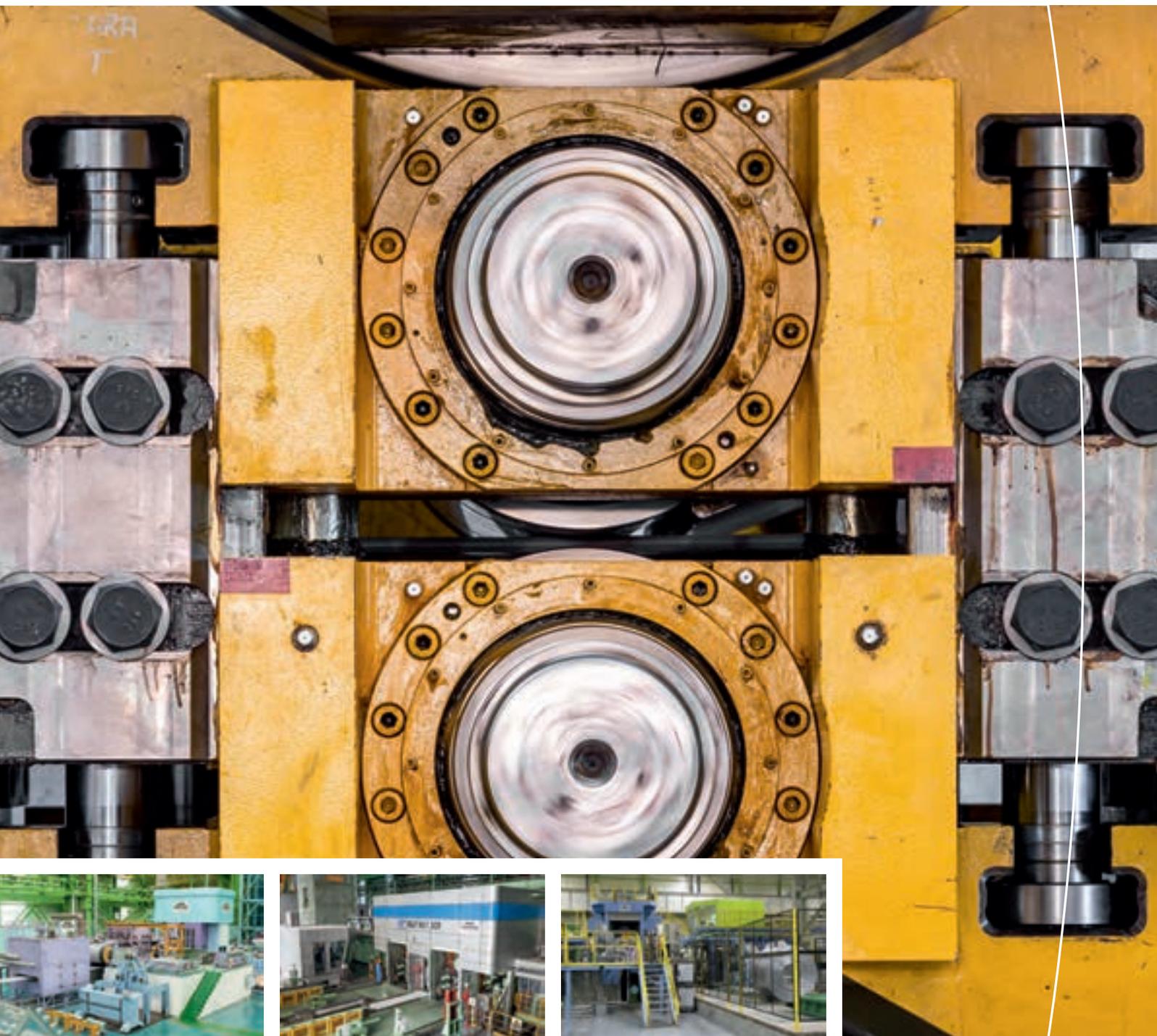


Skin-pass mills
for a perfect finish



Skin-pass mills for a perfect finish

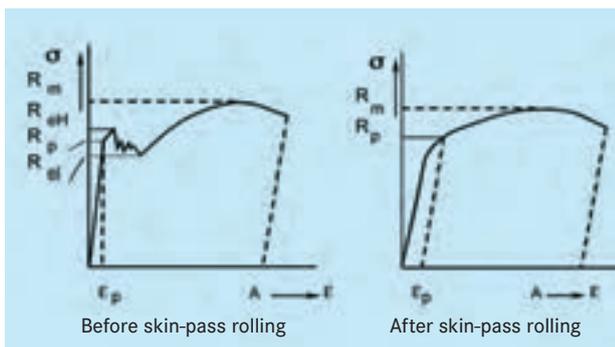
Typical applications

Today, there is cold-rolled strip almost everywhere you look. It comes with various surface effects: high-gloss, matte and other surface effect give the impression of beauty and elegance finishes - qualities that enhance products.

Yet steel strip surfaces are not only good-looking, they also have important technical functions. Take for example the correct roughness, which ensures perfect painted surfaces. Other material properties of cold-rolled steel remain hidden from our eyes but are essential for industrial processing.

Take, for example, a beverage can which is formed from thin tin plate in a single deep-drawing operation. In addition to surface quality, their economic production requires, above all, a low deformation behaviour. The more precise adjustment of the required properties has reduced the weight of the beverage can by 30% over the last 25 years.

Most important of all steps here is skin-passing following cold strip manufacture. It achieves the precise mechanical and geometrical properties that the customer needs for his applications.



Stress-strain curve.

Advantages of skin-pass rolling

The aim of the skin-pass rolling process is setting of yield strengths and desired surface properties.

Definition of yield strength

By means of skin-pass rolling, the inconsistent yield strength range, the so-called Lüders bands, is converted to a defined yield strength. This improves the flow behaviour during the deep-drawing process and prevents undesired flows.

Setting the strip roughness

Setting a desired roughness of the surface of the strip increases, for example, the application of the deep-drawing process or improves the adhesion of paints.

Perfecting the strip flatness

The strip flatness is an important feature for processors. Very good flatness values enable trouble-free operation of downstream process.

High Yield Strength Materials

The new market trend is to produce strips oriented to reduce the weight of each single component, without losing the safety and the design characteristics.

It is in such case that Skinpassing with suitable Mills plays a distinctive role, to combine the highest resistance requested to these grades and the achievement of the properties which enable their downstream processing.

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Flatness of a skinpassed strip.

Products made by skinpassed strip.

Tailored skin-passing for any application

Skin-pass mills are installed at the end of the flat steel production process chain. They are essential for smooth processing of steel strip.

Skin-pass mills for hot strip (HSPM)

Skin-passed hot strip has many advantages. Most importantly, this process helps you attain perfect strip flatness. It also harmonizes the yield points and prevents the flow and break lines that can occur during uncoiling. Furthermore, the downstream pickling process is easier because skin-passing breaks up the scale layer.

With the new performances of the nowadays Hot rolling Mills, the strip at thin gauge, after skin-passing, can be addressed to the market for the final applications, reducing the necessity of further Cold Rolling.

Stand-alone skin-pass mills for cold strip (SPM)

Our stand-alone skin-pass mills are independent rolling facilities. They usually follow the batch-annealing stage and offer high versatility for processing both hard and ultra-mild strip. They also offer perfect finish for stainless steel cold-rolled strips.

A special feature are the so-called DCR rolling mills, or DCR second rolling mode. DCR stands for "Double Cold Reduction". These two-stand facilities combine the thickness reduction in the first pass with the skin-passing in the second. Both passes can also be used for skin-passing. In this case, the material properties, such as a defined yield strength, are set in the first step, while the desired surface features are transferred to the strip in the second step.

Inline skin-pass mill for cold strip

Skin-pass mills can also be installed directly inline in the exit section of continuous annealing or hot-dip galvanizing lines. The strip can be finished in the processing line, which has several advantages. Here's how you benefit from continuous strip processing: lower cost and effort for coil handling, better productivity, and higher profitability.

"Duo", "Quarto"2 and "Sexto" design

The so-called "2-Hi" are used for the treatment of round austenitic stainless steel strips. These skin-pass mills in 2-Hi design ensure high-gloss strip surfaces. 4-high designs are also used for ferritic stainless steels.

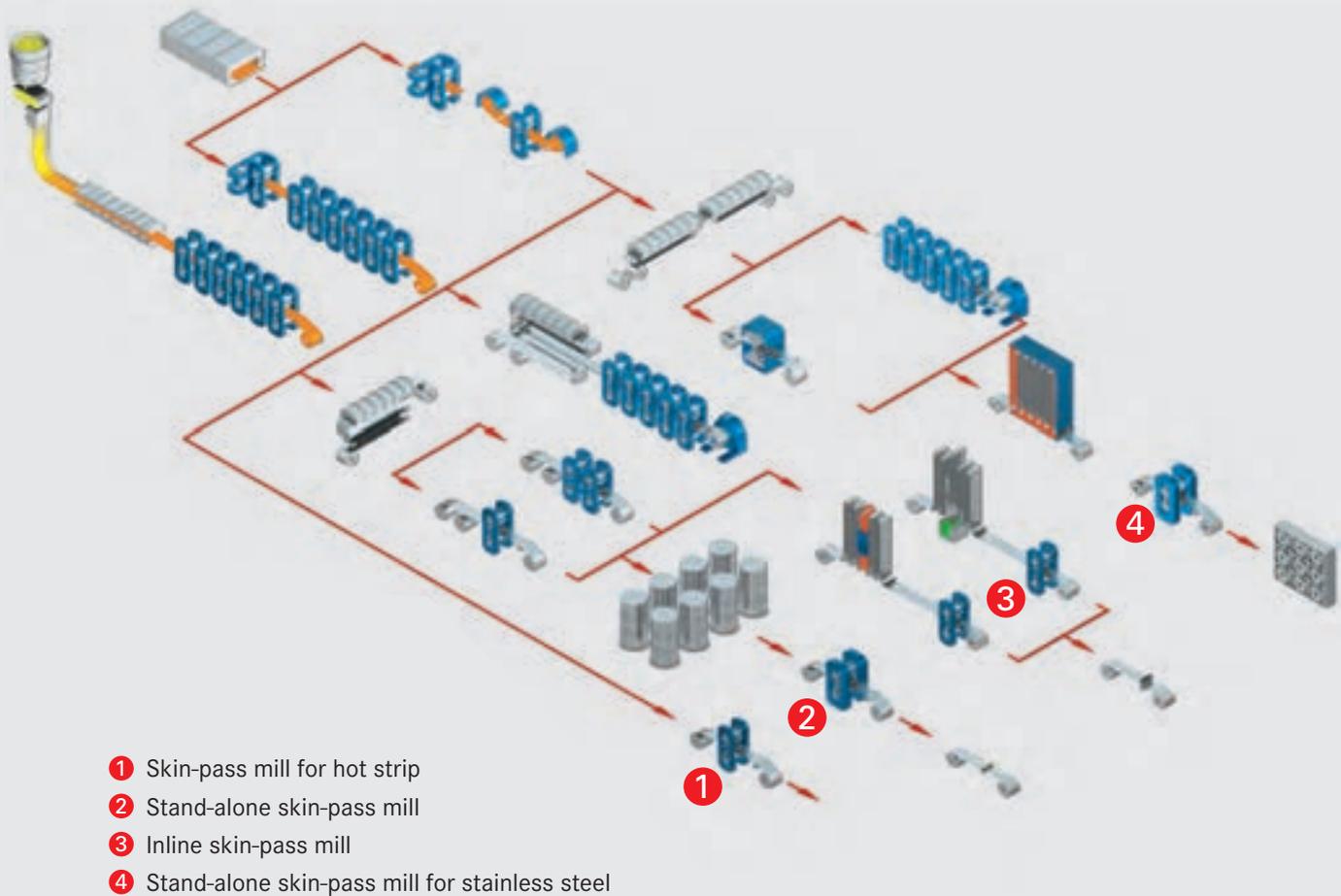
The conventional 4-high design gives you the option of installing two different work roll diameters. As a result, you can skin-pass a wider product mix. Smaller work roll diameters reduce rolling force when skin-passing strips of high strength steels. Work rolls with a larger diameter make it possible to skin-pass with sufficiently high rolling force even very soft steel grades and to improve the roughness impact at the same time.

Since 2003, we have also been supplying ISPMs in 6-high design for highly demanding tempering tasks. That ensures even better strip flatness due to the larger adjustment range of the 6-high mill. Moreover, you can skin-pass a wider product mix.

Designs constructions:**2-high, 4-high and 6-high designs and their technical features and applications**

Feature	2-high*	4-high* design	4-high* design with CVC®plus	4-high* design with CVC®plus
Work roll bending	-	+	+	+
CVC® shift of the work rolls	+	-	+	+
Intermediate roll bending	-	-	-	+
Skin-pass elong. (%)	1 to 2	1 to 4	2 to 4	2 to 4
Flatness	+	++	++(+)	+++
Surface quality	++	++	++	++

* main area of application: Stainless steel



Arrangement of the skin-pass mills in the processing chain.

Quality features

High-tech components

The market

Our skin-pass mills feature technologies that have proven themselves in world-wide use and meet the highest requirements of our customers. By using the latest technology, the requirements for an extended production spectrum, for best product quality and for economical plant operation are fulfilled. Our skin-pass mills are normally equipped with hydraulic controls of the rolling force and work roll bending systems to influence strip flatness. In addition, the extended bending system belongs to special equipment.

Extended bending systems (EBS) and CVC®plus

When skin-passing soft grades, the increase of the roll diameter quickly reaches its limits. With our extended bending system, the rolling force can be safely lowered to values below 100 kN. It involves lifting the upper back-up roll in case of 4-high and 6-high designs. The required rolling force is achieved solely by the work roll bending or, in the case of the 6-high design, by the intermediate roll bending. These are necessary e.g. for skin passing soft steel grades (IF steel).

We use CVC® plus for manufacturing steel strips with excellent flatness. In addition, a CVC® iteration on the support rollers ensures a balanced distribution of the contact load, thus reducing the wear of the rollers.

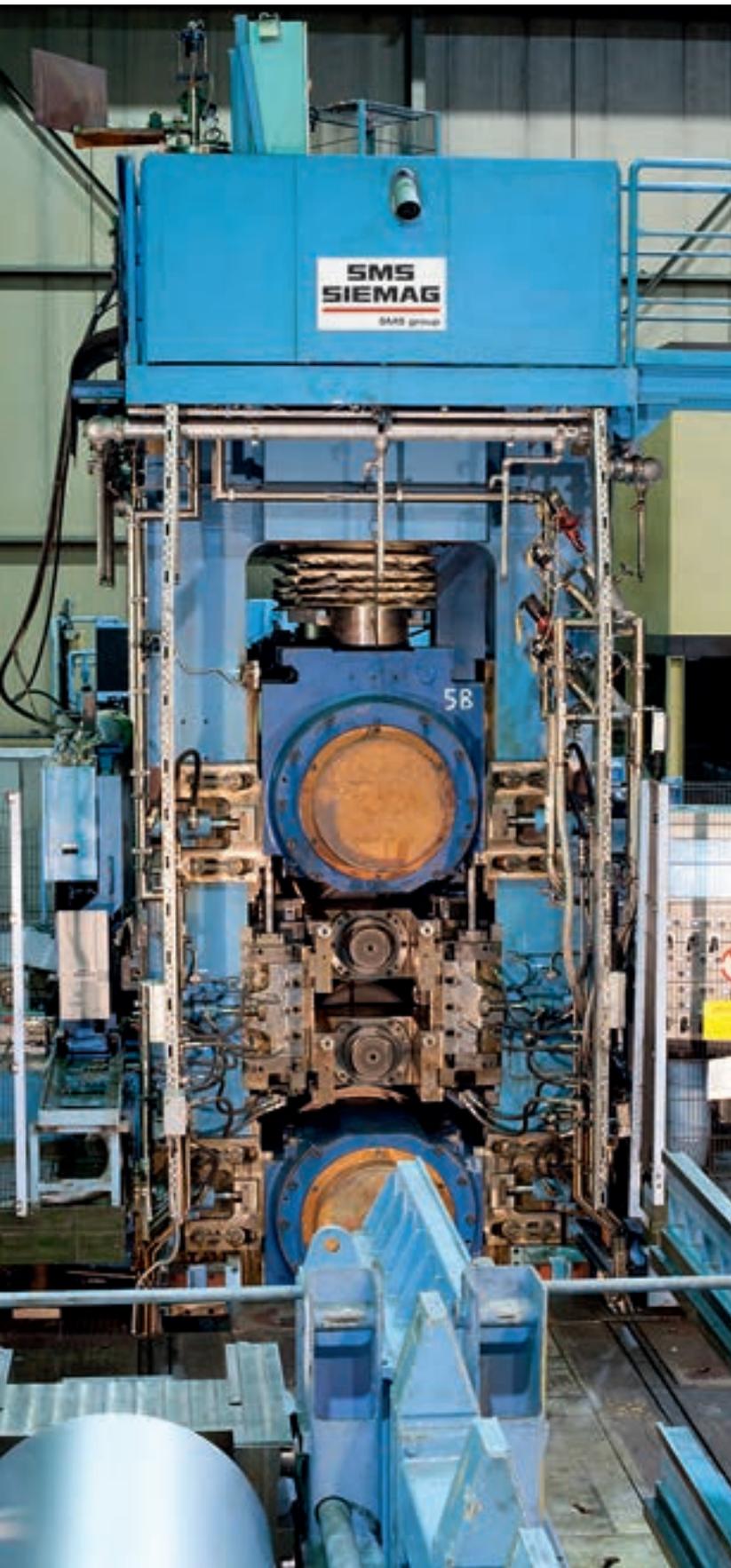
Minimal quantity lubrication

The minimum quantity lubrication LVL (Low volume lubrication) is a lubrication concept for skin-pass mills, which is also suitable for use in existing tandem mills. What makes it so special is that the system applies precisely the right amount of lubricant to the strip, necessary to reduce friction.

This method has the following advantages in skin-pass mills:

- There is less wear on the work rolls which increase their service life more than double.
- Reduces the rolling force required for skin-passing.
- The required lubrication quantities are reduced, with a positive impact on the environment. The strip surfaces are cleaner.
- The strip flatness is excellent, as the process opens up new possibilities for controlling the skin-pass process.
- By loading the work rolls and the strip in the outlet with inert gas, the roughness of the rolls is retained for a longer time, and their service life is extended. This eliminates the downstream strip cleaning. All this is compact in design and suitable for low cost retrofitting in existing skin-pass mills.

Conclusion: LVL increases the proportion of wet skin-pass products and minimizes operating costs. The lower amount of lubricant required also means better environmental sustainability.



Skin-pass mill with LVL system.



Atomizing the lubricant by compressed air.



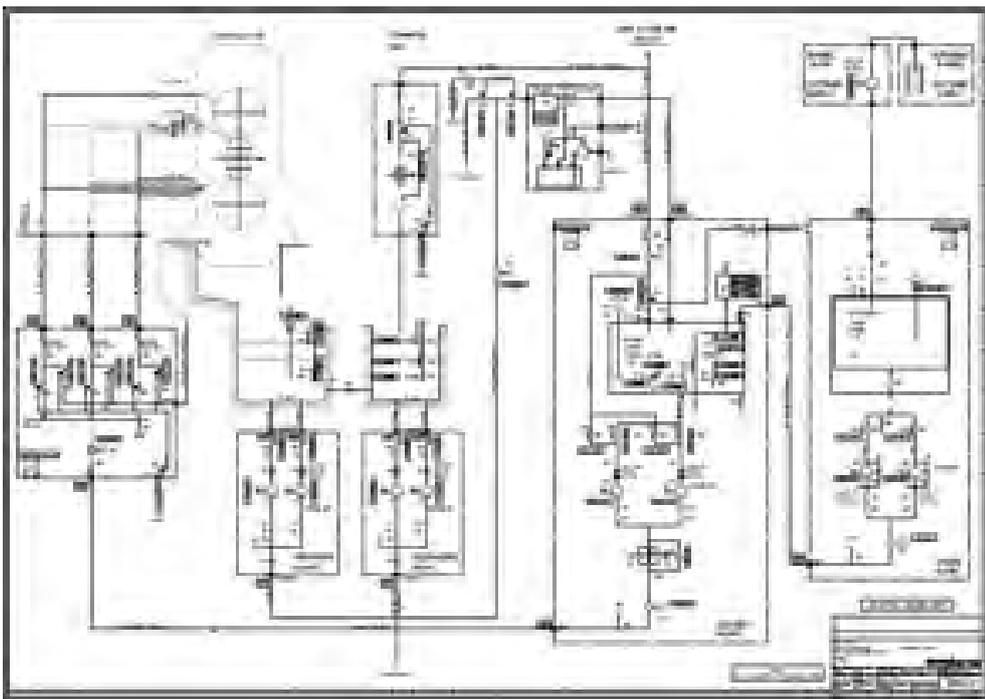
Ecological Solution - From the Stand to the Stand

Closed loop wet skinpassing

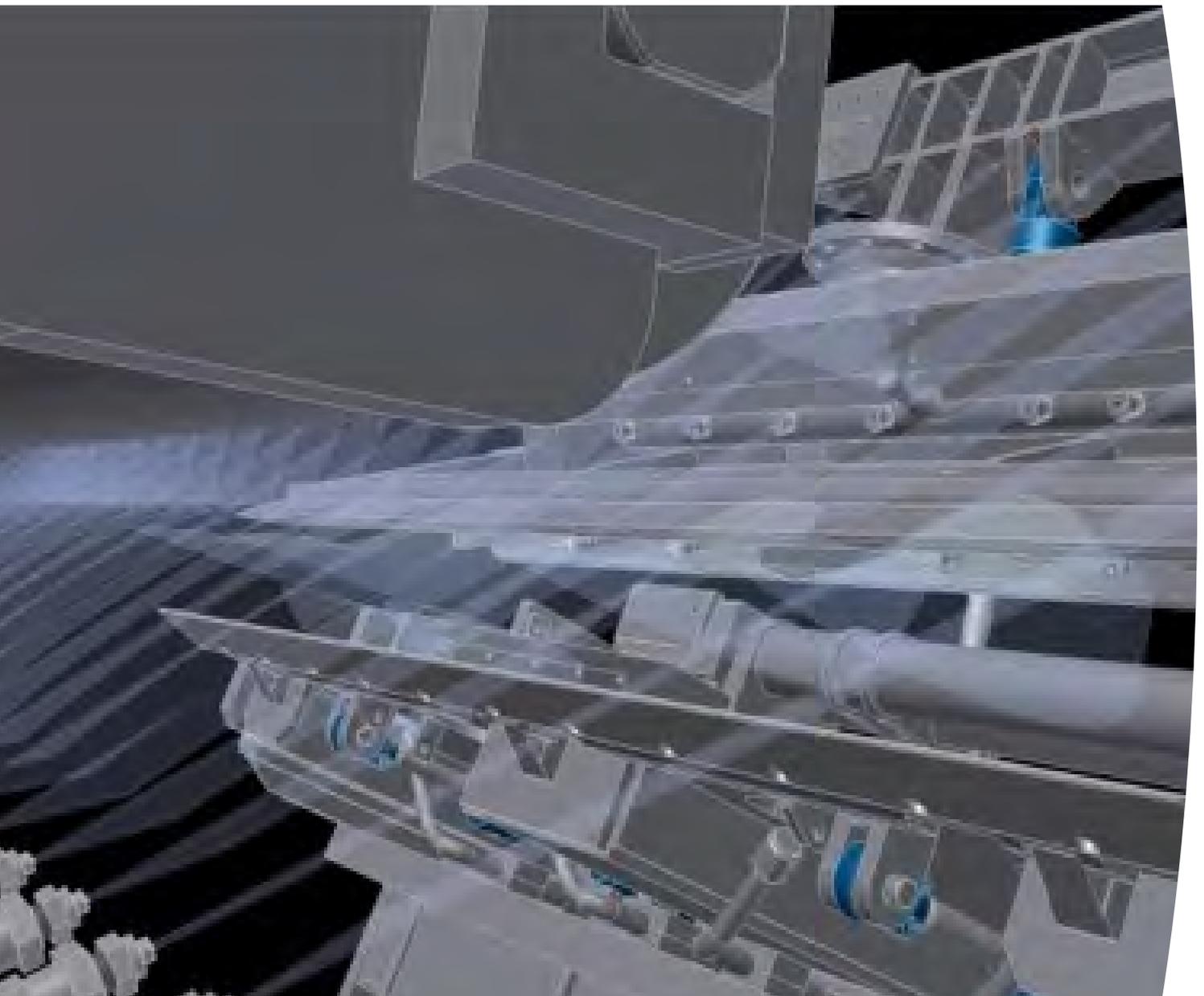
The innovative system of wet tempering with a close loop circuit is designed to reduce energy and waste water.

Wet skinpassing offers following main advantages:

- Less roll marks
- Production increased about 20% (less intervention)
- Lower separating force required
- Higher elongation achievable
- Better surface quality
- Environment friendly: no waste water to be disposed



Reference scheme.



3D rendering.

Quality features

High-tech components

Flatness measurement roll

The measurement of flatness is of crucial importance for the production of high quality steel strip. SMS group builds therefore its own flatness measuring system branded “X-Shape”, which is based on the BFI principle. The roll is characterised by a closed surface, which not only prevents marking of the strip, but also allows coating of the roll with any material. The sensors can be adjusted very flexibly according to the multi- zone cooling. Thus, current as well as future requirements on the flatness system can be met.

Online residual oil detection

The current system is called EMG Solid and is provided by EMG, member of SMS group.

Advantages for the processes:

- improved process stability and reliability
- transparency of input quality and targeted control of the forming process
- minimized scrap
- secure production confirmation
- intelligent combination of more quality assurance systems from EMG:
- electro mechanical and in respect to the software environment, especially
- IMPOC for online measurement of material characteristics
- SORM 3plus for online roughness measurement
- additional systems, e.g. thickness measurement/ laser marking can be integrated

- transparency of the essential quality features
- delivery and system integration from a single source
- joint database and combined visualization of the
- measured values possible

X-Roll®

Our skin pass mills are equipped with sophisticated control and regulation systems. Depending on the application, they have technological detection and control systems for:

- rolling force
- skin-pass elongation
- strip tension
- flatness
- roughness
- residual oil
- mechanical wear.

For example, our X-Roll® technology package enables effective pre-control of the skin pass rate. As a result, dimensions can be reduced, in particular during start-up and acceleration of the system, and the skin-pass rate and flatness can be kept within the narrowest tolerances.

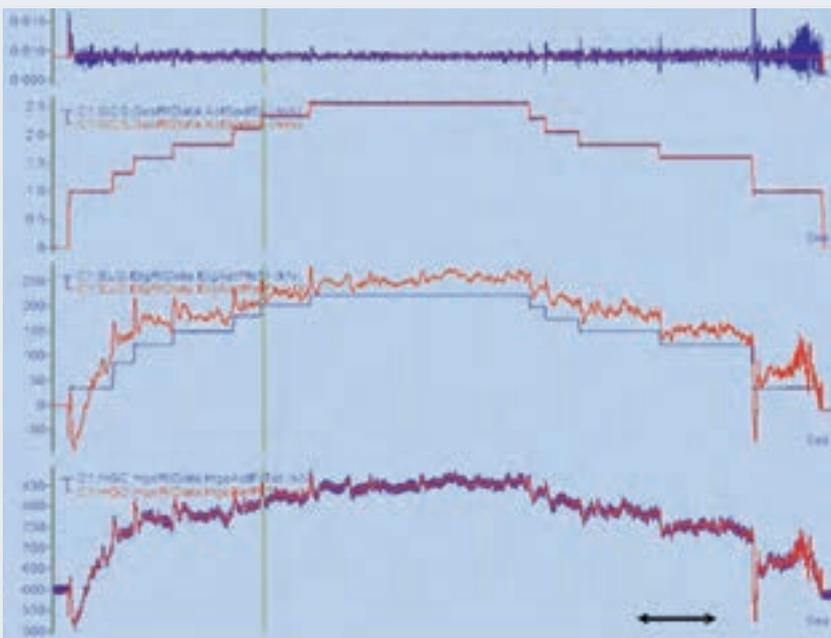
Conclusion: thanks to their high-tech components, our skin pass coaters are already able to meet tomorrow’s requirements. Future challenges for skin-pass mills aim at greater flexibility with regard to the skin-pass rates and the range of products to be rolled. The requirement on surface quality will also continue to rise. At the same time, the operating costs must be reduced. Another contributing factor is the prudent use of lubricants, which is also useful for environmental reasons.



Online measurement system for measuring the residual oil content.



X-shape flatness measurement roll.



Operating results for the skin-pass elongation control using X-Roll pre-control.

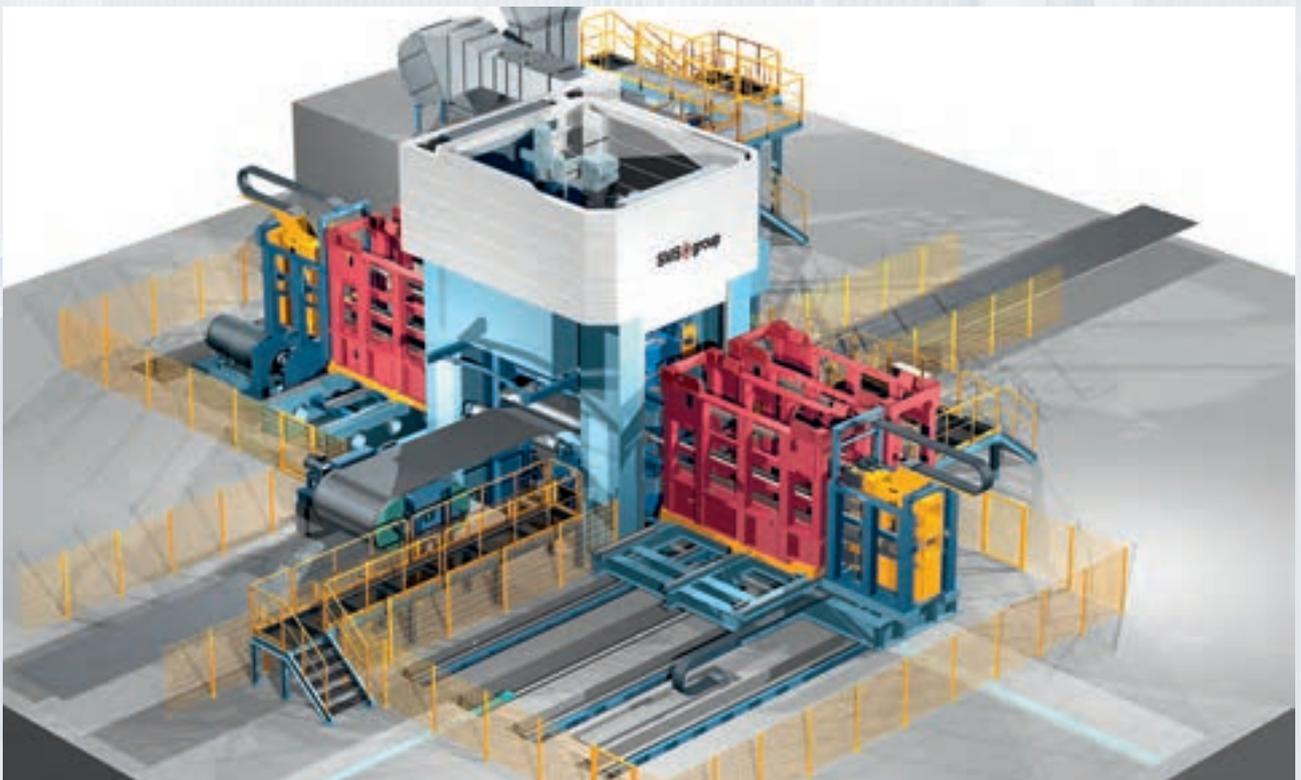
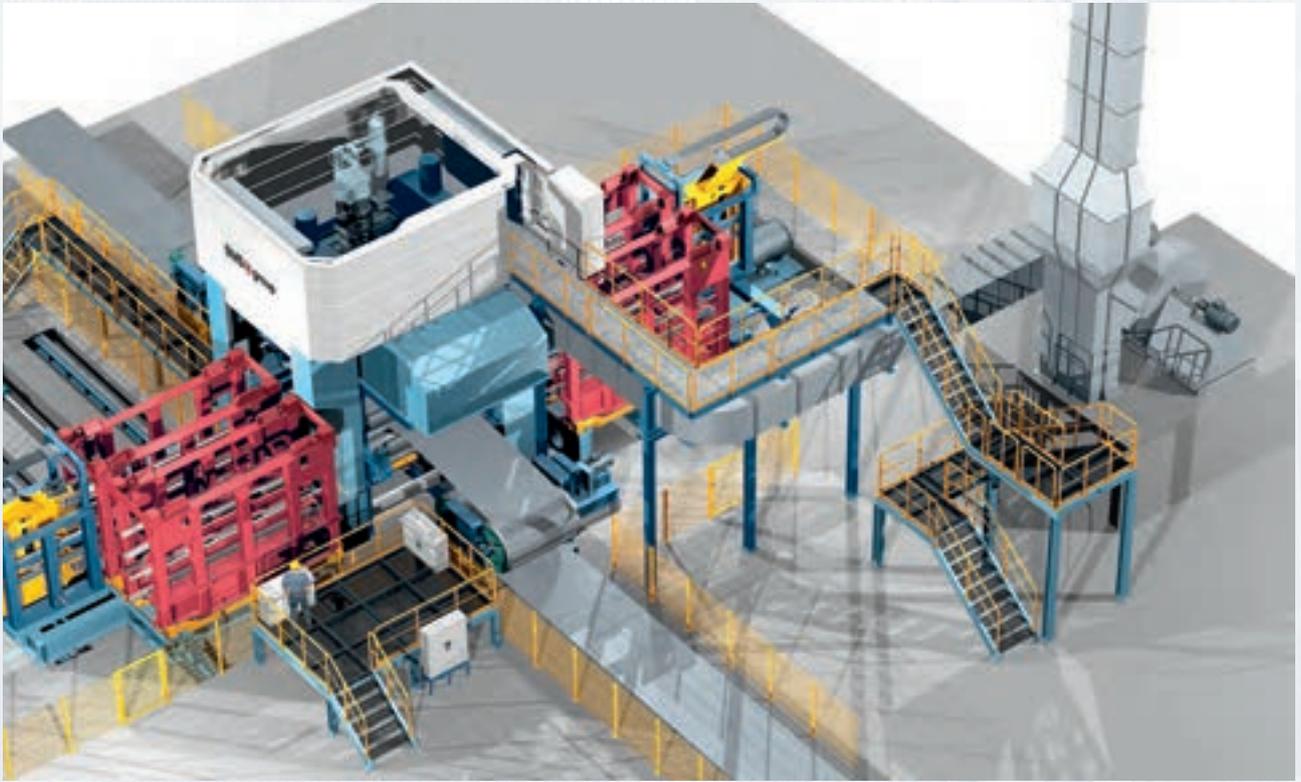
Inline skin-pass mills for all processing lines

Quality at the running strip

Integrated in the exit section of annealing or hot-dip galvanizing lines, or Pickling line of multi-purpose line (CAL-CGL; CGL-CPL, etc.), the skin-pass mills ensure the perfect finish of the strip treatment.

Between 1999 to 2019, we delivered more than 65 inline skin-pass mills, for operation in:

- continuous hot-dip galvanizing lines
- continuous annealing lines
- continuous pickling lines
- combined continuous annealing and pickling lines
- combined continuous annealing and hot-dip galvanizing lines
- a combined continuous pickling and hot-dip galvanizing line



Shandong Rizhao, China

Complete hot and cold rolling complex with three inline skin-pass mills

The task

SMS group delivered a complete hot and cold rolling complex to Shandong Iron and Steel Rizhao, Shandong Province, on the east coast of China. It includes a wide hot rolled strip mill, a pickling tandem mill, a hot dip galvanizing line and two annealing lines.

Our solution

The produced cold strip is completely finished in two annealing lines and one hot-dip galvanizing line. All three lines are equipped with an inline skin-pass mill in the exit area. The annealing lines are 6-high, while the skin-pass function in the hot dip galvanizing line is performed by a 4-high. The skin-pass mills of the annealing lines are largely identical. They differ in terms of the strip width and thickness ranges they process. On the other hand, the 4-high skin-pass mill can process any strip dimensions and qualities. In all three mills, the roll change in the push-through operation can be done with the threaded strip, thus reducing the downtime and ensuring high productivity. The dimensioning of the back-up rolls is identical in all three designs, which simplifies the handling and the provision of rolls.

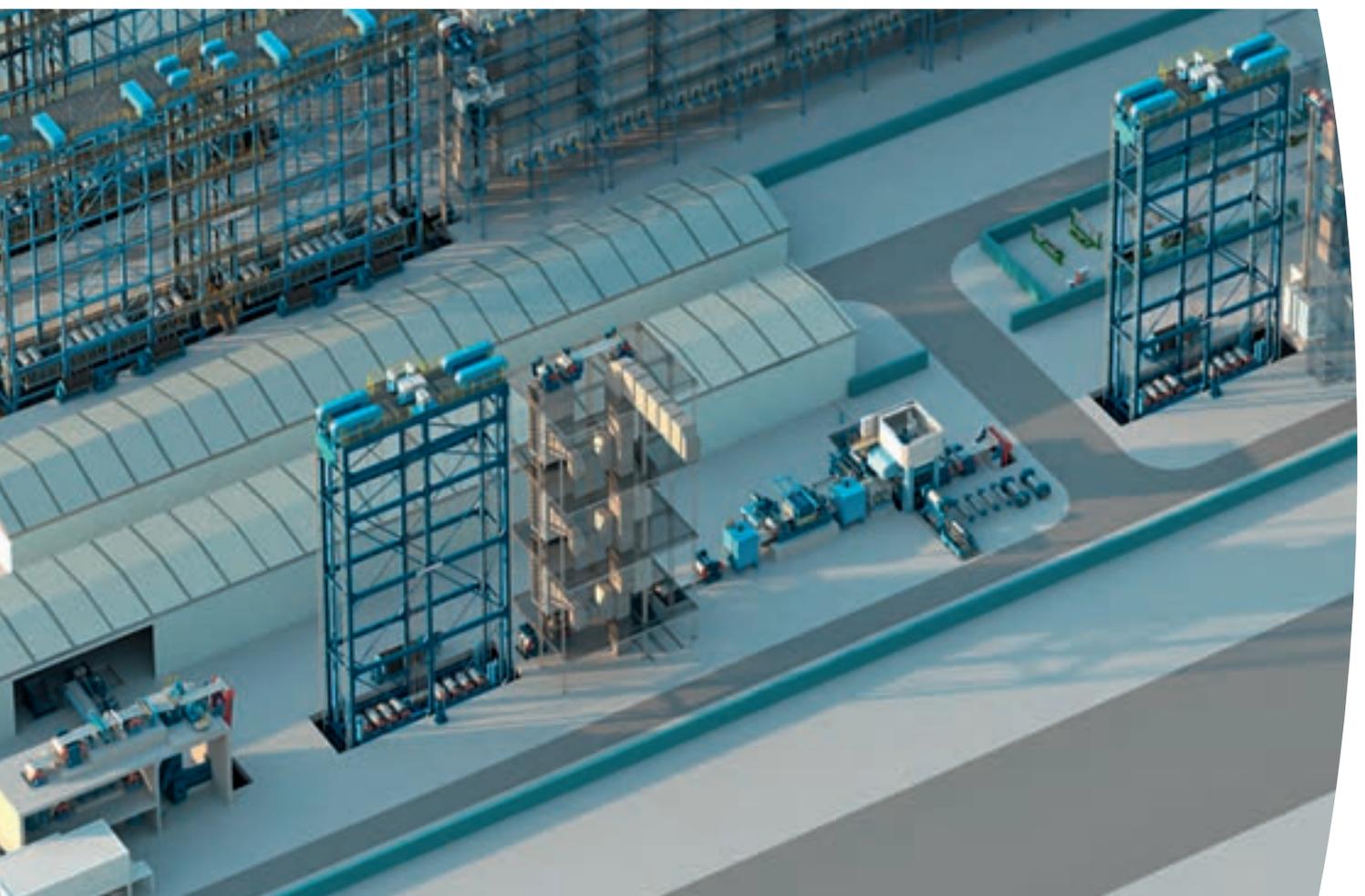
The result

By investing in high-quality equipment combined with the innovative Product Quality Analyzer (POA), Shandong Iron and Steel Rizhao has one of the most advanced plants in the world. Starting from 2018, tube grades, cold rolled steel for construction and household appliance industry, as well as sophisticated steel grades for the automotive industry are manufactured here.

The ISPM are each integrated into the exit areas of the strip facilities of Shandong Iron and Steel Rizhao. The chart shows a detail of the hot-dip galvanizing line in the foreground. Two annealing lines are arranged behind.



Production data	CAL 1880	CAL 1630	CGL
Rolling	CQ, DQ, DDQ, EDDQ, SEDDQ, CQ-HSS, DQ-HSS, DP, TRIP	CQ, DQ, DDQ, EDDQ, SEDDQ, CQ-HSS, DQ-HSS, DP, TRIP	CQ, DQ, DDQ, EDDQ, SEDDQ, BH, HSLA, HSS, DP, TRIP
Strip width	1,880 – 1,000 mm	1,630 – 900 mm	1880 – 900
Strip thickness	2.00 – 0.40 mm	2.50 – 0.30 mm	2.50 – 0.30 mm
Skin-pass elongation	max. 2 %	max. 2 %	max. 2 %
Technical data			
Mill design	CVC®plus 6-high	CVC®plus 6-high	4-high
Roller diameter			
Work roll no. 1	620 – 570 mm	620 – 570 mm	450 – 400 mm
Work roll no. 2	400 – 350 mm	400 – 350 mm	650 – 600 mm
Intermediate rolls	700 – 620 mm	700 – 620 mm	N/A
Back-up rolls	1150 – 1000 mm	1150 – 1000 mm	1150 – 1000 mm
Rolling speed	Max. 820 m/min	Max. 820 m/min	Max. 220 m/min
Annual capacity	950,000 t	650,000 t	400,000 t
Technical characteristics	Hydraulic adjustment, work and intermediate roll bending, X-Shape flatness measuring roll, automatic work roll shift	Hydraulic adjustment, work and intermediate roll bending, X-Shape flatness measuring roll, automatic work roll shift	Hydraulic adjustment, work roll bending, high-pressure cleaning for rolls, automatic work roll shift



Big River Steel, Arkansas, USA

Inline skin-pass mill for America's state-of-the-art steel plant

The task

North America's state-of-the-art and most environmentally friendly integrated steel plant is located directly on the banks of the Mississippi River in Osceola, Arkansas. In 2014, the steel producer Big River Steel (BRS) commissioned SMS group to deliver the complete flat steel complex. The first plants started operations in 2016.

The motto BRS has set for its market entry is "New Depths in American Steelmaking". It characterises the product range, which contains sophisticated niche products for which there is a growing market in the USA. The product mix includes also grades for pipelines, silicon steels for electric steels and advanced high strength grades for the automotive industry in the U.S.

Our solution

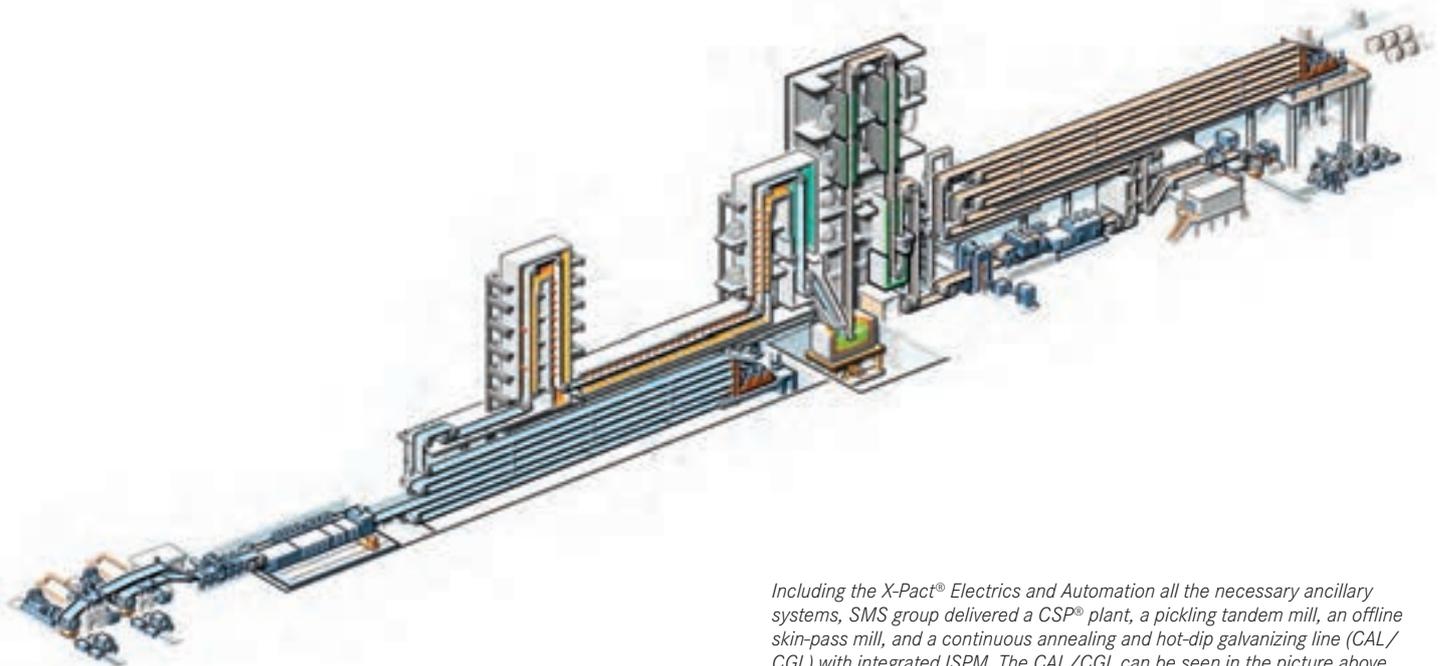
SMS group's range includes a flexible continuous annealing and hot dip galvanizing line (CAL/CGL), which is designed for efficient and sustainable production, including high-strength grades. The hot-dip galvanized cold-rolled strip treated here is used predominantly in the automotive industry.

A 4-high inline skin-pass mill (ISPM) is integrated into the exit areas of CAL/CGL, that operates in wet skin-passing mode. All skin passage tasks are fulfilled by using hydraulic adjustment, work roll bending and variable work roll diameters.

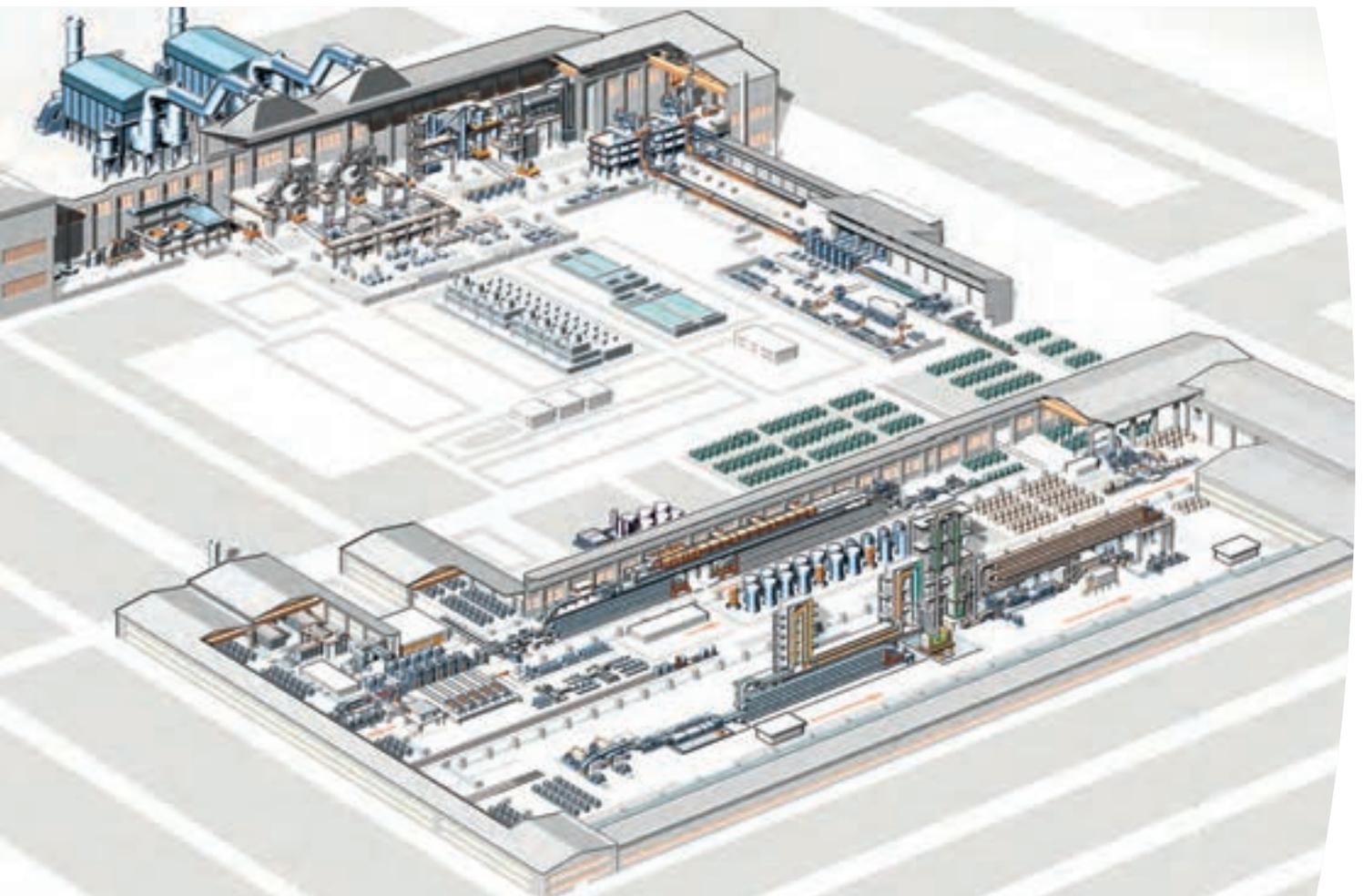
Production data	
Rolling	LC, AL-killed steel, VLC-IF, HSLA, DP, CP
Strip width	900 – 1,850 mm
Strip thickness	0.28 – 1.40 mm
Skin-pass elongation	2.5 %
Technical data	
Mill design	4-high
Roller diameter	
Work roll no. 1	570 – 620 mm
Work roll no. 2	400 – 450 mm
Intermediate rolls	
Back-up rolls	1000 – 1100 mm
Rolling speed	Max. 220 m/min
Annual capacity	484,000 t
Technical characteristics	Hydraulic adjustment, work roll bending, automatic work roll shift, high-pressure roll cleaning device

The result

In its first phase, Big River Steel has a total annual capacity of 1.5 million tons for high-quality steels and special steels. With the implementation of the second phase of expansion it is planned to double these amounts



Including the X-Pact® Electrics and Automation all the necessary ancillary systems, SMS group delivered a CSP® plant, a pickling tandem mill, an offline skin-pass mill, and a continuous annealing and hot-dip galvanizing line (CAL/CGL) with integrated ISPM. The CAL/CGL can be seen in the picture above



Bengang Steel Plates (Benxi), China

Automotive qualities with world record strip width

The task

SMS group supplied three inline skin pass-mills to North China to the steel manufacturer Bengang Steel Plates Co. Ltd. (Benxi), which became operational in 2015, and 2016 respectively. They are part of a major contract that included a pickling/tandem mill, two continuous annealing lines and one hot dip galvanizing line. The three ISPMs are integrated in the strip systems.

Our solution

For the first time ever, a pickling/tandem mill and an annealing line were built with ISPM, which can process strip widths of up to 2,150 millimetres. The two annealing lines supplied are almost identical except for the strip width ranges. The record width was reached in line 1, while narrower strips up to 1,630 millimetres wide can be processed in line 2. The inline skin-pass stands are one of the highlights of the annealing lines as they ensure the required strip properties on both soft and high-strength steels alike.

The result

The ISPM annealing lines ensure a perfect "finish" at the end of the process by setting the yield strengths and the strip properties required for further processing, such as roughness and flatness. Both skin-pass mills in 6-high design are equipped for wet skin-passing. With CVC®plus, work and intermediate roll bending, as well as flatness control, have technically the best conditions, leaving no wish unfulfilled. The 6-high's large field achieves very good flatness results. In addition, a wide range of materials can be skin-passed because both designs can be equipped with different work roll diameters. With thinner work rolls, higher and high-strength steels can be skin-passed with a lower rolling force. Work rolls with a larger diameter allow soft steels to be skin-passed with sufficient rolling force and at the same time excellent roughness impression on the strip.

After both annealing lines went into operation in September and December 2015, the hot dip galvanizing line followed in October 2016. In this line, the steel strips are finished with a zinc or galvanized coating and finished in an ISPM, which is designed as a 4-high.



Drive side. The roll shift takes place in push-through operation.



ISPM in CGL: S-roll sets support the strip tension necessary for the skin-pass process.

Production data	CAL 2150	CAL 1630	CGL
Rolling	CQ, DQ, DDQ, EDDQ, CQ-HSS, DQ-HSS, DDQ-HSS, BH-HSS, DP, TRIP	CQ, DQ, DDQ, SEDDQ, CQ-HSS, DQ-HSS, DDQ-HSS, BH-HSS, DP, TRIP	CQ, DQ, DDQ, EDDQ, CQ-HSS, DQ-HSS, DDQ-HSS, BH-HSS, DP, TRIP
Strip width	2,150 – 1,000 mm	1,630 – 800 mm	1,870 – 800 mm
Strip thickness	2.50 – 0.50 mm	2.30 – 0.30 mm	2.50 – 0.40 mm
Skin-pass elongation	Max. 3 %	Max. 3 %	Max. 2,5 %
Technical data			
Mill design	CVC®plus 6-high	CVC®plus 6-high	4-high
Roller diameter			
Work roll no. 1	620/570 mm	620/570 mm	
Work roll no. 2	400/350 mm	400/350 mm	
Intermediate rolls	700/620 mm	700/620 mm	
Support rolls	1,150 – 1,000 mm	1.150 – 1.000 mm	
Rolling speed	Max. 820 m/min	Max. 820 m/min	Max. 250 m/min
Annual capacity	1,040,500 t	932,700 t	472,300 t
Technical characteristics	CVC®plus, work and intermediate roll bending, flatness control	CVC®plus, work and intermediate roll bending, flatness control	



ISPM in CAL: Bedienerseite mit Vorrichtungen für den schnellen Walzenwechsel.

Magnitogorsk Iron & Steel, Krasnoyarsk, Russia

Skin-pass mills for cold strip complex

The task

MMK is one of Russia's leading steelmakers and is expanding its production of high-quality cold-rolled and galvanized strip. These strips serve primarily for the production of automotive exterior and interior parts and are used, i.a. in home appliance and construction industry.

Our solution

SMS group supplied two 4-high skin pass mills with CVC®plus in a combined continuous annealing and hot-dip galvanizing line, as well as in a continuous hot-dip galvanizing line. In order to be able to skin-pass the required product range, work rolls with two different diameters are used.

For the skin-pass mill as well as the entire cold strip complex with strip treatment lines and coupled pickling/tandem mill, we supplied not only the mechanics, but also the X-Pact® Electrics and Automation.

The mechanical components were manufactured in our workshop Hilchenbach according to the highest quality standards. Pre-assembly and functional tests of the most important parts of the plant ensured a rapid start of production.

The result

The plants were put into operation in 2012. The skin-pass rolling mills in the exit area of the two strip processing plants can skin-pass the entire production spectrum from soft to high-strength steels.

Production data	CGL	CAL/CGL
Rolling	CQ, DQ, DDQ, EDDQ, SE, IF, HSLA	CQ, DQ, DDQ, EDDQ, SE, IF, HSLA
Strip width	850 – 1,880 mm	850 – 1,880 mm
Strip thickness	0.28 – 3.0 mm	0.28 – 3.0 mm
Technical data		
Mill design	4-high design with CVC®plus	4-high design with CVC®plus
Roller diameter		
Work roll no. 1	400 – 450 mm	400 – 450 mm
Work roll no. 2	600 – 650 mm	600 – 650 mm
Back-up rolls	1,150 – 1,250 mm	1,150 – 1,250 mm
Rolling speed	Max. 250 m/min	Max. 457 m/min
Annual capacity	450,000 t	250,000 t / 400,000 t
Technical characteristics	Hydraulic adjustment, CVC® at the work rolls, roll bending	Hydraulic adjustment, CVC® at the work rolls, roll bending



Inline skin-pass mill.



Looper and inline skin-pass mill at MMK.

ThyssenKrupp Steel Europe, Dortmund, Germany

Skin-pass with LVL (Low Volume Lubrication)

The task

In 2006, ThyssenKrupp Steel Europe AG commissioned us to modernise the continuous annealing in the cold rolling mill at Dortmund location. In this production line, ThyssenKrupp processes a wide range of steel grades from soft IF steels to high-strength TRIP steels. The purpose of the modernisation was to increase the availability of the system and to improve the product properties, especially with regard to the requirements of the automotive industry. Part of the contract was the modernisation of the in-line skin-pass mill.

Our solution

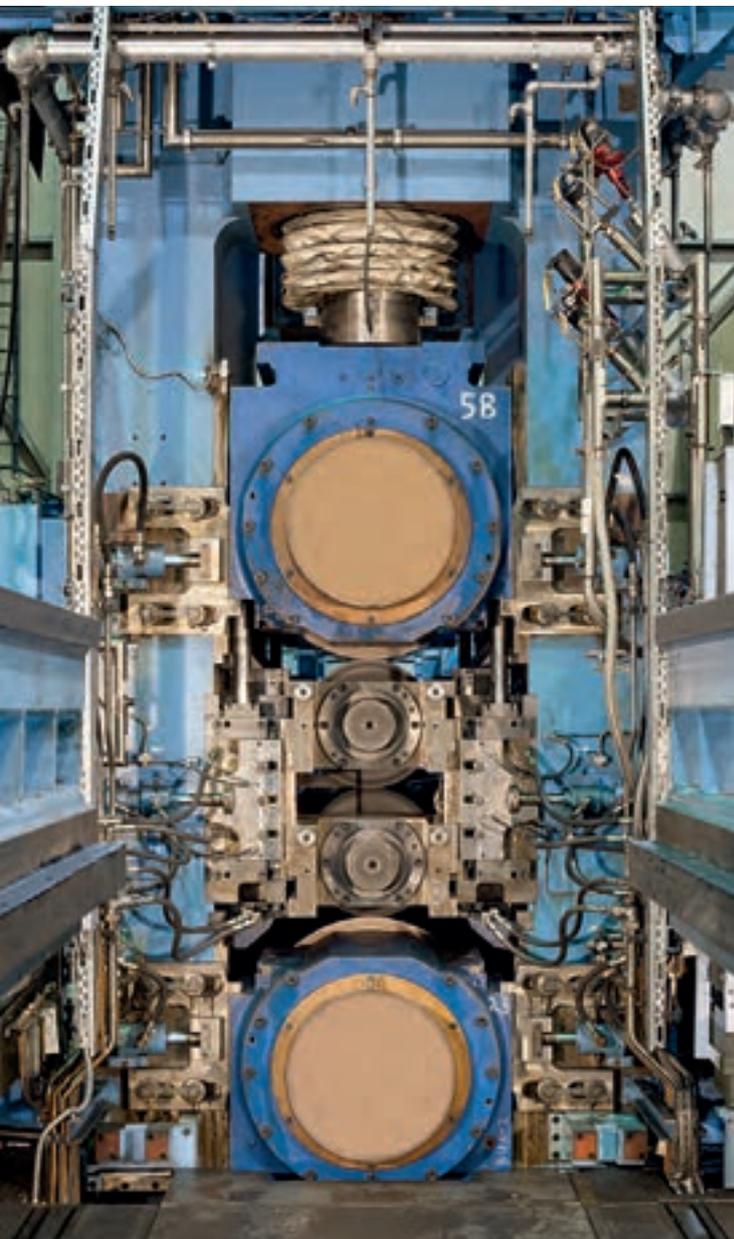
4-high skin-pass mill with CVC® plus, work rolls with two different diameters and minimum quantity lubrication. Through the use of different roll diameters, TKS is able to skin-pass both soft and high-strength steel grades.

The LVL convinced the people of Dortmund by the discontinuation of the emulsion plant, the compactness and simple installation of the equipment and the low oil consumption. Together with our X-Pact® automation and our X-shape flatness measuring roll we have achieved the modernization goals: higher plant availability and product quality.

The result

The plant, which has an annual capacity of 780,000 t, was put into operation in 2007. The new equipment concept is trend-setting. It improves conditions for further processing, makes a decisive contribution to reducing operating costs and has a positive impact on environmental sustainability. The plant configuration described here is interesting not only for new plants, but also for modernisation concepts of existing plants, not least because the conversion requires only short downtimes.

Production data	
Rolling	Soft IF steels up to TRIP grades
Strip width	600 – 1,720 mm
Strip thickness	0.4 – 2.3 mm
Technical data	
Mill design	4-high design with CVC®plus
Roller diameter	
Work roll no. 1	400 bis 450 mm
Work roll no. 2	600 bis 650 mm
Back-up rolls	990 bis 1,100 mm
Rolling speed	Max. 412 m/min
Strip tensions	125 kN inlet and outlet
Technical characteristics	Hydraulic adjustment, work rolls bending, LVL application of minimal quantity lubrication



Viewing window.



Entry: Atomizing of the lubricant by compressed air.
X-shape flatness measurement roll.

Offline skin-pass mills for hot and cold strip

The highest level of flexibility

The offline skin-pass mills for hot and cold strip from SMS group are independent rolling mills that can be flexibly operated from various process stages.

Since 2000, SMS group has been supplying 18 offline skin-pass mills for hot strip and cold strip, including stainless steel strip.



Big River Steel, Arkansas, USA

Strong offline skin-pass mills for high versatility

The task

In 2014, Big River Steel (BRS) commissioned SMS group with the complete delivery of a new state-of-the-art flat steel complex in Osceola, Arkansas. As one of the first plants, the offline skin-pass mill was put into operation in the spring of 2016.

Our solution

The offline skin-pass mill with an annual capacity of more than 400,000 t is located behind the batch annealing furnaces as part of the discontinuous process route. Its main task is to provide the annealed strips of carbon steel and non-grain oriented silicon steel with the necessary quality and material properties for the downstream processes. The technical equipment of the 4-high includes hydraulic adjustment (HGC), the use of different work roll diameters depending on the material requirements, as well as a dry strip system on the outlet side. The plant is designed for operating in wet mode. The use of different work roll diameters in combination with a given rolling force makes it possible to flexibly expand the range of products that can be skin-passed.

The result

A special feature of the BRS offline skin-pass mill is the high rolling force of a maximum of 18 MN. This allows a very high skin pass elongation of up to 8.5 percent. The high rolling force is needed in particular for the skin-passing of silicon steels.

In order to establish the tension required for the skin-pass process, tensioning rolls were installed on the entry and exit side.

The devices on the entry side include an uncoiler with strip centering, a coil preparation station and a system for removing the residual coils. On the exit side, the down-coiler was equipped with a strip winder (belt wrapper?) to support accurate winding of the finished strip while protecting the delicate surface of the strip. In addition, there is an oiling machine in the exit side.

Production data	
Rolling	LC, AL-killed steel, ULC-IF, HSLA
Strip width	1850 – 914 mm
Strip thickness	1.40 – 0.28 mm
Skin-pass elongation	Max. 8,5 %
Technical data	
Mill design	4-high
Roller diameter	
Work roll no. 1	650 – 600 mm
Work roll no. 2	450 – 400 mm
Back-up rolls	1,150 – 1,250 mm
Rolling speed	Max. 1000 m/min
Annual capacity	400.000 t
Technical characteristics	Hydraulic adjustment, DS (dry strip) system, strip centring



Strip preparation, uncoiler and tension roll set of a running, comparable offline skin-pass mill



Concept of a similarly configured offline skin-pass mill from SMS group.

Gazi Metal Mamülleri

Karasu, Turkey

Skin-pass mill for C and Si steel grades with an option for extension to a DCR mill

The task

Turkish company Gazi Metal Mamülleri contracted SMS group to build a new production facility for carbon steel and silicon steel cold strip near the town of Karasu. Our customer now supplies the finished strip to the automotive industry and manufacturers of household appliances. Included in our delivery, in the first stage of expansion, was i.a. a semi-continuous pickling line with integrated acid regeneration plant, a reversing cold rolling mill in 6-high design with CVC®plus technology, and a skin-pass mill in 4-high design. A special feature of this order is that right from the beginning, the mill was designed for future extension in a second construction stage. In the second stage, Gazi Metal intends to produce a total annual output of 700,000 t, and in addition to produce tinplate, which is used for the production of beverage and food cans.

Our solution

The skin-pass mill will be constructed in 4-high design and equipped with hydraulic roll gap adjustment. In the second construction phase, the plant will be expanded to include a second mill stand. The skin-pass mill can be converted into a DCR (Double Cold Reduction) mill capable of processing tinplate and carbon steel strip. The DCR mill allows, in addition to skin pass, a reduction in the thickness of the strip, which takes place in the first stand, while the skin passes occurs in the second stand. The foundations required for the expansion are already in place from the beginning. The existing uncoiler can be displaced so that the second roll stand can be built later on this position.



The result

The skin pass mill processes strip made of carbon steel and silicon steel with a width of 600 to 1,500 mm. The thickness ranges from 0.25 to 3.0 mm. The maximum rolling speed is 1,000 m/min. The annual capacity is 300,000 t. With the expansion of the plant to include a second rolling stand, the annual capacity will be increased to 475,000 t.



Production data	
Rolling	Low carbon steel, silicon steels
Strip width	600 bis 1,500 mm
Strip thickness	0.25 bis 3.0 mm
Skin-pass elongation	max. 9 %
Technical data	
Mill design	4-high design
Roller diameter	
Work rolls	400 bis 450 mm
Back-up rolls	1,050 bis 1,200 mm
Rolling speed	Max. 1000 m/min
Rolling force	18 MN
Technical characteristics	HGC



The skin-pass mill features a coil preparation station, visible in the foreground.

AM/NS Calvert Alabama, USA

Optimal solution for soft to high strength steels

The task

In Alabama, USA the joint venture ArcelorMittal operates with Nippon Steel & Sumitomo Metal Corp. a production complex for hot and cold strip, for which SMS group had supplied essential equipment. The factory produces and refines strips of carbon and stainless steels. The main customers for the high-quality products are the car manufacturers and suppliers in the southern US, but also the construction industry and the household appliances industry. Part of the cold rolling mill and the strip processing lines are a total of five skin-pass mills. Three skin-pass mills are integrated as inline mills in hot dip galvanizing lines, one in a continuous annealing line. The fifth one is an offline skin-pass mill, which is mainly used for skin-pass and reworking of cold rolled strip.

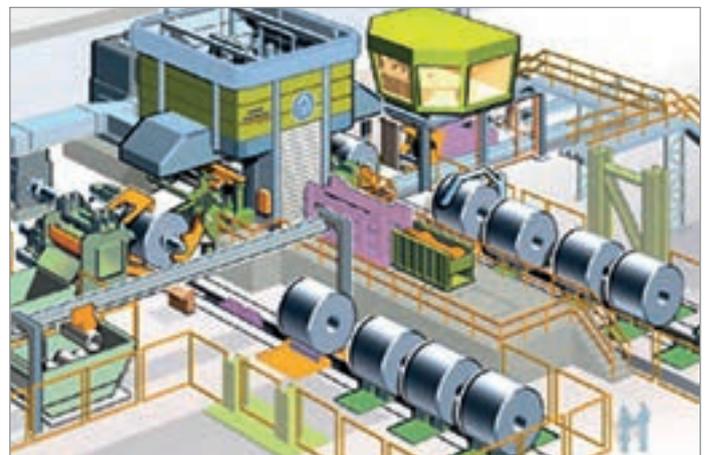
Our solution

The 5th mill is a 4-high design offline skin-pass mill for skin-passing annealed and hot-dip galvanised material. The mill has work roll bending and is equipped for skin-pass in wet mode. It can also wrap high-strength material. One of its special features is that it is equipped for the use of minimum quantity lubrication at the infeed.

The result

The offline skin-pass mill has an annual capacity of up to 700,000 t. It refines strips with widths between 800 and 1,870 mm. The minimum strip thickness is 0.3 and the maximum strip thickness is 3 mm

Production data	
Rolling	CQ, DQ, DDO, EDDQ, HS/BH, soft steels, DP steels annealed and unannealed (high-strength steels)
Strip width	800 to 1,870 mm
Strip thickness	0.3 to 3.0 mm
Coil weight	max. 36 t
Skin-pass elongation	0.3 to 2.5 %
Technical data	
Mill design	4-high stand
Rolling speed	max. 800 m/min
Rolling force	13 MN
Annual capacity	700.000 t
Technical characteristics	HGC, WRB, hydraulic roll gap control, work roll bending



The new steel mill complex in Alabama. The offline skin-pass mill is located in the cold rolling mill for carbon steels.



Salem Steel Plant

Salem, India

Glossy finish through technical highlights for stainless steel strip

The task

The Sail Group's Salem Steel Plant (SSP), in Salem, Tamil Nadu province in the south-west of the Indian subcontinent, had commissioned us in 2008 to supply a skin-pass mill for stainless steel strip. Skin-pass is carried out after cold rolling and recrystallisation of the stainless steel strip. This "gentle" rolling process is aimed at the production of high-gloss surfaces and the adjustment of the desired mechanical strip properties, such as deep drawing strength

Our solution

The dual reversing design of the skin pass mill has a mathematical model for the pass schedule calculation to achieve the productivity and quality of stainless steel strips. The automatic strip cleaning system ensures a clean strip surface. The hydraulic roller adjustment allows the optimum adaptation of the roller gap to the strip. The upper and lower glossy rollers are provided with a polishing device to remove dirt particles from the rollers. In order to prevent markings on the rolls at the beginning of the strip when the strip is threaded, a threading protection for the upper and lower rolls has been installed. Finally, the semi-automatic roll changing device ensures fast roll change and safe handling. The rolling stand was manufactured in our workshop in Hilchenbach and pre-assembled together with the infeed and outfeed devices to ensure a short assembly and successful commissioning. All hydraulic and electrical movements were tested thereby

The result

The dual reversing rolling mill is designed for AISI 200, 300 and 400 stainless steel strips. The plant can roll strips with widths of 600 up to 1,300 mm and thicknesses of 0.3 to 4.0 mm. With a stand drive power of 700 kW, maximum rolling speeds of up to 600 m/min can be reached. The objective of capacity is 100,000 t. The commissioning was carried out in 2009.

Production data	
Rolling	AISI 200, 300 and 400
Strip width	600 to 1,300 mm
Strip thickness	0.3 to 4.0 mm
Technical data	
Mill design	dual stand
Roll diameter	max. 800 mm
Rolling speed	max. 600 m/min
Rolling force	max. 12 MN
Strip tension	max. 200 kN
Annual capacity	100.000 t
Technical characteristics	<ul style="list-style-type: none"> - hydraulic roll gap AGC - oscillating roll cleaning device - new strip cleaning system - thread protection for upper and lower rolls - semi-automatic roll change - anti-crimping rollers in infeed and outfeed



Assembly of the rolling mill.



The system was pre-assembled and tested in our workshop.



This ensured fast commissioning.

Saudi Iron & Steel (Hadeed)

Sar-al-Jubail, Saudi Arabia

Skin-pass mill for hot strip

The task

Founded in 1979, Saudi Iron & Steel Company (Hadeed) is the largest steel producer in Saudi Arabia. In addition to long products, the company also produces hot and cold rolled flat steel products. At Sar-Al-Jubail production site, a skin-pass mill was to be built for the rolling and wrapping of hot-rolled strips of steel grades with a low carbon content.

Our solution

Our solution was a skin-pass mill for hot strip in 4-high design. We supplied all the mechanical equipment of the plant, consisting of an offline-coil preparation station, the skin-pass stand, the uncoiler and the downcoiler, and an inspection table where the strip quality can be examined. In addition, a hydraulic shear is located in the exit area. With it, the strip head is cut off, samples are cut out, and bundles are divided into different strip lengths.

The positive and negative work roll bending allows a maximum crowning range of adjustment. To ensure excellent flatness results and compliance with tolerances, the mill was equipped with a flatness measuring roll and control. This ensures perfect winding of the finished bundles. An uncoiler and downcoiler of proven design have expandable mandrels.

Production data	
Rolling	Steel strips with low carbon content
Strip width	800 to 1,650 mm
Strip thickness	1.2 to 6.0 mm
Skin-pass elongation	0.5 to 3.0 %
Technical data	
Mill design	4-high stand
Roll diameter Work rolls Back-up rolls	470 to 520 mm 1,000 to 1,100 mm
Rolling speed	460 m/min
Rolling force	15 MN
Annual capacity	700,000 t
Technical characteristics	Automatic flatness control Automatic control of elongation Automatic roll gap control Work roll bending

The result

The plant has been in production since 2006; it achieves a maximum rolling speed of 460 m/min. It is designed for the skin-pass of strips with thicknesses from 1.2 to 4.0 mm and recoiling up to 6.0 mm. The annual capacity is 700,000 t.



Tension reel on exit side.



Rolling stand.



Skin pass mill with downcoiler in the exit area.

Skin pass mills for stainless steel

In the world of the Skin Pass Mills, a section is dedicated to the skin pass mills of the Stainless Steel Strips. Stainless steel is a high-quality material for a large variety of applications. Stainless steel is used everywhere where resistance to corrosion, aesthetic appearance and long service life are in demand.

The following are areas of application for stainless steel :

- Architecture and façade cladding
- Chemicals and petrochemicals
- Medical technology and food industry
- Household goods
- Vehicle construction
- Offshore engineering and shipbuilding

Design for hot and cold rolled strip Applying a gloss finish to stainless steel strip

The next stage after cold-rolling and recrystallization is skin-passing the stainless steel strip. This produces high-gloss surfaces and achieves the desired mechanical strip properties such as deep-drawing strength. Skin-passing is performed on 2-high reversing mill stands or 4-hi.

What's evident today is that customers are increasingly choosing 4-high designs. You can also opt for a combined 2-high and 4-high stand solution. There are two versions to suit various plant configurations: inline skin-pass mills are integrated in the annealing and pickling line and/or the bright annealing line, while offline mills are installed downstream. To ensure a brilliant strip finish, the SPM features:

- Hydraulic roll gap adjustment (AGC)
- External bending for 2-high mills
- Automatic quick roll change device
- Automatic paper feed
- Roll polishing device (for both 2Hi or 4Hi)
- Strip cleaning system
- Strip/roll polishing devices with dedicated suction system
- Anti-crimping rolls on the entry and exit sides
- X-Shape flatness control in closed loop design

Main technical data	
Materials	AISI 200, AISI 300, AISI 400
Strip width	600 - 1,300 mm
Strip thickness	0.3 - 4.0 mm
Rolling speed	max. 600 m/min
Capacity	approx. 200,000 t/y



Inline and Offline Skin Pass Mill for CAPL, complete with strip and roll polishers, including dust suction systems.



Skin Pass Mills for Special Applications

The Skin Pass Mill special applications are the SPMs installed in “particular” lines for the process of black or pickled strips to obtain coils or sheets. Thanks to SMS long standing experience, also the references in this field are numerous. Such installations significantly contributed to the success of the End Users giving them the possibility to improve their market position.

In this category of Skin Pass Mill, we found:

- Skin Pass Mill into Continuous Pickling Line, mainly for Strip roughness improving; strips suitable for galvanizing lines or painting lines
- Skin Pass Mill into Cut-to-Length line for skinpassing thick and high strength strips ranging up to 1-inch thickness, yield strength above 1.000 MPa and over 2m width.

The 4-high Skin Pass Mill has the following main characteristics:

- Imparting plastic deformation along the strip section in order to reduce residual stresses in the material
- Improving strip surface appearance
- Heavy stand design with the possibility to achieve up to 50MN rolling force in order to maximize the production flexibility and to enlarge the product portfolio
- Heavy bending dedicated to strip profile improvement
- Advanced automation package like thickness and width gauge system, Automatic Flatness Control (AFC) system, automatic strip defect detection system, CPC, EPC, coil ID optical scanners

Production data	
Rolled material	Hot or Pickled
Strip width	600 to 2,100 mm
Strip thickness	1,5 to 25,4 mm
Skin-pass elongation	up to 2,0 %
Coil weight	max. 35 t
Technical data	
Mill design	4-high stand
Roll diameter	520 / 470 to 563 mm
Rolling speed	50 m/min
Rolling force	50 MN
Technical characteristics	Hydraulic rolling gap control, Wet system (dry strip)



Reference List

Inline skin-pass mill in continuous annealing (CAL/CGL/HDGL) since 2000

No.	Customer	Order year	Annual capacity	Plant concept
1	Thyssen Krupp, Germany	2000	400,000	4-high ISPM in HDGL
2	Boasteel (Beibao), China	2000	750,000	4-high ISPM in CPL
3	Vega do Sul, Brazil	2001	400,000	4-high ISPM in CGL
4	CSN Industria de Aços Revestidos SA, Araucaria, Brazil	2002	330,000	4-high ISPM in HDGL
5	Marcegaglia S.p.A., Ravenna, Italy	2003	—	4-high ISPM in CPL#2
6	SeAH Steel Corp., Kusan City, Seoul, South Korea	2003	300,000	4-high ISPM in HDGL
7	Maanshan Iron & Steel, Maanshan, China	2003	350,000	4-high ISPM in HDGL
8	Winner Steel, USA	2003	250,000	ISPM in HDGL
9	Arcelor Mittal Bremen, Germany	2003	—	4-high ISPM in HDGL
10	Angang New Steel, Anshan, China	2003	1,000,000	6-high ISPM in CAL
11	WISCO-Wuhan Iron & Steel Comp., Wuhan, China	2004	990,000	6-high ISPM in CAL
12	WISCO-Wuhan Iron & Steel Comp., Wuhan, China	2004	405,000	4-high ISPM in HDGL
13	WISCO-Wuhan Iron & Steel Comp., Wuhan, China	2004	475,000	4-high ISPM in HDGL
14	WISCO-Wuhan Iron & Steel Comp., Wuhan, China	2004	405,000	4-high ISPM in HDGL
15	Narkontai Strip Mill Public Co. Ltd. (NSM), Thailand	2004	500,000	ISPM in HDGL
16	USS Kosice, Czech Republic	2005	410,000	4-high ISPM in HDGL
17	Bir Steel South Inc., Severcorr , Columbus USA	2005	362,000	4-high ISPM in HDGL
18	Baoshan Iron/ Steel Baosteel, China	2005	730,000	6-high ISPM in CAL
19	Shougang Jing Tang, (SGJT) , China	2005	950,000	6-high ISPM in CAL
20	Hyundai Hysco, South Korea	2005	750,000	4-high ISPM in CAL/CGL
21	Thyssen Krupp Steel, Dortmund, Germany	2006	780,000	4-high ISPM in CAL
22	Ilva S.p.A., Cornigliano, Italy	2006	470,000	4-high ISPM in HDGL

23	Ilva S.p.A., Taranto, Italy	2006	600,000	4-high ISPM in HDGL
24	NUCOR Steel , Decatur, USA	2006	550,000	4-high ISPM in HDGL
25	CBASCO, Iran	2006	390,000	6-high ISPM in HCGL
26	AO Magnitogorsk Iron & Steel Works, Magnitogorsk, Russia	2007	450,000	4-high ISPM in HDGL
27	Thyssen Krupp Steel, Alabama, USA	2007	475,000	4-high ISPM in HDGL
28	Thyssen Krupp Steel, Alabama, USA	2007	515,000	4-high ISPM in HDGL
29	Thyssen Krupp Steel, Alabama, USA	2007	545,000	4-high ISPM in HDGL
30	Shougang Jing Tang (SGJT), Beijing, China	2007	—	4-high ISPM in CGL
31	Shougang Jing Tang (SGJT), Beijing, China	2007	—	4-high ISPM in CGL
32	AO Magnitogorsk Iron & Steel Works Magnitogorsk, Russia	2007	400,000 (annealed)	4-high ISPM in CAL/CGL
33			250,000 (galvanized)	
34	Thyssen Krupp Steel, (TKS-Compass), Alabama, USA	2007	565,000	4-high ISPM in CAL/CGL
35	Shougang Jing Tang, (SGJT), Beijing, China	2007	830,000	6-high ISPM in CAL 2
36	Shougang Jing Tang (SGJT), China	2008	1,117,500	6-high ISPM in CAL
37	Handan Iron & Steel, China	2008	1,040,000	6-high ISPM in CAL
38	Ilva S.p.A., Cornigliano, Italy	2008	470,000	4-high ISPM in HDGL
39	Severstal Columbus SeverCorr, USA	2008	544,000	4-high ISPM in HDGL
40	Pro-Tec Coating Company (American Customer), Ohio, USA	2010	454,500	4-high ISPM in CAL
41	Shagang Group, Zhangjigang, China	2011	320,000	4-high ISPM in HDGL
42	Shagang Group, China / Zhangjigang	2011	400,000	4-high ISPM in CAL
43	Shagang Group, China / Zhangjigang	2011	418,000	2-eng. 4-high ISPM in TIN-CAL
44	Panzihua I&S, China	2011	816,800	6-high ISPM in CAL
45	Panzihua I&S, China	2011	923,600	6-high ISPM in CAL
46	Handan Iron & Steel, China	2013	428,000	4-high ISPM in CAL
47	Angang Steel Company Ltd., China	2013	600,000	6-high ISPM in CAL
48	BISG Baotou Iron & Steel Group, China	2013	642,100	4-high ISPM in CAL 2
49	BISG Baotou Iron & Steel Group, China	2013	922,200	6-high ISPM in CAL 1
50	Bengang Steel Plates (BENXI), China	2013	1,040,500	6-high ISPM in CAL
51	Bengang Steel Plates (BENXI), China	2013	932,700	6-high ISPM in CAL
52	Angang Steel Company Ltd., China	2013	450,000	4-high ISPM in HDGL
53	Bengang Steel Plates (BENXI), China	2013	472,900	4-high ISPM in HDGL
54	Big River Steel, USA	2014	484,000	4-high ISPM in CAL/CGL
55	Wuppermann, Hungary	2014	500,000	4-high ISPM in PL/HDGL
56	Shandong Iron & Steel Group Rizhao Co., Ltd.,	2015	400,000	4-high ISPM in CGL
57	AO Magnitogorsk Iron & Steel Works, Magnitogorsk, Russia	2015	450,000	ISPM in HDGL
58	NAS North America Stainless, USA	2015	104,000	4-high ISPM
59	Shandong Iron & Steel Group Rizhao Co., Ltd., China	2015	650,000	6-high ISPM in CAL
60	Nucor-JFE Steel Mexico, Mexico	2016	400,000	4-high ISPM in CGL
61	SDI, Buffalo, USA	2019	500,000	ISPM in CGL

Reference List

Offline skin-pass mills

No.	Customer	Order year	Annual capacity	Plant concept
1	Mobarakeh Steel Complex, Iran	2001	—	4-high SPM
2	Vega do Sul, Brazil	2001	280,000	4-high SPM
3	Tangshan Iron & Steel, China	2002	960,000	4-high SPM
4	Jinan Iron & Steel, Shandong, China	2003	425000,000	cold-rolled, annealed hot-rolled, pickled, edged 4-high SPM
5	Saudi Iron & Steel (Hadeed), Saudi Arabia	2004	700,000	4-high for hot-rolled strip
6	JSW Steel Limited (Jindal), Toranagalu, India	2005	814,000 102,000	cold-rolled, annealed Hot-rolled, pickled, edged 4-high SPM
7	Bir Steel South Inc., Severcorr, USA	2005	—	4-high SPM
8	Tangshan Iron & Steel, China	2005	800,000	4-high SPM
9	Thyssen Krupp Steel, (TKS-Compass), Alabama, USA	2007	700,000	4-high SPM
10	Gazi Metal Mamülleri, Turkey	2011	425,000	4-high SPM
11	Ternium, Pesquera, Mexico	2012	700,000	4-high SPM
12	Big River Steel, USA	2014	413,000	4-high SPM
13	RZK, Turkey	2015	350,000	4-high SPM
14	HABAS, Turkey	2015	700,000	4-high SPM
15	BAOSTEEL Zhanjiang, China	2018	500,000	4-high SPM
16	SDI, Buffalo, USA	2019	400,000	4-high SPM



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