non-ferrous metals industries. They include reversing cold rolling mills, tandem plants, and skin-passing mills.

Advantages offered by X-Shape

- Easy installations in new and old plants
- Mark-free measurements through closed roll body
- Choice of roll coating depending on its application
- Variable adaption of the measuring zone width
- Reliable and precise signal analysis
- High degree of integration
- Strip speeds up to approximately 1,600 m/min.
- Low maintenance and robust structure
- Extremely wide range of strip tensions measurable

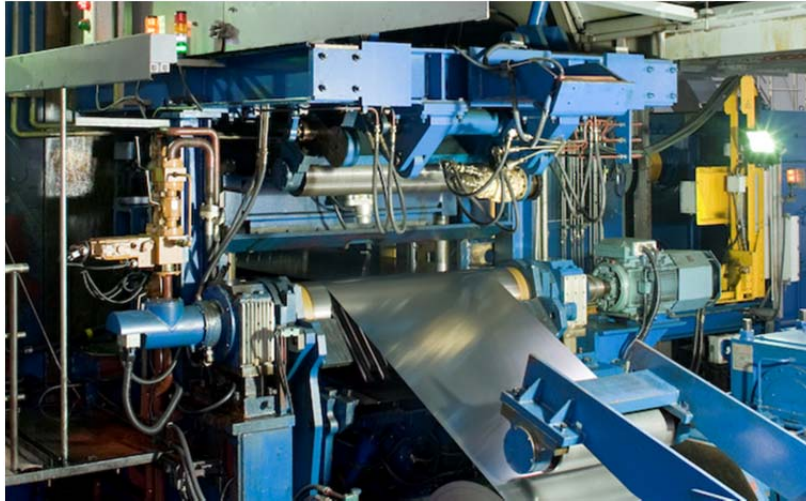


Figure 3: Installation of X-Shape measurement roll in the entry section of a reversing cold mill.

3.2 Improvement of Strip Cleanness and Dryness

3.2.1 Dry strip system

The necessity of a Dry Strip (DS) system in the exit of a tandem cold mill or a reversing mill needs not to be discussed. In general it helps to reduce oil losses and to save expenditures in the downstream processes. The main challenge is to fulfill the task in the most economical way.

The conventional DS system removes the emulsion from top and bottom side of the strip surface by using compressed air for blowing off.

SMS SIEMAG has two Dry Strip Systems in the portfolio: the compressed air combined blower type and the pure blower type. The compressed air combined blower type is equipped with a fan as suction system. The pure blower type uses a fan for blowing as well as for suction. Both types are aerodynamically balanced systems with significantly reduced energy consumption and a low noise level. The compressed air type is characterized by a space saving and compact design, which sometimes is advantageous for modernizations. Additional blowers do not have to be installed. The benefits of the blower type are manifold. These are low operation costs, extended fume suppression at the exit of the last stand and low noise level of 70 – 80 dB, without additional cladding for noise protection.

Figure 4 shows the costs of the combined compressed air blower type and the pure blower type in comparison to a conventional DS System. The summarized costs include costs for compressed air station and/or ventilators, energy costs and losses due to rejected coils.

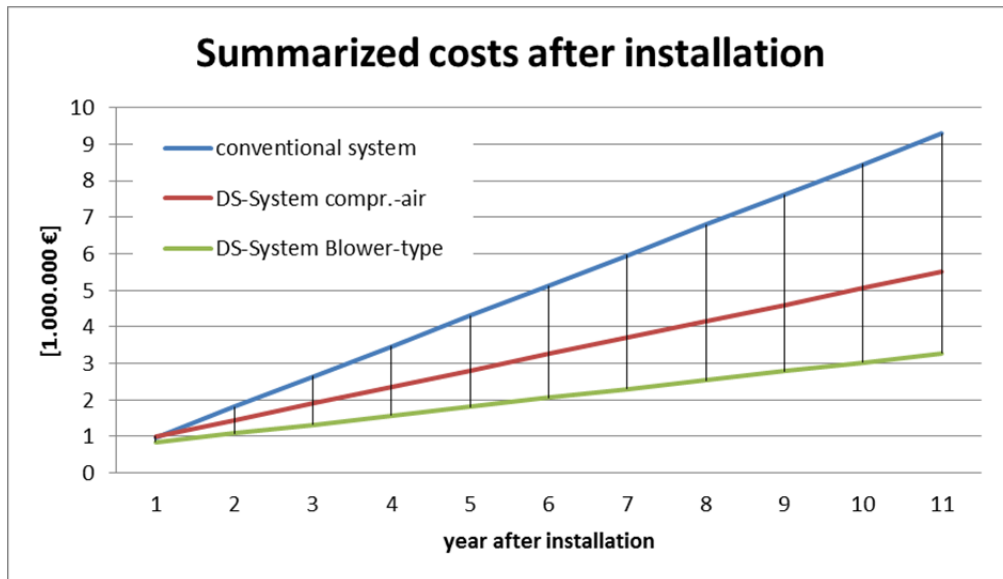


Figure 4: Cost overview conventional Dry Strip System compared with Dry Strip Systems by SMS Siemag.

74 installed systems, of which 22 are part of a revamp, give proof of the advantage of the Dry Strip Systems by SMS Siemag.

3.2.2 Nipco[®] – innovative wiper system

Producers of stainless steel expect clean and dry strip surfaces, of the cold rolled strip, because a wet strip surface means a limitation of rolling speed and causes a poor winding result. They require the residual oil content to be evenly distributed on the rolled strip and to exactly correspond to the quantity which is ideal for further processing of the strip.

The Nipco[®] wiper system is a corporate development of SMS Siemag and Voith and sets new standards with regard to efficiency and effectiveness of wiper systems for cold rolling mills. The system consists of one roller shell with a hydrostatic bearing that is adjusted to the strip width. This way, a uniform force distribution is achieved over the complete strip width and an automatic adjustment of the rolls to the strip profile. Also oil discharge is minimized.



Figure 5: The hydrostatic support can be activated in accordance with the width (l). Nipco[®] wiper roll with two of various shell types (r).

In order to relieve the strip edges, the roll is hydraulically retracted in the lateral shell area. In this way, contact between the top and the bottom rolls is prevented in case

of thin strip, and the wear on the shell in the area of the strip edges is reduced, thus increasing the service life of the wiper roll.

Depending on the case, the wiper roll can be designed with metal or composite compound shell and coated with polymer or resin-fiber compound. Nipco[®]-oil wipers are completely pre-assembled with chocks and roll carrier so that they are easily be installed in the oil wiper unit. A special benefit is that the Nipco[®] wiper system can directly connected to the existing rolling oil circuit and that is not operated via the hydraulic system. The system is suitable for installation in new rolling mills and retrofitting of existing plants.

3.2.3 Reference Outokumpo Nirosta, Benrath Works, Germany

The Nipco system was tested for the first time in a 20-roll cold rolling mill with a speed range of 450 m/min. During a test phase in the Benrath works of Outokumpo Nirosta. Applications with different metallic and polymer-coated wiper roll shells resulted in a uniform wiping effect over the strip width and an even distribution of the residual oil on the strip surface.

Compared with conventional wiper systems, it was possible to reduce the residual oil content on the strip by up to 60 percent. As the limitation of rolling speed caused by conventional wiper rolls was no longer applicable, the rolling speed was able to be considerably increased with Nipco[®].

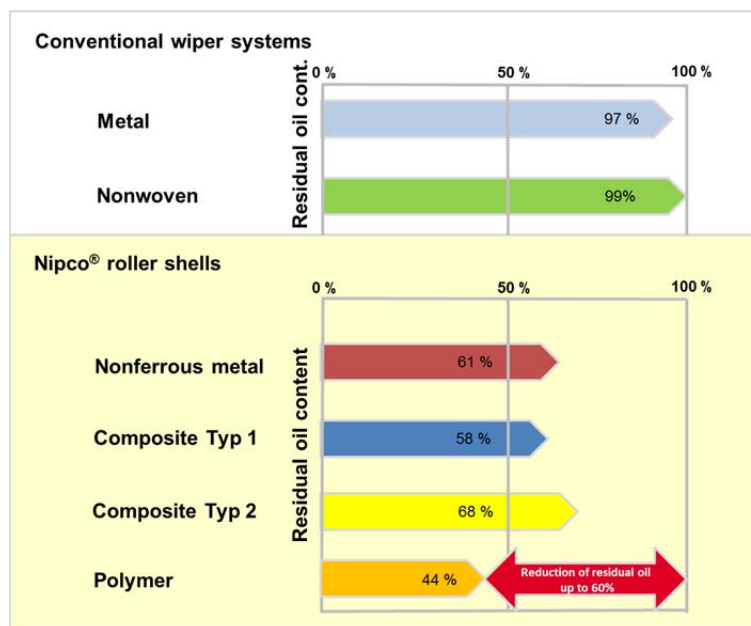


Figure 6: Operational results of the Nipco[®] wiper system in comparison to conventional wiper systems.

The results have convinced the customer to install the new Nipco[®]-oil wiper system also in another plant in Dillenburg.

3.2.4 Reference Outokumpo, Dillenburg Works, Germany

In 2011 Outokumpo Nirosta ordered a new Nipco[®] high-efficiency wiper system for a cold rolling mill in the Dillenburg works. In this mill, the existing oil wiper systems at the entry and at the exit section were to be replaced by the Nipco[®]-system.

In the summer of 2012, the system was installed and put into operation with some more positive operational results. Thanks to Nipco[®], Outokumpo Nirosta is now able

to roll also small dimensions with a rolling speed of 880 meters per minute. The wiper, compared with the previous system, causes significantly lower operating costs.

4 MEASURES FOR ENLARGEMENT OF PRODUCT MIX

Steel companies are investing not only in the expansion of capacity with new plants and modernizations but also in measures to enlarge the product mix, which nowadays goes along with extended portion of high strength steel grades. Two new technologies developed by SMS Siemag, which support producers in doing so, are presented.

4.1 Drive Technology: High Capacity Spindle

The production of high-strength-steel cold strip requires higher rolling torques and forces. Because it is not always possible to enlarge the work roll diameter, it is absolutely necessary to increase the capability of the drive train.

To make this possible, SMS Siemag has optimized the geometry and materials of the Sieflex[®] spindles. Especially to be mentioned here is the improvement of the tooth shape of the spindle. The new geometry leads to an increased gear modulus with reduced surface pressing. This almost doubles the specific rolling torque of the new spindle compared to older models. High performance spindles can be installed in new plants or used in revamps.

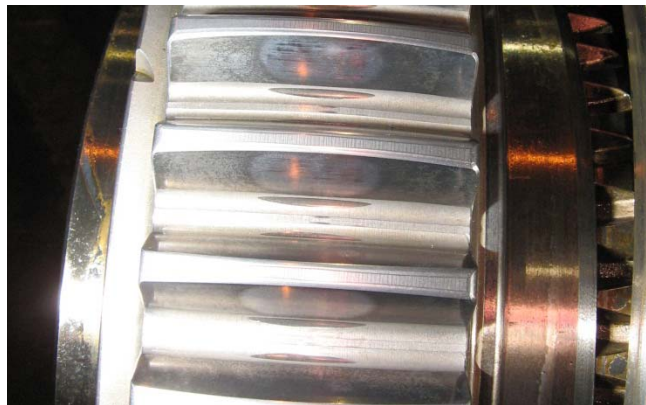


Figure 7: Tooth rim of the high capacity spindle after one year in operation with increased gear modulus and reduced surface pressing.

In future the high capacity spindle will have a high impact on mill design of SMS Siemag. Using high capacity spindles allows reduction of work roll diameters, which goes along with lower investment and operational costs and saving of energy.

4.2 Hydraulic Gap Control (HGC)

In combination with the application of higher rolling torques the rolling force has to be increased. Therefore in many cases new hydraulic gap control systems are required. The latest modernization of Ruukki's tandem cold mill is an example for that. Hydraulic gap control cylinders by SMS Siemag are characterized by a high positioning accuracy, precise adjustment of roll gap, easy accessibility of position transducer and an easy and safe maintenance. Thereby performance and reliability of the mill and quality of products will be enhanced definitely once again.

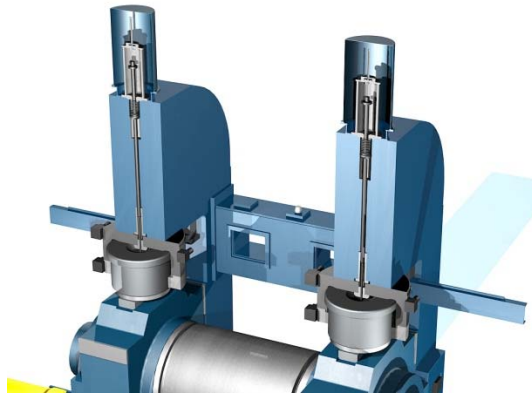


Figure 8: Functional principle of hydraulic gap control system by SMS Siemag

4.3 CVC plus M18/4 Multipurpose Mill

There are customers, who produce a wide range of products, from carbon steels through high-strength grades to stainless steels, partly in small amounts. SMS Siemag developed its multipurpose rolling mill CVC[®] plus M18/4 for these customers.

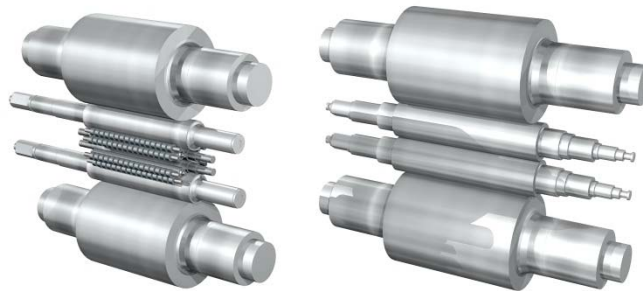


Figure 9: Multipurpose Rolling Mill CVC[®] plus M 18/4. CVC[®] plus 18 HS and CVC[®] plus 4 high designs combined in one mill.

This design makes it possible to change from CVC[®] plus four-high operation to CVC[®] plus 18-HS mode during a regular roll change. The intermediate and work rolls are arranged together with the supporting rolls in a change cassette, so that the entire set is changed at once. That eliminates any effect on rolling operation, because alignment of the supporting rolls is not necessary in the mill. The supporting rolls can be inspected and adjusted in the roll shop.



Figure 10: Change cassette for 18 HS mode.

Our CVC® plus M18/4 mill stands come with the following advantages:

- Low investment costs, because of “two in one” concept
- Flexible production, from soft to extremely high-strength materials
- High productivity due to higher reduction, reduced number of passes and minimized roll change and operation mode change time

5 MEASURES FOR REPLACEMENT OF MECHANICAL EQUIPMENT

The ThyssenKrupp Steel subsidiary Rasselstein is Germany’s only manufacturer of tinplate. TKS Rasselstein and SMS Siemag look back over more than 50 years of cooperation, including new plants as well as plant modernizations. One of the recent challenging revamp projects was the modernization of the 5-stand tandem mill, commissioned in 1960 and modernized by SMS Siemag in 2008. TKS Rasselstein uses this mill to roll strip widths from 600 to 1,080 millimeter to minimum final thicknesses of 0.10 to 1.20 millimeter at a maximum rolling speed of 1,830 millimeter.

The project aims were:

- Tighter thickness tolerances
- Improved flatness
- Reduced off-gauge lengths
- Shorter coil-to-coil times
- Environmental improvements

To achieve these goals, the modernization focused, beside other measures, the entry area of the tandem mill. The walking beam, lowering station and pay-off reel were replaced completely.

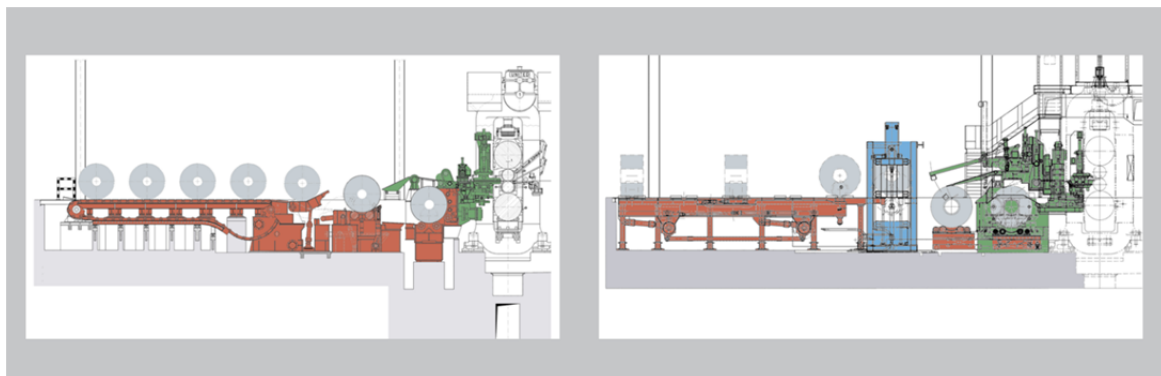


Figure 11: Entry section of TCM Rasselstein before (l) and after (r) revamp.

The new entry-side configuration concept uses the given fundament setting with only slight modification. But the benefits of the new entry arrangement are manifold. Just to mention some of them: Using a pay-off reel allows fast setting of strip tension in the rolling mill and therefore fast matching of quality targets. Coil – to-coil times could be decreased. At the same time the number of strip surface damages was reduced. Further the mill stands were equipped with new hydraulic gap control systems; a new mill platform and mill stand cladding. Also included in the supply scope was a fume exhaust system with scrubber to establish fundamental environmental improvement. Equipment for high and low pressure hydraulics and the associated piping completed the scope of supply. It was necessary to keep a tightly planned project schedule with a standstill time of just four weeks. Due to thoroughly preassembled and pre-checked modules, erection and commissioning time could be kept that short and a fast start-

up and return of investment was made possible by SMS Siemag in close cooperation with TKS Rasselstein.

6 MEASURES FOR OPTIMIZATION OF DISCONTINUOUSLY OPERATING MILLS

Discontinuous cold rolling mills have many advantages. They offer scope for flexible planning of production and cost-effective processing of small batches. However, disadvantages are, e.g., higher idle periods and more operating personnel than continuous plants. Further threading in and out causes more often marking of the work rolls or even cobbles. The number of unscheduled roll changes and breaks are higher and consequently productivity is reduced. Even in case threading in and out runs smooth, yield is reduced by off-gauge length. However turning a batch mill into a fully continuously operating mill is technically complex and expensive. In the face of innovative technical solutions provided by SMS Siemag, in many cases it is not necessary to change the operation mode to increase yield and profitability.

6.1 TRC[®] Rolling Assistance System

SMS Siemag has developed advanced rolling assistance systems as extension of the level 2. The assistance systems support the operator in his responsibility for the rolling process and help him to react flexibly on the rolling events and on different rolling jobs. By this especially such rolling jobs are conducted, which cannot be solved completely by the automation system. Rolling assistance systems help to diminish rolling risks and to improve yield and mill availability significantly.

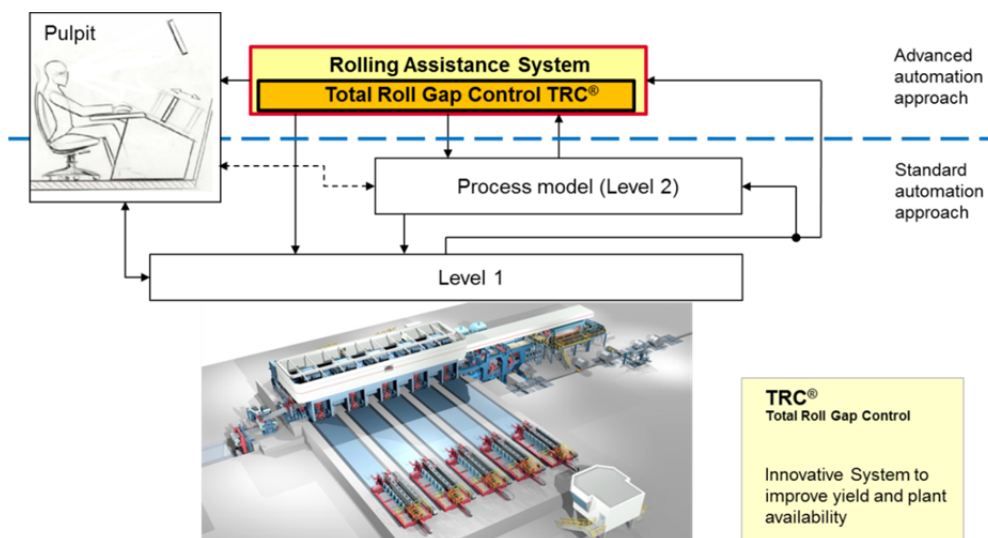


Figure 12: Advanced rolling assistance systems improve the quality of automation and support the operator to manage critical rolling jobs.

One example for such a critical rolling job is threading in and out in a discontinuously operating tandem cold mill. Therefore SMS Siemag developed “Total Roll Gap Control” (TRC[®]) to make threading in and out safer and to reduce off-gauge length to a minimum, resulting in a higher yield and boosting the economic efficiency of the discontinuously working plants. In fact TRC[®] opens up a new quality level for batch mills and allows them to compete against continuously operating mills.

TRC[®] is a special technological assistance system implemented in the level 2. As precondition to do this, roll gap setting is improved by thickness control based on direct roll gap measurement. This simplifies the overall control strategy of the discontinuous cold rolling mill. A coupling of gap adjustment and drive control is no longer given. Besides adjusting the overall rolling speed, the drives are only used for the tension control.

The TRC[®] assistance system comes into play when the strip is being threaded in and out. It considers the wedge profile and thickness deviation at the strip head and tail ends, and ensures strip flatness and straight strip flow. Depending on the material properties the incoming thickness deviation and profile at strip head and tails ends, it keeps roll force within calculated as well as adjustable limits considering the biting condition and ensuring the flatness of the head end or tail end. The assistance system stays active only as long as necessary during threading in and out, and it does not affect body thickness quality as well as flatness. All this helps to keep the strip thickness in tolerance as soon as possible – while threading in – and as long as possible – while threading out. This makes threading in and out safer and in addition reduces the off-gauge length.

6.1.2 Reference BILSTEIN GmbH & Co. KG, Hohenlimburg, Germany

For the first time SMS Siemag installed the innovative TRC[®] threading assistance system in a four stand batch tandem mill at BILSTEIN GmbH & Co. KG, Germany, as part of a comprehensive revamp. BILSTEIN rolls a wide product range, including standard steel grades up to micro-alloyed high strength steels. Further our customer processes narrow and slit strips with different strip wedges, which is an additional challenge for threading.

Apart from the supply of powerful mechanical equipment, SMS Siemag installed an integrated automation system, including level 1 and level 2. TRC[®] as part of the new automation system allows a full automatically threading in and out procedure. Operators need only keep attention to levelling.

The improved process stability as well as the faster and more reliable threading in and out, together with new and more powerful drives, resulted in an increased production of 20%. At the same time, we were able to reduce the off-gauge length by some 50%. In addition the advanced automation reduces the personnel required to operate the tandem cold mill.



Figure 13: TRC[®] helps the operator of the TCM BILSTEIN threading in and out safe and fast.

8 CONCLUSION

Since 2000, SMS Siemag has constructed more than 100 new cold rolling mills and carried out a large number of revamps. This underlines our global leadership as a supplier of equipment for cold rolling mills, as well as the high level of acceptance of our technological solutions.

The experience of SMS Siemag has left its marks on many tailored modernization concepts. But essential in every case is the close cooperation and matching with the customer in all stages of the project.