



MASTERING THE FUTURE WITH X-ROLL 2.0 – COLD ROLLING TECHNOLOGY OF THE NEXT GENERATION*

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Abstract

Cold rolling mills by SMS Siemag are well known for their reliability and long-life cycle. They are an investment in the future. Nowadays mill owners are under considerable competitive pressure and are asked to organize production in a more and more efficient and flexible way. Doing so, a number of elevating screws have to be turned. These are: cutting of operation costs, especially by more efficient equipment and processes as well as transition to more process flexibility to fulfil future product requirements. To support owners in their effort, SMS Siemag offers convincing solutions in cold rolling technology under the brand X-Roll 2.0. Examples to be presented are: Sieflex[®]-HT drive technology; Redesigned DS system; New reel design: Twin Reel; Emulsion compact unit ECU Compact; TRC[®] threading assistance system; ECOMode and Energy ADVISOR monitoring system.

Keywords: X-Roll[®]; Sieflex[®]-HT; Emulsion Compact Unit (ECU); Twin reel; TRC[®]; ECO Mode; Energy advisor.

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1 INTRODUCTION

The well-known and well-proven rolling technology of SMS Siemag is established under the X-Roll® label. For further support of mill owners, who are under huge competitive pressure, SMS Siemag has developed a bunch of new technological solutions and introduces them under the brand X-Roll® 2.0 to the market. The new X-Roll® generation features innovations, ensuring an even more flexible and economically efficient plant operation as well as meeting ecological requirements, which become more and more challenging nowadays.

The technical solutions of the second X-Roll® generation offer numerous advantages not only for the design of greenfield plants but also for upgrades and modernizations of existing ones. The examples to be discussed in this paper are:

- Sieflex® HT drive spindle for transmission of high rolling torques with the same or even smaller work roll diameter (Compact Mill)
- More cost-efficient strip blow-off system through further reduced compressed air consumption
- Twin Reel: the compact reel concept for highest requirements of a continuous tandem mill
- ECU – The space and energy-saving compact emulsion system
- TRC® – Thread and tail-out assistant for fast start of rolling and lower off-gauge lengths
- ECO Mode and Energy Advisor create the required transparency for operating the mill and the plant more efficiently

2 SIEFLEX®-HT DRIVE SPINDLE FOR TRANSMISSION OF HIGH ROLLING TORQUE

2.1 Initial Situation

In cold rolling mills the preferred type of drive is the work roll drive (Figure 1). It has the highest process stability and is normally less expensive than intermediate roll or backup roll drives. However, there are constraints for the work roll drive because for thinner work rolls the respectively thinner roll necks and drive spindles are often limiting the capability of transmitting the required rolling torque.

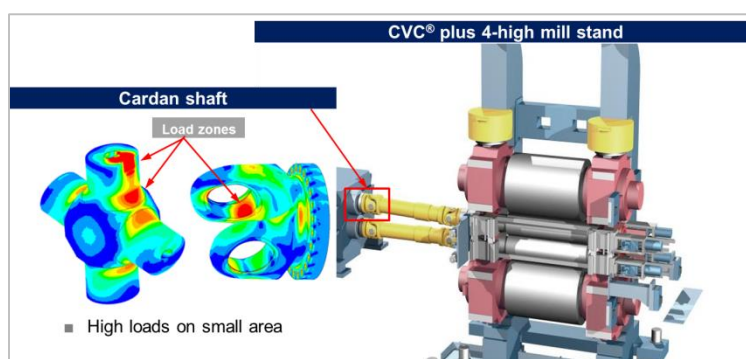


Figure 1: CVC® plus 4-high mill stand with driven work rolls and load distribution on the cardan shafts

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2.2 Solution

The newly developed Sieflex[®] HT spindle from SMS Siemag is able to maintain the advantages of the work roll drive even for significantly smaller work rolls and large rolling torques. Along with the modified design of the work roll drive necks, with this new drive spindle SMS Siemag has enhanced the application limits of the efficient work roll drive and more than doubled the performance (Figure 2). All this is possible, because SMS Siemag optimized the gear geometry to distribute the strain evenly across the tooth flanks – also for work with large deflection angles. Special about the Sieflex[®]-HT drive spindle is its practically full torque capacity and much lower wear with up to a deflection angle of 3.5°.

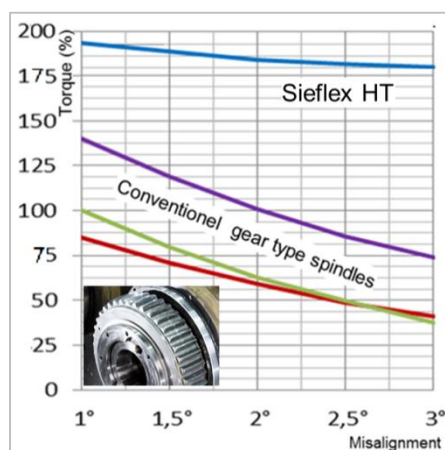


Figure 2: Sieflex[®]-HT drive spindle provides a high torque capacity with an alignment range up to 3.5°

2.3 Results

By using the newly developed drive spindle it is possible to design new plants in a more compact way, e.g. as tandem cold mill in CVC[®] plus 4-high design, being able to master even more demanding cold rolling jobs. Thus the customer is enabled to roll a wide range of materials from soft to high-strength steel grades in one mill. Thinner final gauges can be achieved for high strength material and investment for new plants will be lower.

For modernizations the spindle opens up more economic concepts with reduced investment costs. The Sieflex[®] HT drive spindle allows to enhance the capacity of the existing mill and to realize higher reductions.

3 MORE COST-EFFICIENT STRIP BLOW-OFF SYSTEM THROUGH FURTHER REDUCED COMPRESSED AIR CONSUMPTION

3.1 Initial Situation

The DS system is used to blow surplus cooling lubricant residues off the strip surface and consequently avoids stain spots. It is installed in the exit of a cold rolling stand. Conventional systems use compressed air for blowing off the strip. Beside a lot of noise emission, these systems are characterized by a huge compressed air consumption with remarkable energy costs per year. Therefore SMS Siemag developed some years ago the DS system based on blower for removal of emulsion residues. By this the compressed air consumption was reduced by up to

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approx. 60 percent. However, there is still a significant amount of compressed air required for SMS Siemag's wearless sealing of the work roll barrel in the last stand. So the main target of the further development of the X-Roll® DS system was to reduce the remaining compressed air consumption.

3.2 Solution

The productive efficiency of the SMS Siemag DS systems is characterized by well aimed blow-off and sucking areas (Figure 3).

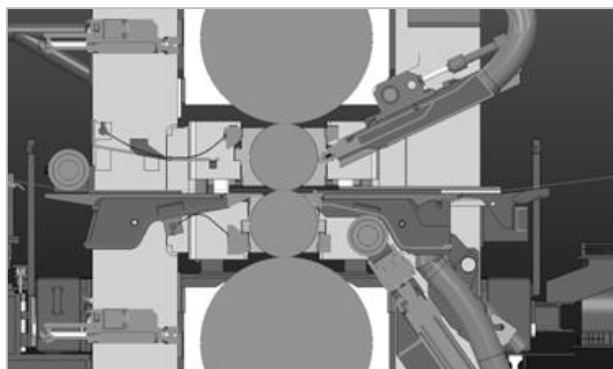


Figure 3: Basic design of an exit-side DS system with elements for blowing off an sealing.

The wearless and contactless sealing of the roll barrel is achieved by a high-speed air flow, generated with the aid of the Coanda effect of the so called "COANDA nozzle". In order to cut down the amount of compressed air, it was simulated with CFD (Figure 4) and the contour was optimized.

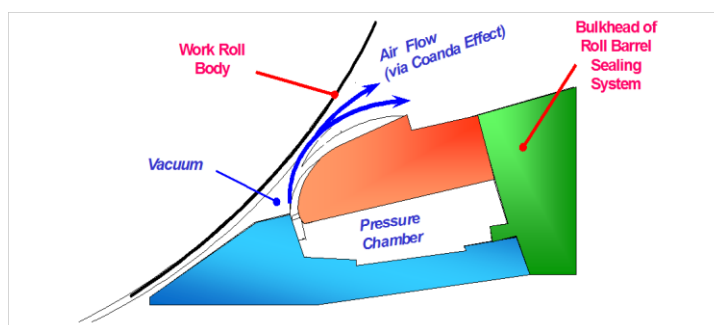


Figure 4: Functionality of the COANDA nozzle as contactless sealing of the work roll barrel

3.3 Results

The modified contour ensures an improved flow, deflecting the drop-laden air and providing reliable sealing towards the strip. In that way a higher drying effect can be achieved on the strip. Furthermore, the nozzles in the edge area can be switched off. With the modification of the nozzle contour it is now possible to reduce the consumption of compressed air by more than 50 percent, which comes along with appropriate operation cost savings.

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4 TWIN REEL: THE COMPACT REEL CONCEPT FOR HIGHEST REQUIREMENTS OF A CONTINUOUS TANDEM MILL

4.1 Initial Situation

SMS Siemag offers two proven reel concepts for the continuous exit section of tandem cold mills: double reel (Figure 5) and carousel reel (Figure 6). Both reel concepts ensure high productivity and very accurate winding results. However each has specific advantages making it preferable for different production scenarios.



Figures 5 and 6: Double reel (l) and carousel reel (r) are both proven solutions for the exit section of tandem cold mills ensuring continuous operation

For the double reel, two individual reels are arranged in a row and therefore the required space is bigger than for the carousel reel. The double reel is designed for high capacities and high strength material. Coiling under high strip tensions is possible right from the beginning. For the transportation of the finished coils two coil cars are needed. The distance between the last mill stand and the two mandrels is different. As different is the way the strip head end has to pass safely before being coiled. This might increase the risk for strip damages, especially in case of ultra-thin strip.

The carousel reel is compactly designed with its two mandrels being arranged on a rotor. The mandrel position for the initial windings is always the same. Also there is only one coil take off position and therefore only one coil car is needed. In the “start of winding position”, the mandrel is not stabilized by a support bearing, with the result that high strip tensions cannot be applied as long as the mandrel has reached the winding and take off position. After pivoting to this position, it is hold by a support bearing. Only now high strip tensions can be applied for the winding. This situation has effects on the stability of the first windings. However for thin and ultra-thin strips the carousel reel concept is beneficial.

4.2 Solution

SMS Siemag asked itself how an alternative reel design for the continuous exit section of tandem mills could look like. Result of this process is the Twin Reel. It combines the advantages of both conventional solutions and even outclasses them by its intelligent, very robust and economic design. It opens up the opportunity of coiling with remarkably higher strip tensions right from the beginning and allows constant coiling quality for all products required, from soft to high-strength and very thin strips.

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Double and carousel reel have in common that the finished coils are removed on the operator side. The new Twin Reel breaks with this principle. Both reel drives are opposed to each other, one is arranged on the operator and one on the drive side. In between the coiling takes place. Figure 7 shows the entire Twin Reel configuration. The reel mandrels are of proven design and are supported in every position on both sides. The first windings of the new coil are coiled with the mandrel in the upper position. It will be finished in the lower position and transported away inline to the mill. All this simplified the design compared to the carousel reel.

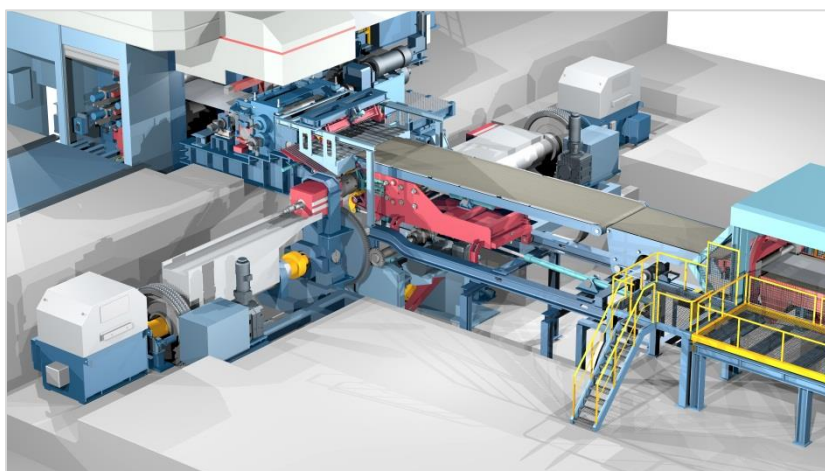


Figure 7: Concept presentation of the new continuous exit section by SMS Siemag with the Twin Reel

4.3 Results

The Twin Reel is designed for coils of up to 60 tons weight, so called “jumbo coils”. The finish-rolled strip is coiled from the start at high strip tension, thus leading to a stable coil eye and allowing higher accuracy in coiling, even for wide strips. The strip tension level as a whole is higher, which is an advantage for rolling high-strength grades.

Even very thin strips are coiled safely because the initial coiling distance is very short. Compared to similar exit configuration as in figure 7 but with carousel reel for the Twin Reel the coiling distance is even smaller. Belt wrapper and spool operation can certainly be integrated into the new reel concept as well as the “Rotary Inspect” inspection station. The coil transport in direction of the strip flow is significantly simplified and more cost-efficient.

The complete accessibility of the exit area with gearbox, reel mandrels and belt wrappers is improved by transporting the coils under mill floor level. The design of the foundation is very simple and clear.

The new Twin Reel is not only suitable for new plants but can also be installed in existing tandem mills, for example along with the revamp from the discontinuous to continuous operation.

5 ECU – THE SPACE AND ENERGY-SAVING COMPACT EMULSION SYSTEM

5.1 Initial Situation

The main components of an emulsion system are the pipelines to the rolling mill, fluid tanks, cleaning equipment, stirrer, cooling and heating equipment, pumps and

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pipework (Figure 8). With the conventional design, this requires a floor space of approx. 300 square meters.

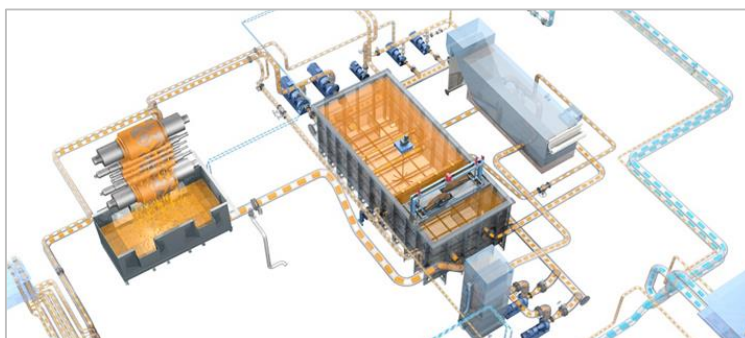


Figure 8: Typical arrangement of a conventional emulsion plant

For further improve the well established conventional emulsion system SMS Siemag launched the Emulsion Compact Unit (ECU).

5.2 Solution

The ECU compact emulsion system is characterized by its extremely space-saving design. The components of the emulsion plant are no longer arranged separately and linked with each other by long piping systems. They are arranged compactly in a unit. The devices are arranged on two levels. The pumps and tanks are installed on the floor plate while the heat exchanger, filters and magnetic separator are located on the tanks (Figure 9).



Figure 9: SMS Siemag's new economical ECU emulsion system

The emulsion heated up in the rolling mill is cleverly used to control the temperature of the oil and water tanks. Therefor and together with an intelligent piping, for these tanks any heating equipment is completely redundant. The other heating and cooling units can be designed smaller. Both are controlled via temperature sensors and ensure that the optimum operating temperature is maintained. Well-aimed conducting of the flow also renders the water make-up pump redundant. Finally the use of speed-controlled pumps ensures the required emulsion delivery.

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5.3 Results

Depending on the size of the plant, ECU requires less than half of the floor space of a conventional emulsion plant. Moreover, the compact design allows highly energy-saving operation. The energy consumption is reduced up to 45 percent by using lost heat for heating up the base oil. Out of these approx. 35 percent is saved due to reduced pumping to deliver the demand and approx. 10 percent through utilizing of the waste heat. Downsizing the necessary auxiliary system, e.g. a water treatment plant, here also leads to reduction of the cost. Moreover, maintenance is cut down because the plant is made up of fewer components. In addition all units are easily accessible. All this cuts operation costs.

Compared to a conventional emulsion system, the ECU investment expenditures are nearly reduced by 20 percent. The modular structure in line with the considerably reduced piping expenditure shortens the final installation period and enables speedy commissioning. In fact assembly and commissioning time is cut down for more than 15 percent.

6 TRC[®] – THREAD AND TAIL-OUT ASSISTANT FOR FAST START OF ROLLING AND LOWER OFF-GAUGE LENGTHS

6.1 Initial Situation

SMS Siemag introduced the rolling assistant system Total Roll Gap Control (TRC[®]) into the market as a part of the level 2 (Figure 10) to compensate certain disadvantages of discontinuous cold rolling mills versus continuous mills. The rolling assistant system increases process stability in rolling and improves the yield, especially during threading in and tailing out of the strip.

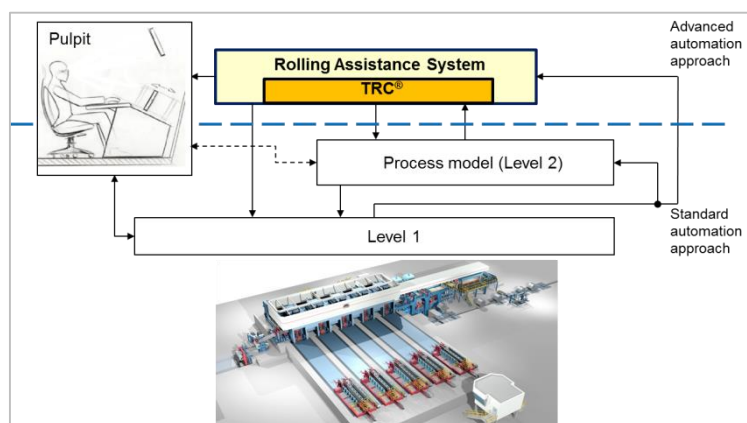


Figure 10: TRC[®] as part of the level 2 ensures a fast and save threading procedure in cold rolling mills

6.2 Solution

TRC[®] supports the threading and tail-out processes in such way that the strip can rolled down as early and as long as possible to the target gauge and intended quality. This achieves a reduction of off-gauge lengths at the strip head and tail ends.

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6.3 Results

TRC[®] was installed for the first time in the discontinuous tandem mill of Bilstein GmbH & Co.KG as scope of modernization (Figure 11). Experience gained in operation showed that TRC[®] significantly accelerated the threading and tail-out processes and made them more reliable. The off-gauge lengths were reduced by approx. 50 percent. The annual savings of Bilstein, thanks to the TRC[®], averages up to 1 million € per year. Meanwhile SMS Siemag also installed the system in an aluminum tandem cold mill.



Figure 11: The TRC[®] rolling assistance system at Bilstein supports the TCM operator in fast and reliable strip threading and tailing-out with the result of significant yield increase

7 ECO-MODE AND ENERGY ADVISOR CREATE THE REQUIRED TRANSPARENCY FOR OPERATING THE MILL AND THE PLANT EFFICIENTLY

7.1 Initial Situation

In a cold rolling facility generally energy savings are limited. In the actual rolling process energy-savings only can be realized by further optimization of the emulsion used, at which process stability has to be guaranteed at any time. Process data allowing to control or tune the auxiliaries under energy saving aspects more efficiently, were hardly available.

7.2 Solution

SMS Siemag's new assistant ECO-Mode and monitoring system X-Pact[®] Energy Advisor make a substantial contribution to efficient and resource-saving operation of cold rolling mills (Figure 12).

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Figure 12: ECOMode and X-Pact® Energy Advisor are part of the ecoplants strategy of SMS Siemag for a more efficient and resource saving production

ECO-Mode is comparable to the start and stop automatic in a car. Mill functions and electrical consumers are switched off in consideration of their restarting time. So the ECO-Mode ensures automatically that during a shut down or a longer break all pumps and devices are stopped or their operation reduced to minimum performance required.

The X-Pact® Energy Advisor is an energy data management system contributing to bringing energy cost of rolling mills down and keeping them stable. It allows energy monitoring and consumption analysis including electric power, gas, steam as well as compressed air and other fluids (Figure 13). It is designed helping to optimize an entire production complex, but also a single mill by correlation of products to their specific energy consumption. For the first time it is possible to optimize e.g. the emulsion system under the aspect of energy saving. In this way savings potentials are identified that can be used as a basis for operational decisions.

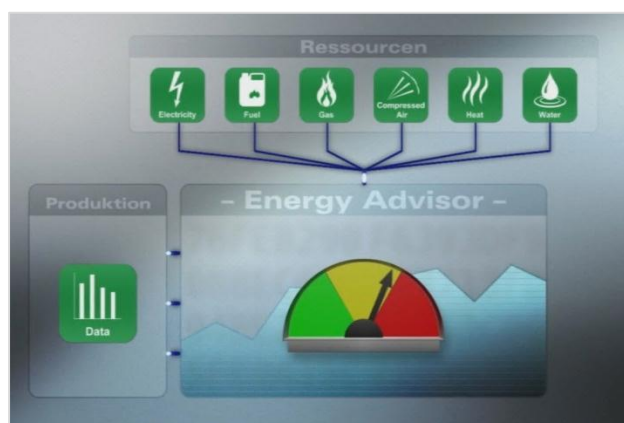


Figure 13: The Energy Advisor supports efficient plant operation

7.3 Results

Both newly developed systems are now ready to be implemented in the automation systems of new plants or to be retrofitted in existing ones. Experience has shown that up to ten percent of the average energy consumption of the selected units can be saved by using the ECO-Mode.

The energy data management system can help to realise energy savings of 5 to 20 %, as for example stated in Stahl und Eisen 129 (2009) [1]. The system also supports the continuous improvement process as defined in the energy management norm ISO 50001. Reimund Laermann, head of the energy management department

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of Georgsmarienhütte GmbH, points out the importance of key performance indicators in controlling energy efficiency, and especially their product and status dependencies. *“For an effective energy management, it is necessary to connect energy data with the production as does the X-Pact® Energy Advisor by SMS Siemag AG”*, says Laermann.

8 CONCLUSIONS

Beside the well-known and well-proven systems that characterize SMS Siemag’s cold rolling mills, such as highly dynamic adjustment systems and CVC® plus, the new developments presented enable compact plant design without compromising performance and ensure profitable and ecological operation of the facility. The technological examples are components of recent development effort for new plants but also for revamping of existing ones.

REFERENCES

1 Hundrieser J, Seifert O. Stahl und Eisen, 2009; 129 (7).

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