

Strip Processing Lines Product Portfolio, Technology and References



Efficient strip processing lines from the system supplier

For more than six decades SMS group has been designing, erecting and commissioning processing lines for carbon steel, electric steel, stainless steel and aluminum strip. Today, the comprehensive product range includes all the necessary plants for highest product quality. Common to all lines is the high cost-efficiency that results from modular designs, constant improvement, quality consciousness and a focus on saving resources.

Drawing on the combined strength of the companies in SMS group, the lines can be supplied from one single source. In this brochure you will find comprehensive information about our products, technologies, services and references regarding strip processing lines and strip processing equipment.



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Highlights

Numerous references

Since 2000, SMS group has attracted orders for much more than 200 strip processing lines for carbon steel, silicon steel, stainless steel and aluminum including all important line types.

Examples of metal producers using SMS strip processing technology

- Accia Speciali Terni
- Amag Austria Metall
- AM/NS Calvert
- Angang Steel Company
- Aperam Stainless
- ArcelorMittal
- ASAŞ Alüminyum
- Baoshan Iron & Steel
- Boatou Iron & Steel
- Bengang Steel Plates
- Big River Steel
- China Steel Corporation
- Coil Gmbh
- CSN-IMSA Aços Revestidos
- Gazi Metal Mamülleri
- Handan Iron & Steel
- Henan Zhongfu
- Hyundai Hysco
- Ilva
- JFE Steel
- Jinan
- JSW Steel
- Kobelco Angang Auto Steel
- Ma'aden-Alcoa Joint Venture
- Maanshan Iron & Steel
- Madar Coil Coating
- MMK
- MMPZ
- Nakornthai Strip Mill
- NAS - North American Stainless
- Nucor Steel
- Panzihua Iron & Steel
- PRO-TEC Coating Company
- Salzgitter Flachstahl
- SeAH Steel
- Severstal
- Shagang Group
- Shandong Nanshan
- Shougang Jingtang
- Shougang Corporation
- SSAB
- Steel Dynamics Incorporated
- TATA steel
- Tatmetal
- Tezcan
- thyssenkrupp steel
- Tianjin Tiantie
- Tianjin Zhongwang
- TISCO
- Tokyo Steel
- Tosyali Toyo
- US Steel
- Wuhan Iron & Steel
- Wuppermann Group

- **Market leadership**

The majority of market leaders among metal producers rely on SMS group technology.

- **High product quality**

Significant for all processing lines is the high-quality of the final product. Thus, the processing lines are specially equipped to ensure flawless surfaces and homogenous material characteristics.

- **Flexible production**

Flexible production conditions allow quick reaction to changing market demands with the greatest economic efficiency. SMS group has built several multi-purpose lines with changeable process routes.

- **System supply**

SMS group is capable of delivering almost all lines completely from one single source. This means that you get everything you need from one supplier, without any interface problems.

- **Production know-how**

SMS group offers process support for all materials and quality grades. This covers both metallurgical and design activities as well as support during commissioning, operation, quality control and certification.

- **Service**

Whether you want spare parts, modernizations, tailor-made maintenance procedures, or customized training programs: the Technical Service Division of SMS group is ready at 50 locations around the world to offer you service packages geared to the requirements of your processing lines.

- **Ecoplants**

All strip processing lines are designed to keep resource consumptions as low as possible. All technologies and processes are continuously evaluated in order to improve eco-friendliness. SMS group's ready to built fossil-free processing lines.

- **Project management**

Professional project management according to the latest knowledge and international standards ensures consistent and reliable fulfillment, in combination with modern design methods.

- **Manufacturing**

The set-up includes several modern and well-equipped manufacturing locations worldwide to ensure a high level of quality control and short distances to the customers.

- **Modernizations**

Comprehensive services and experience for revamps. Starting from the replacement of single machines up to major revamps of complete plants using several measures.

- **Electrics & automation**

In close collaboration with the customers SMS group designs tailored solutions and implement advanced technologies in line with customer requirements enabling complete automation and digitalization. Whatever plant the customer chooses, with X-Pact® leading automation SMS group provides the complete package of electrical and automation systems – ranging from the field devices to the production planning systems.

- **Digitalization**

With digital solutions that reduce the need for on-site personnel deployment and with climate-friendly solutions for CO₂-free steel production, SMS group and SMS digital meet the ever-increasing demands of sustainable industrial production.

Strip processing is based on processes

Strip processing line technology is driven by processes aimed at enhancing the material quality, and thus the value of the material, step by step. SMS group has extensive know-how and understanding of all important process steps. Depending on the different materials, SMS has developed special solutions to fulfill all special requirements.



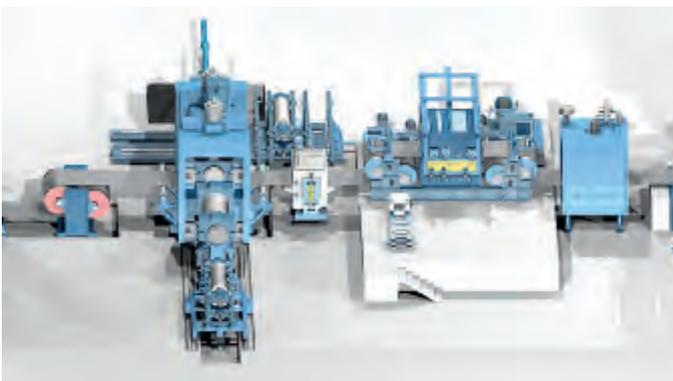
Pickling

- Carbon steel
- Silicon steel
- Stainless steel
- Aluminum



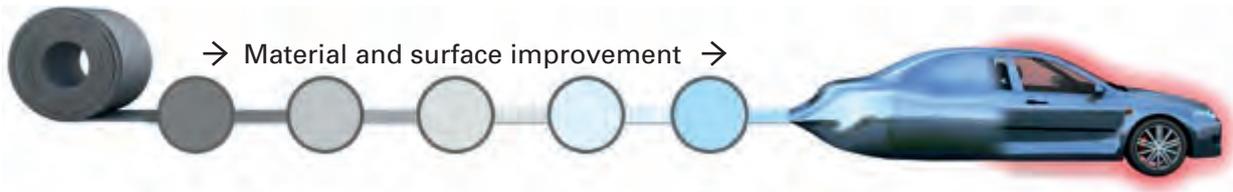
Annealing & cooling

- Carbon steel
- Silicon steel
- Stainless steel
- Aluminum



Tension leveling & skin-passing

- Carbon steel
- Silicon steel
- Stainless steel
- Aluminum



Hot-dip galvanizing

- Carbon steel



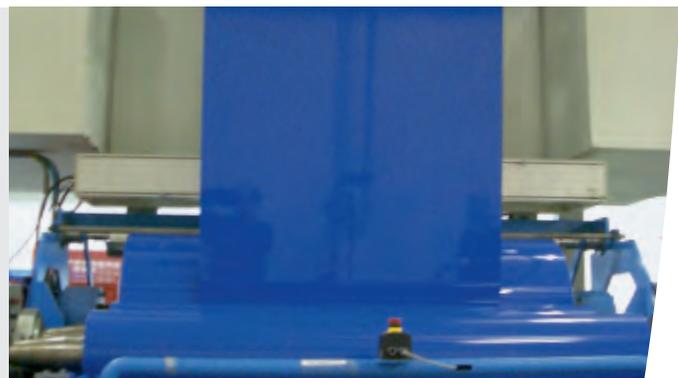
Electrolytic coating

- Carbon steel



Color and chemical coating

- Carbon steel
- Silicon steel
- Aluminum



Product Portfolio – Overview



**Pickling Line /
Tandem Cold Mills
(PLTCM)**

**Continuous
Pickling Lines
(CPL)**

See pages 22-37



**Continuous
Galvanizing Lines
(CGL)**

**Continuous
Annealing Lines
(CAL)**

See pages 42-57



**Annealing &
Coating Lines
(ACL)**

**Annealing &
Pickling Lines
(APL)**

See pages 70-79



**Hot-strip Annealing
& Pickling Lines
(HAPL)**

**Cold-strip Annealing
& Pickling Lines
(CAPL)**

See pages 80-87



**Heat & Chemical
Treatment Lines
(HCTL)**

**Heat Treatment
Lines
(HTL)**

See pages 88-101

Hot-strip Galvanizing Lines (HCGL)

See pages 38-41

Rolling technology

As a system supplier, SMS group offers also advanced rolling mill technology for all process routes of carbon, silicon, and stainless steel as well as for aluminum production

More information in separate SMS brochures or on www.sms-group.com

Universal Annealing & Galvanizing Lines (CALCGL)

Batch Anneal- ing Furnaces (BAF)

Color Coating Lines (CCL)

Tinplate Continuous Annealing Lines (Tin-CAL)

Electrolytic Tinning Lines (ETL)

See pages 58-59

See pages 60-69

Decarburizing & Coating Lines (DCL)

Intermediate Annealing Lines (IAL)

MgO Coating Lines (MgOCL)

Flattening & Coating Lines (FCL)

High tempera- ture annealing furnaces (HTA)

Hot- & Cold-strip Annealing & Pickling Lines (HCAPL)

Integrated Rolling, Annealing & Pickling Lines (IRAPL)

Bright Annealing Lines (BAL)

Besides these main lines, SMS group offers various other line concepts or variations of processes depending on the individual customer requirements. Revamps or integration of single components also belong to the product portfolio.

Furthermore, smaller lines such as electrolytic cleaning lines (ECL), tension leveling lines (TLL) or recoiling lines (RCL) can also be delivered. Process technological plants such as acid regeneration or hydrometallurgical plants complete the comprehensive portfolio.

Chemical Treatment Lines (CTL)

Color Coating Lines (CCLA)

System Supplier

SMS group is the only company worldwide capable of delivering strip processing lines as a full system supplier. That's because all products and services are available within the SMS group – from mechanical and process components through furnaces to electrical and automation, control and measuring systems, and all the associated know-how.

Mechanical Equipment

- Terminal equipment
- Skin-passing mills
- Tension levelers
- Side trimmer units
- Cross-cutting shears
- Strip accumulators

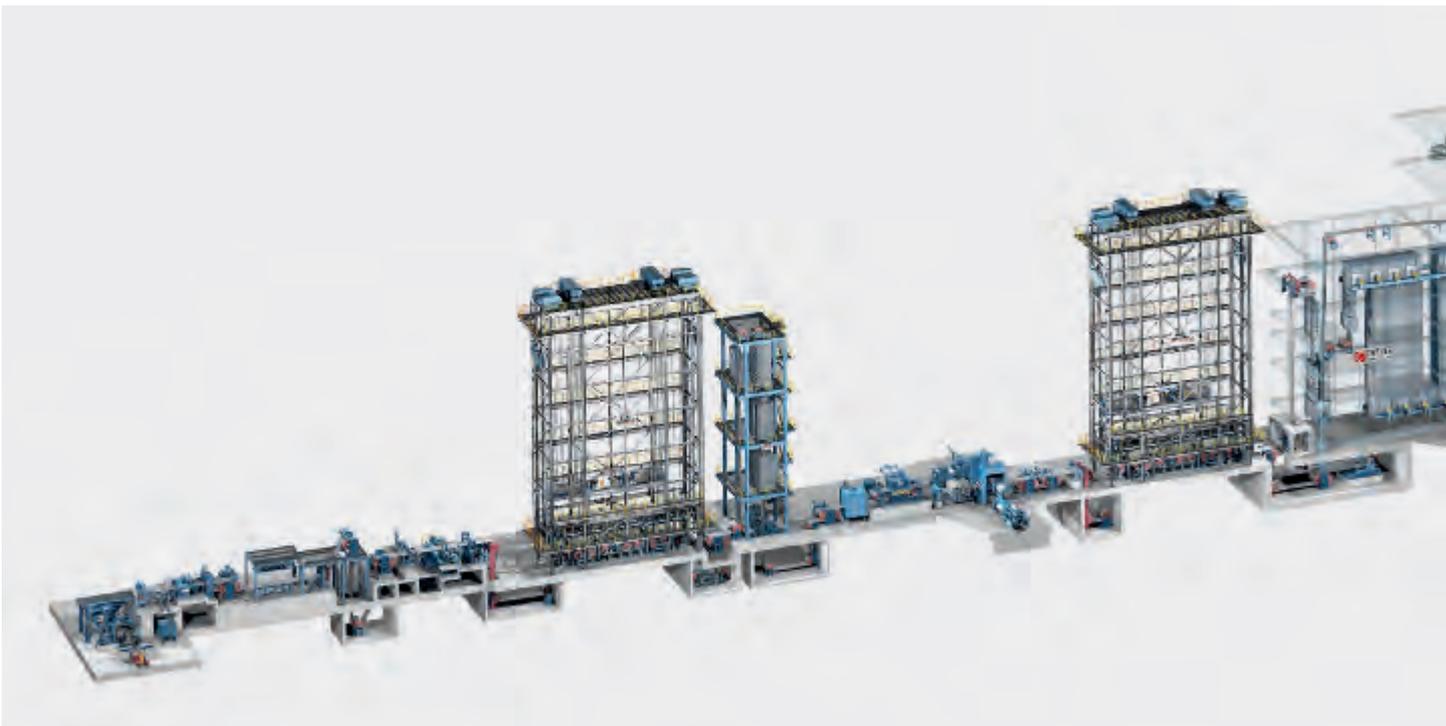
Processes

- Cleaning sections
- Pickling sections
- Galvanizing sections
- Coating sections
- Tinning sections
- Electrostatic oilers

Furnaces

- Full-radiant tube furnaces
- Direct-fired furnaces
- Inductive heating
- Floatation furnaces
- Catenary furnaces
- Flattening furnaces
- Decarburization furnaces

SMS group is capable of delivering strip processing lines with all necessary components and services from one source.



Advantages due to complete system supply:

- Perfect match of all components
- Clear responsibility
- One face to the customer
- Fast start-up

Electrics & Automation

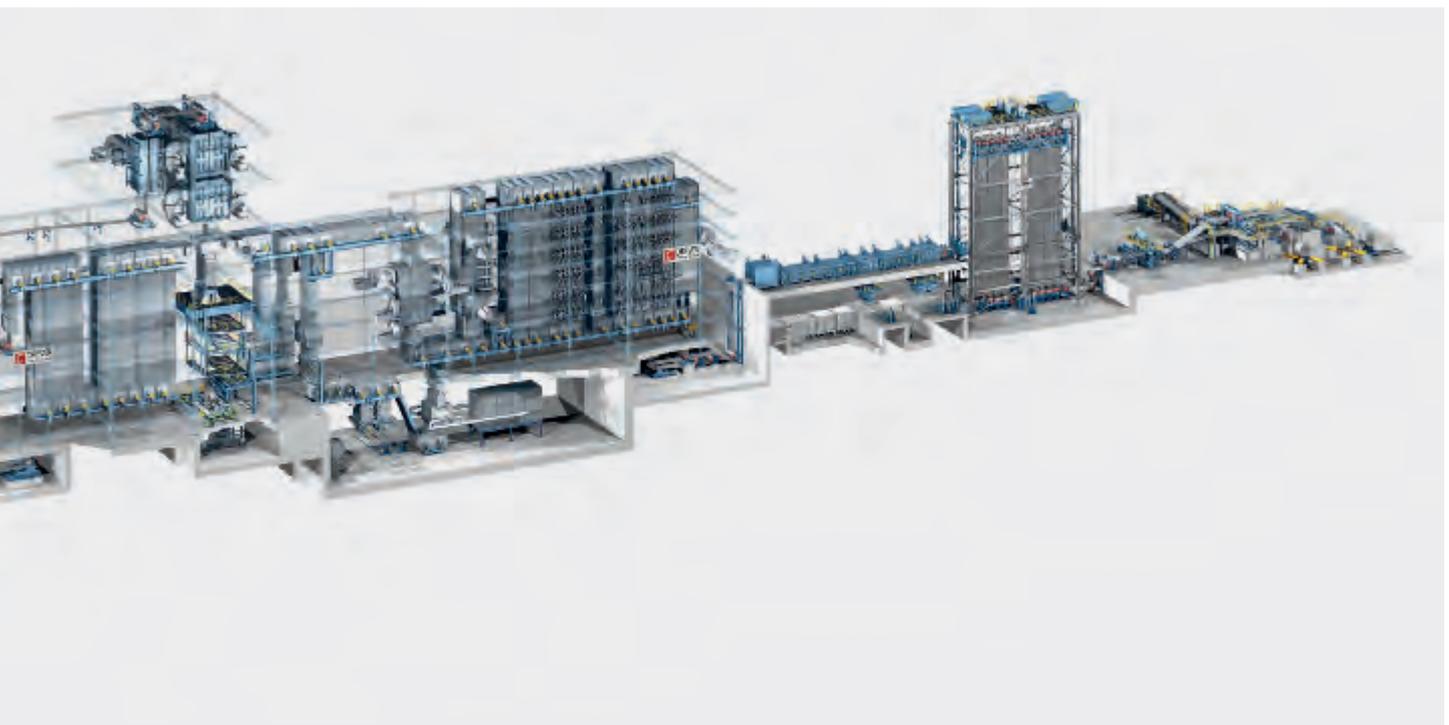
- Basic and process automation with process and production models
- Quality monitoring and predictive system for condition analysis Innovative measuring systems
- Smart operation and visualization systems
- 3D Plug & Work integration test
- Fast start-up and commissioning

Special Services

- 3D layouting and plant planning
- Production know-how
- Start-up assistance
- Continuous production assistance and process optimization
- Qualification assistance
- Certification and approval assistance
- After-sales service
- Revamps and modernizations

Digitalization

- Data handling with the SMS DataFactory
- Data infrastructure solutions
- Predictive asset optimization solutions
- Predictive product quality solutions
- Predictive production planning solutions
- Predictive energy management solutions



Leading automation and digitalization

Operational Technology (OT) and Information Technology (IT) in one hand

As one of the world's largest system integrators in the metallurgical business, SMS group combines **Operational Technology (OT)** with the **Information Technology (IT)** of SMS digital. The solutions for all strip processing lines are jointly designed to implement the advanced technology required for the production of the envisaged first class materials. Core issue is here that the technology is an integral part of automation.



High-quality and productivity due to integrated solutions.

The proven solutions in the field of electrics & automation, are summarized under the term **X-Pact® (process, automation, control, technology)**. Characterized by high flexibility through their modular design, X-Pact® makes sure, that all of the customers' plant components operate in perfect harmony –

- from energy supply and distribution to drive technology,
- further to instrumentation and automation
- and finally to production planning.

Therefore, **basic und process automation** systems are integrated into all activities regarding engineering, commissioning or research and development. The same models, which are used to design and optimized the line, spicily for each individual customer, are within the basic und process automation used to operate the line. X-Pact® electrical and automation systems open up new competitive opportunities for plant operators by implementing customized modernization strategies especially with a view to digitalization, plant reliability and product quality and provide a solid

foundation for future-oriented extensions and applications. SMS group combines digitalization expertise with 150 years of metallurgical process knowledge and technological know-how as well as with complete system competence along the entire process chain. More than 1400 employees worldwide are serving excellent background for all automation and digitalization tasks.

SMS digital

As the digital unit of the SMS group, SMS digital creates innovative solutions in the fields of digitalization as well as platform and cloud services. Together with the SMS group experts SMS digital develops customer individual solutions fueled with data expertise and AI and consults the customers in order to successfully manage the digital transformation of their business.

Digital commissioning of the SMS group basic and process automation systems is already done during the **Plug & Work integration test**. The simulation model – the digital twin of the plant – allows pre-commissioning under realistic conditions with 3D simulation view. During the training of the customer's staff at the SMS group test field, the reality of working in a real plant is replicated.

All operation modes and processes are simulated in real-time and are visualized by using X-Pact® Vision, with the original hardware and software on the customer's systems. The Plug & Work integration test significantly shortens commissioning times. Apart from this, SMS group provides



Simulation of technology prior to installation. 3D VIRTUAL PRODUCTION with a digital twin.



New standard for the future automatic control with X-Pact® Process Guidance. Towards lights-out operation.

remote support during and after commissioning activities. **The X-Pact® Service** has a perfect infrastructure for remote commissioning support.

The innovative X-Pact® Vision HMI-concept, its forward-looking interactions, structures and communication channels within the plant automation ensure safe operator guidance and offer comprehensive tools for system maintenance, diagnosis and trouble-shooting.

X-Pact® Process Guidance is pioneering for process control and will establish itself as the new standard for plant automation in the future getting ready for **Lights-out operation** in the metals industry.

The vision of a **Learning Processing Line**, enabling intelligent and largely autonomous production sets the direction into the future.



Learning algorithms turning data into value. Learning processing line.

With the help of learning algorithms from SMS digital in the **Learning Processing Line** SMS group converts data into value. The main focus here is on the four central perspectives for PREDICTIVE: Asset Health, Planning, Energy and Product Quality.

Portfolio highlights

Power supply and drive systems for greater sustainability

X-Pact® Drive low-voltage frequency converter Modular drive solution for top-level production



The modular principle of the X-Pact® Drive system means tailor-made drive solutions can be designed for all SMS group products. The X-Pact® Drive is standardized, modularized, and ideally adapted to our customers' process needs. With its energy efficiency and optimized lifetime costs this drive system ensures maximum process-oriented drive performance for top-level production. SMS group has installed the X-Pact® Drive in numerous different plant types all over the world. Customers highly appreciate the spare parts service and the operator training provided by SMS group.



Torque drive – Highly efficient, compact, mechatronic solution



For application in the mechanical engineering sector an energy efficient, low-noise and extremely maintenance-friendly machine has been developed.

The innovative direct drive allows the machine to achieve a total efficiency of 98 percent. In addition to the ecological aspect this drive concept comes with a particularly high effectiveness resulting from the abandonment of lossy converting stages and from saving ancillary equipment in the drive system. What's more, the physical/electro-technical principle of a permanently excited synchronous motor makes it operate essentially more efficient than an asynchronous motor. Torque drive components integrated



in the mechanical application ensures maximum process-oriented drive performance with low maintenance.

X-Pact® High Current – Innovative switch mode power rectifier for electrolytic processing lines



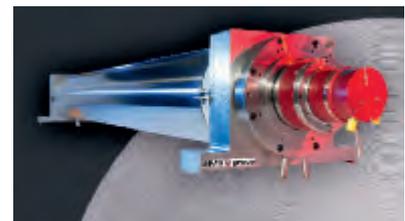
The switched-mode power supply units enable customized, module-based DC power supply for electrolytic processes in the steel industry.

The compact design makes the system perfectly suitable for new plant installations and upgrades. As this SMS group solution saves more than 40 percent of energy and reduces the costs of installation, commissioning and maintenance, it qualifies as an EcoPlants module. The benefits at glance are: high energy efficiency, enhanced plant performance and plant availability, efficient troubleshooting and monitoring, fast return on investment, and everything from a single source.



X-Shape Flatness Measurement and Control – Stepping up with the reliable and precise flatness measurement and control

X-Shape Flatness Measurement and Control is a high-precision, low-maintenance, and cost-efficient system that sustainably ensure and improve the productivity of the plant and the product quality. Highly sensitive sensors detect even minimum variations in strip tension across the strip width by measuring the vertical force components of the strip tension. The technological control is designed to ensure strip flatness even under the most adverse conditions and at high rolling speeds of up to 3,000 m/min within narrow tolerances and across the entire strip width. The standardized communication concept enables simple integration of the system even with an existing automation solution.



Basic and process automation

Innovative solutions for the future

The SMS group continuously adapts to the requirements of modern technology in the basic and automation process. All systems are subject to constant optimization of the electrical design, the latest technology is used and efficient programming of the basic and process automation.

New methods of optimization and implementation of energy-saving systems are integral part of SMS group portfolio for Ecoplants.

X-Pact® Modular basic und process automation packages

A holistic X-Pact® package of basic and process automation systems is a crucial success factor in the realization of complex plants. This is where everything comes together to control, monitor, test, evaluate, optimize and coordinate the system.

X-Pact® ensures that all system parts mesh with each other and work smoothly together: from the optimized energy supply and distribution to innovative drive technology, intelligent instrumentation and future-oriented automation and processing to production planning for one ensures high product quality and flexibility.

All basic and process automation functions included in X-Pact® are carried out by modular components that are available worldwide. This ensures standardized solutions for all tasks - carefully worked out according to international standards. This guarantees maximum reliability, increases process stability, reduces downtimes and enables a high degree of independence in production. Thanks to the modular technology, one of the modules can be optimized and modernized at any time. This also increases flexibility and saves costs.

Diagnostics for startup, devices, sequences, safety, and plant

The challenges of the X-Pact® basic automation are the stability, simple maintenance, uncomplicated adaptation to new conditions, and high-tech solutions of the system. Technical advantages are the effect diagnostics with face-plate and pop-ups for faster and better analyzing of production process. Further highlights are the high availability, fewer line stops, the fast troubleshooting and fast start up of line. The system is also easy to adapt to the different requirements of individual processing lines and easier to maintenance.



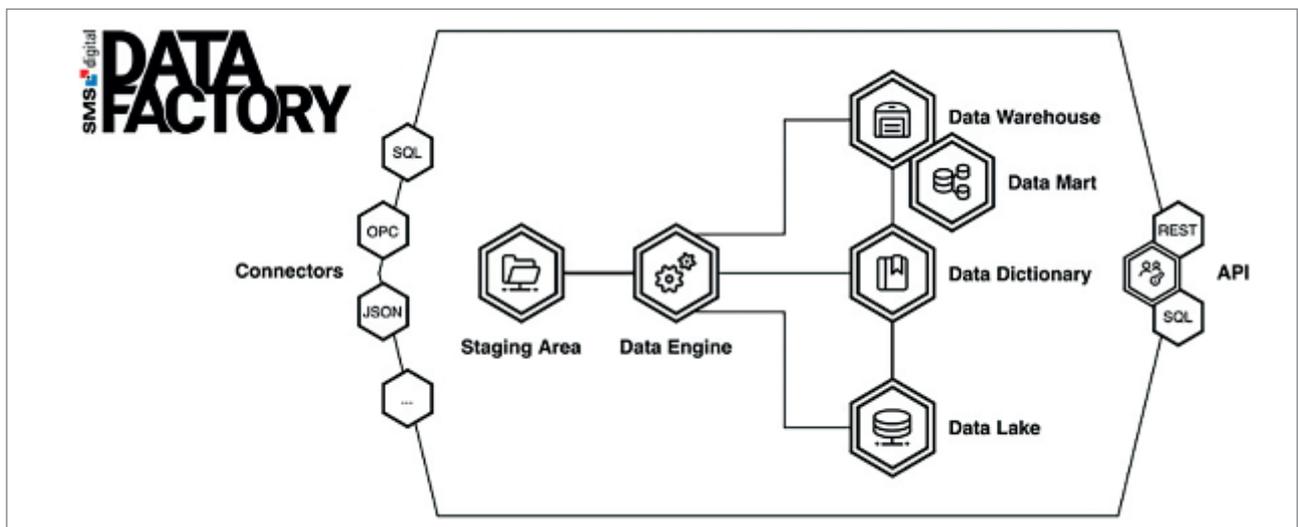
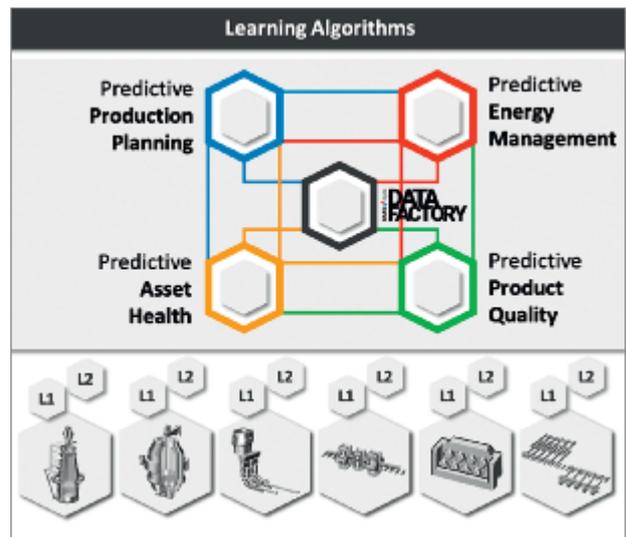
Where everything comes together: Pulpit in a modern strip processing line.

Digital solutions – Efficient and sustainable production

Resource-efficient and sustainable production processes are becoming increasingly important in manufacturing industries. High plant availability and maximum product quality are essential performance indicators in plant operation. When plant expertise, process modeling experience, and cutting-edge data science such as machine learning and artificial intelligence are intelligently combined, improvements in predictive maintenance, quality, production planning, and energy management can be achieved, increasing a steel plant's profitability. With digital solutions that reduce the need for on-site personnel deployment and with climate-friendly solutions for CO₂-free steel production, SMS group and SMS digital meet the ever-increasing demands of sustainable industrial production.

Data handling with the SMS DataFactory

Data should always be linked to value-added services. To solve this task, eliminating data silos and historically grown structures is essential. The SMS DataFactory provides the basis for turning data into information and information into added value. Only by networking and evaluating all parameters the Learning Steel Plant is able to interact continuously and coordinate and optimize the process flow to the required extent. Insights into the plant condition and process performance and their influence on product quality and operating costs become possible.



The SMS DataFactory architecture.



New business models offer maximum flexibility

New, performance-based subscription business models are especially suitable for the long-term implementation of solutions within the context of the learning steel plant and thus for generating added value. Instead of individual transaction services, integrated service bundles consisting of equipment and intelligent digital services are offered, including a value proposition associated with them.

Depending on the solution for the customer as well as the agreed and promised service, SMS group offers various models, from conventional contracting, through licensing and Software as a Service (SaaS), right up to Equipment as a Service (EaaS). In particular, the as-a-service models from SMS group give customers the opportunity to concentrate on their core processes and secure the positive profit contribution of the SMS solution during the term of the contract. The optional switch from CapEx to OpEx in conjunction with a long-term service agreement also enables customers to minimize the risks associated with initial investments and to optimize working capital.

With regard to purely digital solutions in a SaaS model, the necessary tools that enable fully networked cooperation can be provided cost-effectively. What's more, configuration settings can be altered and the software can be adapted within certain parameters to individual requirements.

Your benefits at a glance

Data infrastructure solutions:

- Turn data into information and information into added value
- Value chain transparency
- Focus on data analytics not data preparation
- Analyze the data along all production steps
- Document & manage the genealogy of your product

Predictive asset optimization solutions:

- Improved maintenance cost
- Increased plant availability
- Evaluate equipment health and detect complex anomalies from real-time sensor data
- Predict equipment failure days in advance with associated probability
- Uncover feature and sensor-level factors that resulted in the failure
- Determine optimal maintenance to maximize value

Predictive product quality solutions:

- Reduction of downgrading and scrap
- Possibility to react to process deviations in real-time
- Product quality certification along the entire value chain
- Reduction of human influence on product quality evaluation

Predictive production planning solutions:

- Improved productivity in terms of profitability and delivery performance
- Improved collaboration of sales and operations
- Improved efficiency by generating sales orders to sell specific quantities of products required by the production

Predictive energy management solutions:

- Improve energy efficiency with AI-based monitoring and real-time recommendations
- Reduce energy costs by exploring the fit between supply and demand for all energy sources
- Enhance energy efficiency with dedicated tools for managers and operators
- Automate routine tasks
- Track carbon and GHG emissions by measurement and by equivalence on all processes and all elements of the energy matrix

Service at a glance

For all challenges involved in the operation of your plant, you can rely on a competent partner

Whether you want spare parts, modernizations, tailor-made maintenance procedures, or customized training programs: the global service business of SMS group is ready at 50 locations around the world to offer you service packages geared to the requirements of your processing lines. It's due to the know-how of the entire SMS group that our employees provide the services you require – on schedule, within budget, and in the right quality.

Our well-connected service network means we can respond quickly and offer rapid support for all the challenges you face. Wherever your plant is, you can be sure we are close by to guarantee fast reaction times and meet your needs.

Roll Coating Solutions

Lifetime of rolls are key for product quality and maintenance budgets in processing lines. SMS group offers a large range of coatings for different applications. In addition, our coating competence center is constantly developing improved coatings for processing lines. Our goal is to help you succeed in cost efficient production.

Furnace rolls

Depending on your furnace design, you require specific thermal spray coating. The main roll types are strip accumulator rolls, sealing rolls, deflector/steering rolls, and bridle rolls. All of them benefit from our optimized manufacturing process that ensures the best product quality.

Our coating Service usually starts with a detailed inspection of your furnace rolls. Based on the furnace design and – in older furnaces – the wear pattern we can determine the best coating solution for your end product. The thermal spray coatings of SMS group offer superior lifetime, perfect strip quality at competitive costs. We also manufacture complete new furnace rolls customized for your furnace.

Bridle- and process rolls

Rolls are everywhere in processing lines. And they require special treatment. For each area and application, we offer specific metallic or ceramic coatings. Bridle rolls and other process rolls are inspected and overhauled by our experts in the locations to improve lifetime and supreme quality of the thousands of Kilometers of strip processed in your lines every year.





Zinc bath Service

In all galvanizing lines the zinc pot is one of the most critical elements. SMS group has an answer to this challenge. Our ceramic bearing solutions combine stable strip position in the bath. In combination with the long bearing life and the air knife solutions this results into excellent and constant surface quality of the coated strip. Exact coating thickness control in addition reduces production costs.

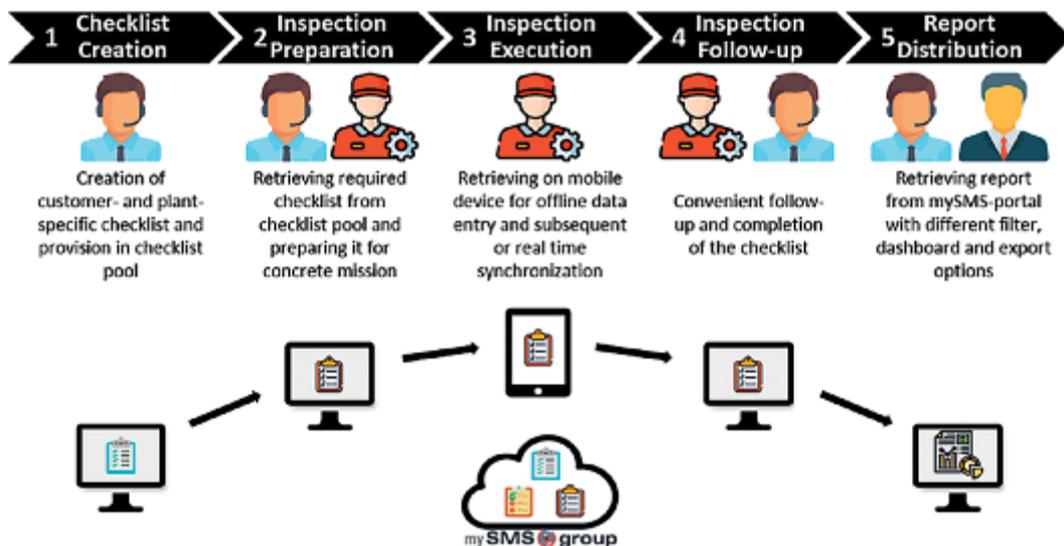
Rollers in the zinc bath are usually the limiting factor for campaign live. To face this challenge, SMS group offers superior ceramic coatings together with perfect sealing. Campaign lives of 6 weeks and more for automotive

sheet are possible. Without compromising quality, you can significantly increase production and reduce maintenance costs.

For several customers around the world we have implemented full service packages for their zinc bath equipment. Depending on your requirements such packages can include: Consignment Stock for spare parts on site, repair of the complete assemblies incl. arms, roll coating and bearing replacements and also the handling on-site with preheating, installation, alignment and deinstallation of the zinc bath equipment.



Digital Equipment Check



Inspection and On-Site support

Precision is in many areas of your production line a key element to achieve high product quality. We have a global team of experienced field service engineers who can help you to maintain your lines.

Inspection service

Regular inspections for key production machines are an important element of our offering. For shears, trimmers, laser welders and other critical process steps we regularly perform on-site checks at our customers. This service does not end with just a visual inspection. We realign and calibrate your machines to ensure smooth operation. Included in our service are recommendations for production or maintenance improvements and very often also a training of your personnel along with the service provided.

On-Site support

Apart from inspections we can support you with all kind of expertise out of our global engineering network. This starts with the provision of qualified teams for exchange of spare parts like gearboxes and ends with consulting studies for new steel grades, production upgrades or cost reduction.

New machines and components

To meet the requirements of your end customers you are constantly improving your lines. Sometimes your existing machines like shears, straighteners etc. are not anymore able to meet the technical requirements of your adopted product portfolio. With our modular plant engineering we can offer perfect solutions to these challenges. We also can offer complete machines like a new shear, leveler, notcher, welder etc. to close the gap in the technical capabilities of your line. More important: we can install this equipment into your production line and on request also offer integration into your automation system.





X-Pact® Service team.

TECademy

As your partner for plants and machines, the SMS group is also a partner for your employees. With the services offered by SMS TECademy, we aim to strengthen you in your competence as a plant owner. Modern and practice-proven training formats are employed in which the focus is clearly on the practical benefits. In addition to the standard training courses, the SMS TECademy experts can also tailor an individual training concept specially geared to your needs, on request. Expanding, consolidating and above all safeguarding know-how is the motto here!

Class of its own - Our training courses

In our annual program, we offer you a wide range of high-quality training modules. You can choose between the three topics Technology, Maintenance or Plant technology. These are carried out as a part of standard training sessions (basic and expert training), individual training – tailored to customer requests and e-learning courses by our SMS group experts.

The SMS TECademy offers you a wide range of services, which continuously expanded: (Live-)Webinar, virtual and augmented reality applications in our Digital Classroom, e-learning and classroom training.

The motto is to expand, deepen and, above all, secure knowledge!

24/7/365 X-Pact® Service for electrics & automation

The automation system is the beating heart of any production facility. It controls the production processes, assures smoothness of operation and generates data and reports critical for the performance of the plant. Immediate and reli-

able technical support by an expert team and state-of-the-art automation systems are indispensable for companies to remain competitive. Therefore, X-Pact® Service is always ready to support, promptly and reliably – the world over.

With its X-Pact® Service, SMS group supports its customers along the complete process chain – even beyond the commissioning of the customer's plant. This guarantees high availability and stability of the automation systems in the long run. In addition to a full host of individual services, the customers may also choose from a range of full-line service packages. Under these customized service agreements, SMS group guarantees reliable and efficient operation of the customer's facilities on a long-term basis and in close relationship with the customers as partners.

The X-Pact® Service agreement offers the following benefits:

- 24/7/365 telephone hotline
- Global expertise network
- A service specialist familiar with the plant equipment
- Remote support via the X-Pact® Service Portal

This allows the customer's employees to take advantage of tailored support for their automation system 24 hours a day, 365 days a year. The common data platform of the X-Pact® Service Portal is where SMS group's automation specialists can immediately connect with customer's plant and, if required, bring in other specialists. Many issues can be resolved straightaway. This reduces overall costs and boosts the plant's performance. No time-consuming troubleshooting, but rather proper expert support and well-functioning just-in-time partnerships.

References from reputable manufacturers demonstrate the effectiveness of this work-sharing approach.

Pickling Lines

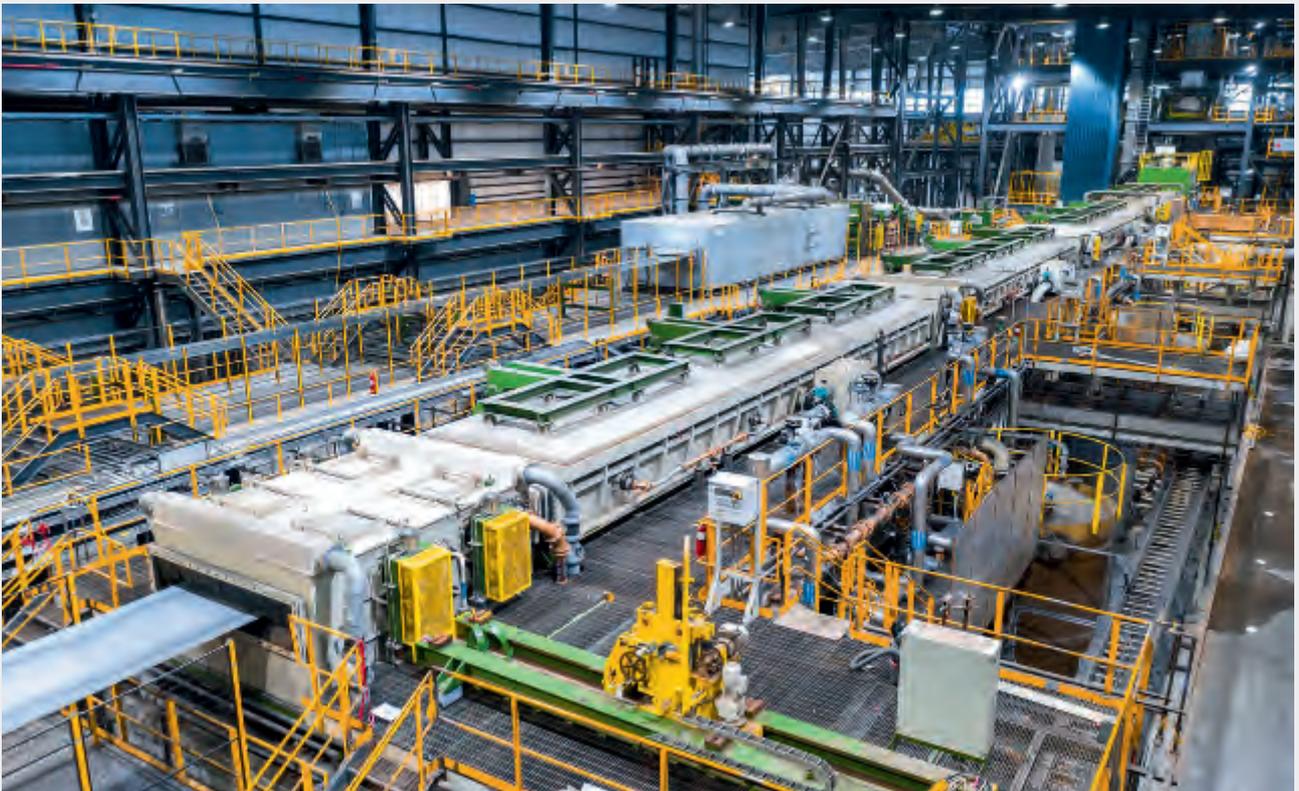
Economic and ecological turbulence pickling lines

Eco-friendly descaling at high capacities

SMS group delivers pickling lines from a single source as a system supplier. The lines are outstanding for their high pickling performance as well as low maintenance and operating costs over a long service life. With the ECO production and pickling model and various other innovations, it has become possible to increase the performance still further.

The turbulence pickling process can be integrated into all lines designed for pickling carbon steel: pickling line/tandem cold mills, continuous, semi-continuous, and push-pull pickling lines.

There are, however, more advanced components for carbon steel pickling lines from SMS group. Just one example is the X-Pro® laser welder that joins even hard-to-weld materials. The mechanical equipment used here, such as



Since 2000 SMS group has acquired orders to supply 37 pickling lines for carbon steel.



A scale breaker breaks up and removes some of the scale and increases the flatness upstream of the pickling process.



Pickling sections consist of three to four pickling tanks with own circulation systems.

scale breakers, loopers, entry and exit sections, is specifically tailored to the conditions in pickling lines. Our cold rolling mills come in a modular design, complete with high-tech elements such as CVC®plus technology. Effective and eco-friendly, acid regeneration plants recover spent pickling acid and feed it back into the process. This means SMS group is your one-stop-shop for complete pickling lines, including coil logistics, binding, strip treatment, laser welding machines, all the mechanical components, and

drive and control technology. This ensures that you can cut your operating expenses for your overall plant because both your maintenance and spare parts costs are minimized due to perfectly matched components. You also save on customer coordination and training costs.



Pickled and cold-rolled coils for the market or further processing in galvanizing or annealing lines.

Line types

Off-the-peg is not our style. SMS group tailors your pickling line to your specific requirements. Depending on the capacity, the steel grades and qualities as well as the strip dimensions you want to produce, your plant comes equipped with the right technologies and components. Generally speaking, pickling lines are available in four types.

Continuous Pickling Lines (CPL)

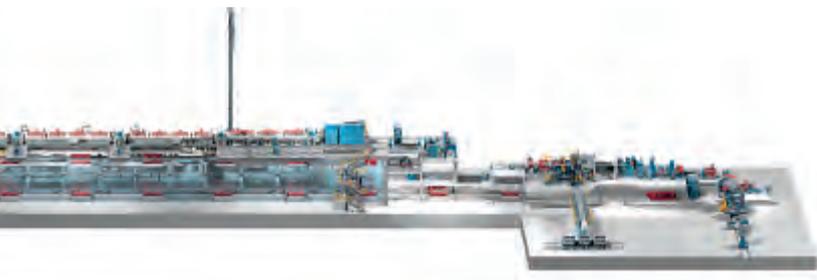
A welding machine at the entry of the continuous pickling line joins individual strips into endless strip, then horizontal loopers ensure continuously high speed in the processing section. That means you achieve top quality standards at very high capacities. Continuous pickling lines can also be coupled to cold rolling mills.



Pickling Line/Tandem Cold Mills (PLTCM)

What happens here is that these mills continuously pickle and cold-roll hot-strip in one go. They come with three loopers to ensure a continuous process. Both the entry and exit areas are designed so that the plant can operate continuously at high speed.





Typical plant parameters:

Strip thickness:	1.2 – 6.5 mm
Strip width:	600 – 2,080 mm
Capacity:	1,500,000 – 2,700,000 t/a



Typical plant parameters:

Strip thickness	
Entry:	1.2 – 6.5 mm
Exit:	0.3 – 3.5 mm
Strip width:	600 – 2,080 mm
Capacity:	1,500,000 – 2,500,000 t/a

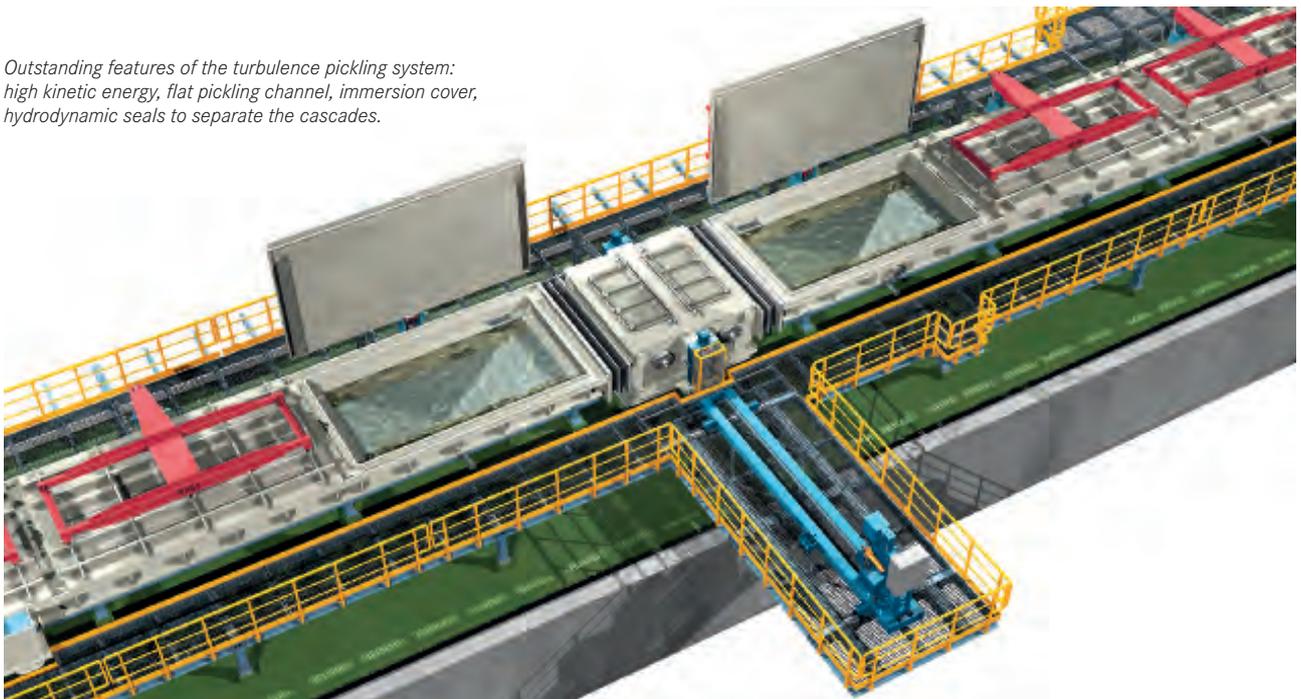
Economic and ecological turbulence pickling lines

Turbulence Pickling Technology

Racks of nozzles are constantly spraying heated hydrochloric acid into the shallow pickling channel and generate an extremely high turbulence. This ensures maximum contact between the acid and the strip surface by continually forcing fresh acid into the cracks in the scale layer. It only takes a short time to create the required

electrochemical potential which results in fast and efficient pickling. The patented immersion cover above the pickling channel closes off the acid bath surface, minimizing evaporation losses by 30 % and the heat losses by 70 %. Furthermore, the exhaust system requires a smaller volume, which again reduces losses.

Outstanding features of the turbulence pickling system: high kinetic energy, flat pickling channel, immersion cover, hydrodynamic seals to separate the cascades.



Influences of the changed chemical composition of modern AHSS-grades on the pickling process

The changed chemical composition of modern advanced high-strength steel grades (AHSS) has certain influences on the pickling process. Especially the higher contents of silicon and manganese have a critical impact, which leads to problems in conventional pickling lines. Further problems are caused due to the higher strength of the material.

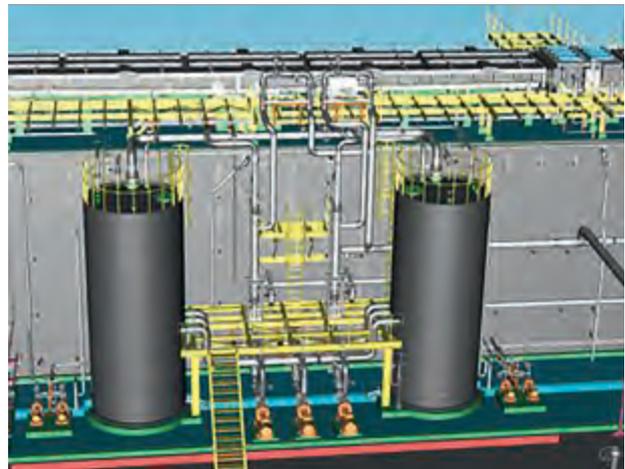
The most significant challenges are sludge occurrence during pickling, varying pickling times, weld ability of the materials, changed visual appearance and required high surface qualities. Due to the higher strength of the material also the mechanical equipment has to be designed differently in some ways.

Based on the turbulence pickling technology and the proven line equipment SMS has developed some features and modifications, which allow efficient pickling of these new materials.

Sludge removal

SMS group has huge experience with electrical silicon steel grades with high silicon contents. The proven two tank system can be used for sludge removal in carbon steel pickling lines when it comes to AHSS-grades with high silicon contents. Here, two tanks are integrated and are used alternating as circulation and sedimentation tank.

Furthermore, a settling tank should be included before the waste acid flows into the regeneration system. This increases the efficiency of the acid regeneration and helps to remove the silica content out of the process.



Sludge removal with proven two tank system.

X-Pact® Turbulence Pickling Model for eco production

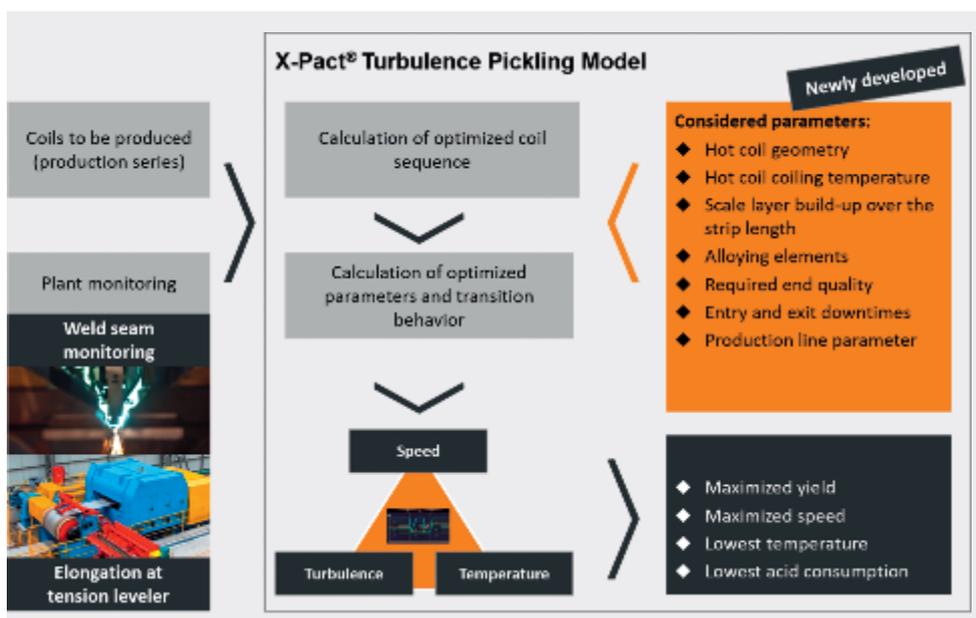
Maximum productivity at minimum energy and acid consumption

The demands on the quality of the pickling process are increasing, as is the need to reduce energy and acid consumptions. The SMS group X-Pact® Turbulence Pickling Model for eco production meets these requirements:

- Optimal strip surface quality
- Minimize excessive pickling
- Lower maintenance costs
- Lower operating costs

The Pickling Model enables flexible pickling of any desired coil sequence. It dynamically controls all relevant technological setpoints so that high product quality is achieved at maximum throughput. The process conditions are controlled concerning each strip segment's requirements. The operators are relieved from time consuming and error prone tasks.

The production order module optimizes the order of strips. This optimization leads to significant savings in energy and resource consumption.



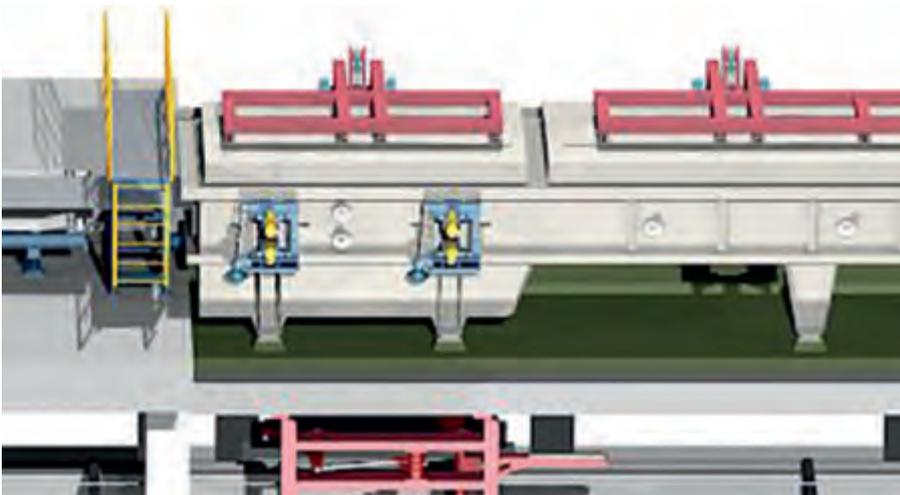
X-Pact® Turbulence Pickling Model.

Economic and ecological turbulence pickling lines

Recuperator Tank

In the patented recuperator tank upstream of the first pickling tank, the hot waste acid is sprayed directly onto the strip. This removes loose scale particles, heats the strip and chemically activates its surface to speed up the

subsequent pickling process. Thus, not only the pickling results will be optimized and thermal energy saved, but it also cuts down acid consumption due to pre-pickling and -activation.

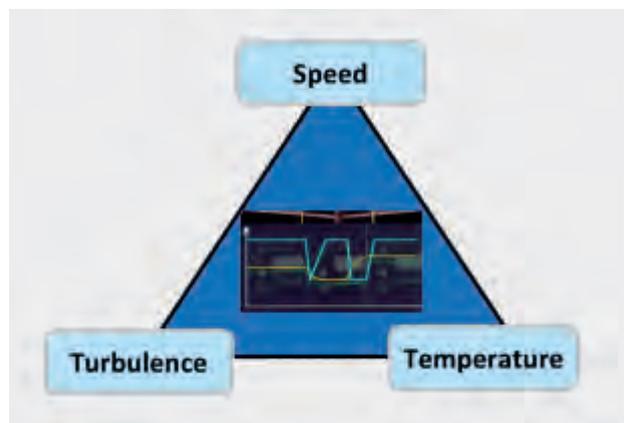


The hot waste acid is used to pre-clean and pre-activate the strip surface in order to increase the efficiency of the pickling process.

Pickling times

The alloying contents in modern AHSS-grades cause different scale layer characteristics (e.g. layer thickness, distribution of hematite, magnetite and wustite). In general, the pickling times of steel grades with high alloying contents are significantly higher and vary a lot more. The hot rolling and coiling temperatures have to be considered more strongly, since they have a major impact on the pickling times.

Again, the turbulence pickling system has certain features to deal with the varying and increasing pickling time. It is the most flexible pickling technology. It is possible to change the line speed, the acid temperature and the turbulence very fast. This way, the pickling efficiency can be adjusted easily based on the materials to be pickled using an efficient process control via the X-Pact® Turbulence Pickling Model for eco production.



The X-Pact® Turbulence Pickling Model for eco production is a level 2 model, which changes the important pickling parameters speed, turbulence and temperature very fast according to the material to be pickled.

Acid regeneration plants

An increasingly important factor for any pickling plant is compliance with environmental protection regulations, plus high energy efficiency. Acid regeneration plants for hydrochloric acid are an outstanding example of green and efficient technology. Depending on the individual cus-

tomers requirements, spray roaster or fluidized bed technology is used. These systems put the regenerated acid back into the process and produce a valuable by-product. Thus, all resources are circulating in a closed-cycle inside the plant. Even considering only the saved transportation costs for waste acid and rinse water, which do not have to be neutralized, savings of more than EUR 250,000 per year are possible for a conventional pickling line.



Acid regeneration plants ensure saving of operating costs and compliance with all environmental standards.

Integrated suction concept for scale dust

An integrated central suction system with several suction devices minimizes scale dust problems in the entry area of pickling plants, while simultaneously reducing the suction power. This makes pickling lines safer, more effective and greener. In practice the advantages are better working conditions for the employees, reduced wear, no sudden downtimes due to contaminated components and minimized dust emissions. The manual cleaning requirements are reduced to a minimum.



Suction devices in a pickling line.

Economic and ecological turbulence pickling lines

X-Pro® laser welder

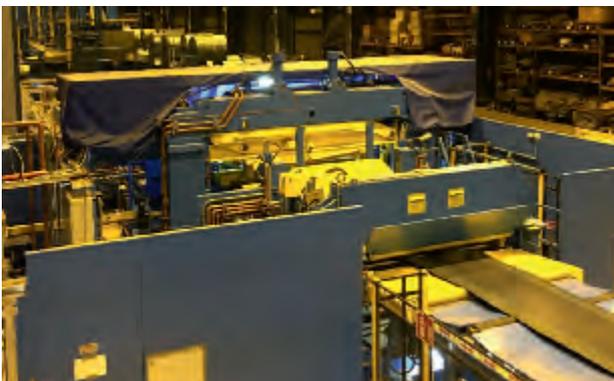
The X-Pro® laser welder is designed to join hard-to-weld strip material. One of the components developed to master this challenge is a patented, inductive heat treatment system. Further advantages are an automatic welding parameter calculation system, a quality assurance system, short cycle times and an exchangeable laser source. The laser welder has been installed in numerous new plants as well as in modernization projects.

Strip processing lines have to treat a wide product range including state-of-the-art high-strength steel grades. Although some of the materials are difficult to weld, they must properly be joined in the entry section of a strip processing line within a short period of time.

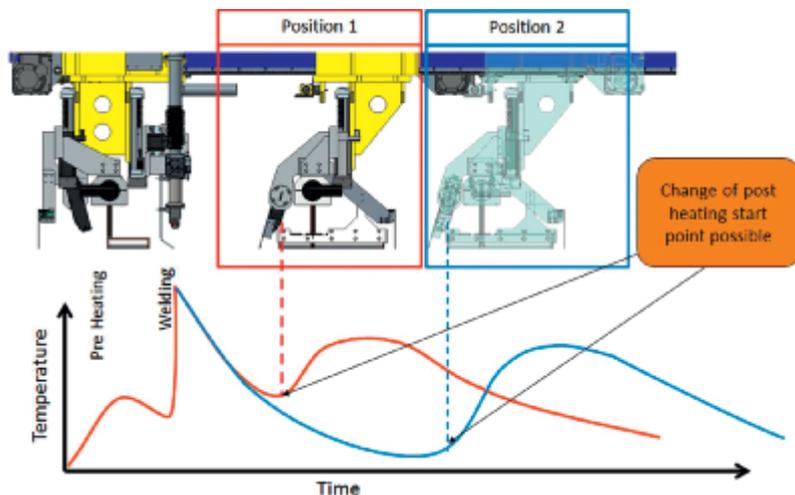
The X-Pro® laser welder offered by SMS group has been specifically developed to meet the requirements involved in joining hard-to-weld strip material. One of the components developed to master this challenge is a patented, inductive heat treatment system. Further advantages are



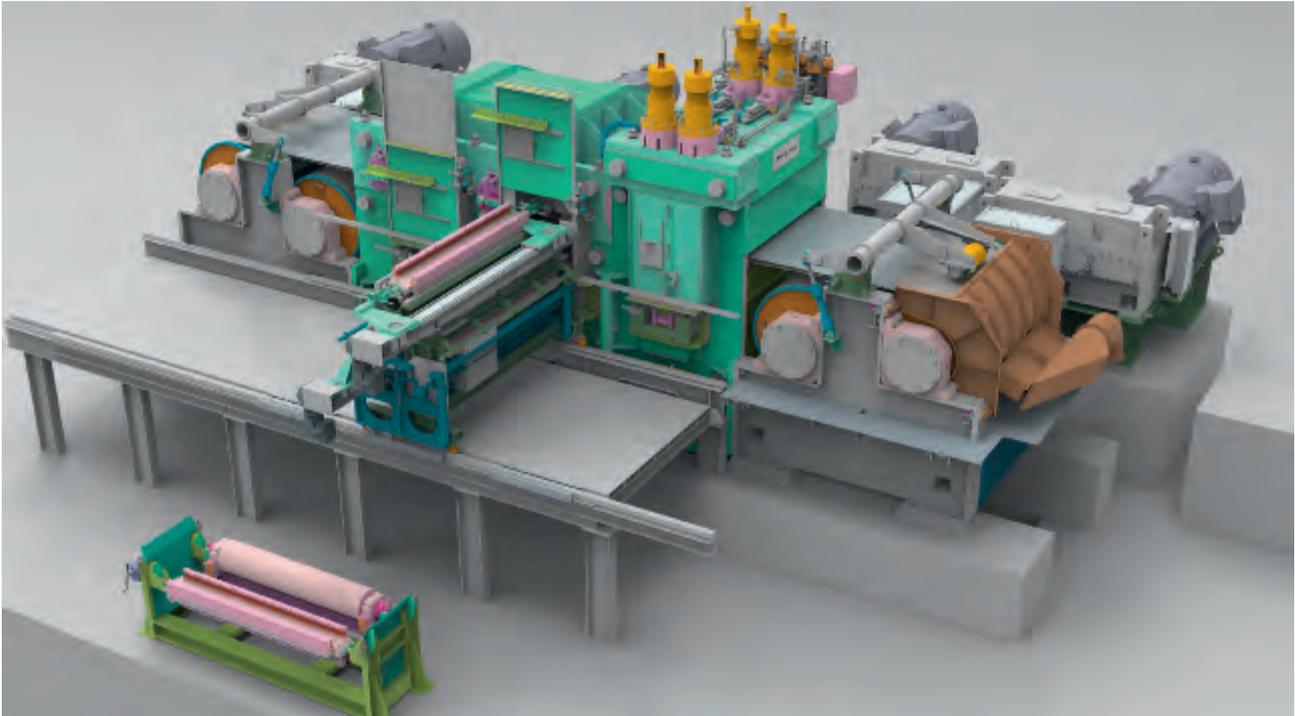
an automatic welding parameter calculation system, a quality assurance system, short cycle times and an exchangeable laser source. The laser welder has been installed in numerous new plants, but also as part of modernization projects.



The X-Pro® laser welder was integrated in the entry section of the pickling line at SSAB as part of a modernization project. Using a fiber laser, the machine now joins even hard-to-weld strips quickly and fully automatically, and thus ensures an automated welding process



Patented system for weld seam pre- and post treatment with freely selectable starting points and temperatures



Designed for hot strip with yield points over 1,000 megapascals: scale breaker SB-80-V1050 made by SMS group.

Scale breaker for high-strength materials

In pickling lines, scale breakers minimize irregularities such as waviness, cambers or length- and crossbows by a combined tensioning and leveling action to create a flat final product. An additional task is to break the scale layers by alternate bending and stretching to ensure better pickling medium efficiency and hence a faster pickling process. Market demands for higher material strengths lead to exacting changes in machine technology. One aspect is higher forces in stretching and bending. SMS group has developed scale breakers, that are capable to level steel strip with yield points much higher than 1,000 megapascals. The machines are also suited for installation in existing plants to make these facilities meet future material requirements.

To meet the higher requirements in continuous pickling lines, SMS group developed tension leveler SB-80-V1050, a special machine for hot-rolled strip material. The machine is particularly made for use in pickling lines and designed for strip tensions of up to 1,100 kN.

Usually, the required high tensions are established and released by at least two bridle roll units upstream and downstream of the machine. Two bending and two correcting roll units are installed to bend and stretch the material as needed. Further integrated in the machine are several backup rolls ensuring a uniform bending effect at the top and bottom strip sides.

This has the following advantages: a notable elongation referred to the strip tension applied, an increase in bending roll service life and a reduction in pickling time due to effectively pre-breaking the scale layer. Scale breaker adjustments are all hydraulic, and an exchange system permits the bending cassettes to be changed during ongoing operation.

References

Pickling line/tandem mill for JSW, India

The new combined pickling line/tandem cold mill at JSW Steel Ltd. is highly regarded thanks to its environmentally friendly components, low maintenance costs and high-quality.

The pickling line/tandem cold mill in CVC®plus six-high design has been in operation in Toranagallu, in the state of Karnataka, India, since October 2013. JSW now has a yearly production capacity of 2.3 million tons of cold strip with maximum strip widths of 1,890 millimeters and minimum end gages of 0.3 millimeters. The strips are mainly intended for use in the automotive industry and, amongst others, are made of high-grade and multi-phase steels.

In the entry section, the strips are joined by an X-Pro® laser welder, which also joins difficult-to-weld steel grades without filler metal. A newly developed, integrated suction system reduces exposure to scale dust. In the turbulence tank pickling section, a tension leveler then breaks up the scale, and loose scale particles are removed from the strip in a recuperator tank, while the strip is preheated and chemically activated. In the three pickling tanks, each 35 meters long, the strip is efficiently descaled.



In a turbulence tank pickling section, more than 100 meters long, the strip is completely descaled using few resources.



Upon entering the line, difficult-to-weld steel grades are also joined by an X-Pro® laser welder without the use of filler metals.

References

Pickling line/tandem cold mill and continuous pickling line for AM/NS Calvert, USA

SMS delivered all strip processing lines for the cold rolling complex at AM/NS Calvert (formerly ThyssenKrupp Steel USA) in Alabama, USA. A pickling line/tandem cold mill and a continuous pickling line, which have both successfully been in operation since 2010, are part of the complex, in addition to four cold strip processing lines.

The pickling line/tandem cold mill has a yearly capacity of 2.5 million tons. The up to 1,870 millimeter wide strips are pickled in three turbulence pickling tanks, each 35 meters long, then reduced on the coupled five-stand four-high tandem cold mill to final gages of 0.3 to 3 mm.

The continuous pickling line is designed for a capacity of 1.1 million tons per year. And the current layout allows for a capacity expansion to 1.6 million. In the entry section, the strips ends are joined by an X-Pro® laser welder to form an endless strip with a thickness between 1.5 and 6.0 millimeters. In the next stage of the process, the strips are treated in the turbulence pickling section with a maximum pickling rate of 110 m/min.



Upon entry to the continuous pickling line, an X-Pro® laser welder reliably joins the hot-strip ends to form an endless strip.



In total, well over 3 million tons of steel strips can be pickled per year in the two pickling lines.

References

Continuous pickling line for Gazi Metal in Turkey

In August 2014, Gazi Metal's new continuous pickling line produced its first strip in Turkey. The pickling line represents a key element in Gazi Metal's new production complex in Karasu. SMS group delivered all the essential production facilities, including mechanical systems, process technology, and the electrical and automation systems.

The pickling line frees the hot strip from scale and prepares it for the rolling process that follows. Gazi metal decided on a continuous pickling line for a plant concept with a capacity of 350,000 tons per year, that can easily be converted into a continuous pickling line with double

the capacity. Two small horizontal strip accumulators, which ensure a minimum process speed, are a major feature of this concept. The process section consists of a tension leveler and a 54 meter long turbulence pickling section. Next, the strip passes through a trimming shear and a DUMA-BANDZINK oiler. In order to further re-condition the used and iron-fortified hydrochloric acid from the pickling process, a fluidized-bed acid regeneration plant with a capacity of 1,700 liters per hour is used.



In the turbulence pickling section, the strip is completely descaled with low resource consumption.



In the acid regeneration plant, the used pickling acid is recycled and returned to the process.



Completely descaled strip exiting the pickling section.



The strip is safely coiled by a belt wrapper, without clamping.

References

Coupled pickling tandem mill at Shandong Iron and Steel Rizhao, China

Shandong Iron and Steel Rizhao, China, has contracted SMS group to supply a complete flat steel complex including newly developed quality assurance system and operation know-how in the Shandong province on the Chinese east coast. A special feature of this project is the supply of cross-process know-how while simultaneously monitoring, documenting and securing the product quality. The flat steel complex comprises also a pickling tandem mill.

SMS group also supplied the electrical and automation systems. Thanks to this investment in high-quality equipment technology combined with extensive know-how and

innovative quality assurance, Shandong has one of the most up-to-date plants worldwide. In addition to the production of tube grades and cold strip for the construction and household appliances industries, the focus lies on sophisticated steel grades for the automotive industry.

A major part of the hot strip produced is processed in the pickling tandem mill with an annual capacity of two million tons to obtain high-quality cold strip. The new facility produces cold strip in widths from 900 to 1,880 millimeters and final thicknesses between 0.3 and 2.5 millimeters with the starting stock having a gage from 1.8 to 6.0 millimeters. In the entry section, speed achieves maximum 700 meters per minute, whereas the pickling section will be passed at maximum 270 meters per minute. The maximum rolling speed of 1,450 meters per minute can be used even with minimum work roll diameter.

The pickling tandem mill has two payoff stations in the entry section of the pickling line where the strips are welded together to an endless strip. A newly developed exhaust system reduces scale dust in the entry section and comes with high efficiency combined with low susceptibility to failure and wear.

A tension leveler also is integrated in the exhaust concept. Its purpose is to break the scale on the strip surface, improve strip flatness and hence create ideal preconditions for an optimum pickling process. The pickling section comprises three pickling tanks, each having a length of 35 meters, with subsequent cascade rinsing and drying. The turbulence pickling section impresses with low maintenance and operating costs, low consumption of resources and high pickling performance along with first-class surface quality. Spray headers continuously spray heated acid into the shallow pickling channel thus generating extreme turbulences which maximizes the contact between the pickling acid and the complete strip surface. A patented immersion cover minimizes evaporation and associated energy losses.



High-quality pickling.



References

Continuous pickling line/5-stand tandem cold mill at Steel Dynamics, Inc., USA

A pickling line/5 stand tandem cold mill (PL/TCM) will be arranged downstream of the CSP® NEXUS plant. To meet future demand, the process section of the pickling line will feature SMS group's latest turbulence technology and a 600-kN leveling unit. An upstream payoff reel allows the pickling line and tandem cold mill to be operated in a coupled mode or independently of each other. This means that the hot strip can be either pickled and oiled or guided directly to the tandem cold mill. The annual pickling capacity will be 1.1 million short tons (1.0 million mt).

The modularized software architecture of the X-Pact® automation at the pickling line is supported by the state of the art automation hardware platform Siemens S7. The X-Pact® functional modules are proven in several of processing lines realized in the last years. During the "plug and work" integration test, the complete line will be tested in pickling mode and pickling/cold rolling mode.

The TCM is characterized by its outstanding flexibility, as it is suitable both for continuous operation, in conjunction with the pickling line (PL), and for batch operation. For this challenge, the high sophisticated X-Pact® total roll gap control (TRC®) is responsible. A threading in and tailing out system minimizes strip off-gauge weight and/or lengths and therefore increases the yield substantially. The five-stand/six-high TCM is designed to roll a wide range of materials that each come with their own requirements.

Proven control elements, such as CVC®plus technology combined with enhanced shifting system (ESS) for the intermediate rolls, positive and negative work and intermediate roll bending, highly dynamic hydraulic adjustment systems and multizone cooling in the last stand, together with the X-Shape Flatness Measurement and Control system guarantee optimal strip flatness and thickness tolerances.

The dry strip system in the last stand has low compressed air requirements and prepares the strip surface for downstream processes. Contributing to the high proportion of high-strength steels, the carousel reel is equipped with the new revolving mandrel support bearing. It prevents lowering of the mandrel during coiling and allows for higher tension winding, thereby ensuring higher reductions and improved flatness at the strip head end. The exit section includes an offline inspection stand for ergonomic, fast, and comprehensive inspection of the finished strip.

Technical data

Technical details for pickled and pickled & oiled material grades (P&O)

Process type	turbulence pickling technology
Process tank length	4 pickling tanks, length 82 ft (25 m) each, total: 328 ft (100 m)
Hot strip dimensions:	
Entry strip width	78 in - 38 in (1,981 mm - 965 mm)
Entry strip thickness	0.25 in - 0.047 in (6.35 mm - 1.2 mm)
Entry speed:	max. 1,476 ft/min (450 m/min)
Pickling speed:	max. 820 ft/min (250 m/min)
Exit speed:	max. 919 ft/min (280 m/min)



The new PLTCM at SDI, Sinton, Texas.

References

Pickling line/tandem cold mill and continuous pickling line for Big River Steel, USA

Big River Steel located in Osceola, Arkansas, USA on approximately 1,300 acres is one of the country's most modern and environment-friendly steelworks. Applying innovative, clean, and effective processes, the company produces high-quality steels for the energy, automotive, oil and gas industry from recycled steel scrap.

Big River Steel banks on innovative technology from SMS group. In three years, a steelworks of the latest state-of-the-art was set up as a Greenfield project.

The plant has an annual capacity of 3.0 million tons of high-grade steel products and specialty steels and also contains a coupled pickling line/tandem mill, including CVC®plus, hydraulic screwdown, multi-zone cooling, emulsion system and innovative fume extraction system.

The pickling line/tandem cold mill is designed to process up to 900,000 tons of steel strip per year with strip widths ranging from 914 to 1,880 millimeters. It is equipped with an X-Pro® laser welder, a scale breaker, a turbulence pickling section and tandem cold mill. A large portion of the production volume, cold strip being 0.27 to 1.4 millimeters thick, is processed with-in the plant. Another component is the DUMA-BANDZINK oiling machine installed in the mill to produce pickled- and-oiled material. Strip thicknesses here are between 1.4 and 5.0 millimeters. First strips were processed on the line in the summer of 2017.



The turbulence pickling section comprises three plastic tanks and is characterized by high performance at low operating costs.



Combined pickling line/tandem cold mill.

Thanks to the X-Pro® laser welder it is possible to precisely and quickly join difficult-to-weld, high-alloy strips, to lead them through the process reliably and roll them without any problems. This ensures the line can handle even high-carbon or high-silicon grades.

The turbulence pickling section comprises three plastic tanks of 27 meters length, each provided with its own cycle. The system is characterized by high pickling performance, low energy and acid consumption as well as low maintenance and operating costs paired with a long service life. To achieve optimum pickling results at minimum energy input, operators can actively influence and perfectly adjust all essential parameters.

Hot-strip Galvanizing Line

The galvanizing of hot strip enables the production of zinc-coated steel strips with long-life corrosion protection and an attractive look, at low production and investment costs. There is a growing market and a great many areas of application for galvanized hot strip, for example in the construction, furniture or automotive industries.

Economically-speaking, the use of galvanized hot strip is particularly attractive for applications where a galvanized cold strip would normally be used. Because a number of cost-intensive process steps are omitted from the production of galvanized hot strip compared to the production of galvanized cold strip, enormous cost advantages arise here, which ultimately increase the margins of the steel producer. The classic way to galvanize hot strip consists of heating the already pickled hot strip to galvanizing temperature on a line and then galvanizing and post-treating it. Economically-speaking, the production of galvanized hot strip in combined pickling and galvanizing lines, just like those established by SMS, is considerably more effective. Here, galvanized hot strip is first pickled on a line, heated to galvanizing temperature, galvanized, skin-passed and post-treated ("heat-to-coat" process).

Thus, a high-value end product, that can be delivered to many customers, is made from unpickled hot strip in one step. In order to increase the material quality – particularly the flexibility – of first and foremost very thin materials, further modifications to the line concept are possible, depending on the hot strip used. Particularly suitable options are the integration of a skinpass mill stand and an annealing module.

Economical pickling and continuous galvanizing line for Wupperman in Hungary

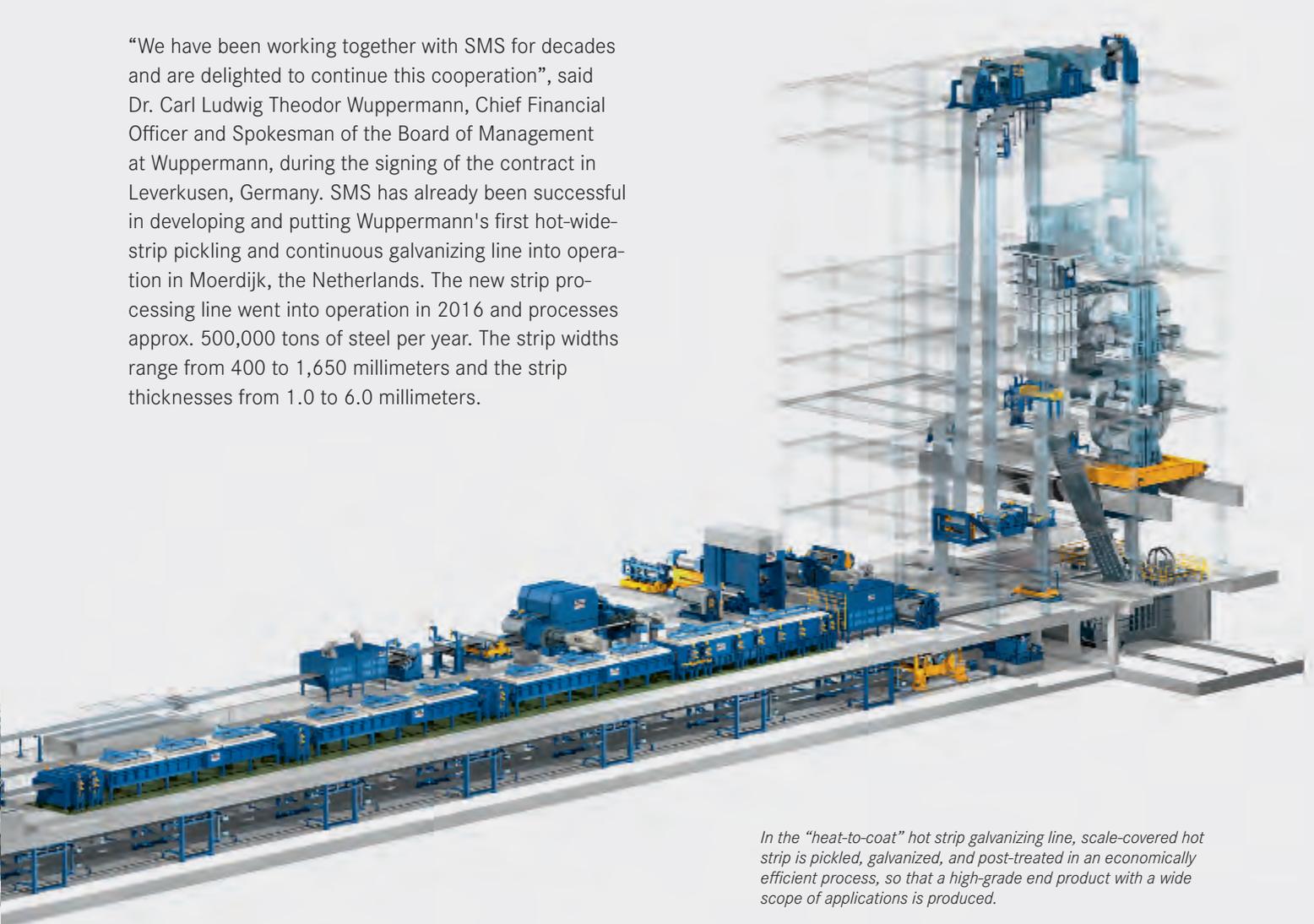
In 2014 the Wupperman group commissioned the SMS group to deliver a hot-wide-strip pickling and hot-dip galvanizing line for the new works in Győr-Gönyű, Hungary. delivered the complete line, including the mechanical equipment, process engineering, and electrical and automation systems.





High-grade, galvanized hot strip on the galvanizing line made by the SMS group at Steel Dynamics Incorporated in Mississippi, USA.

“We have been working together with SMS for decades and are delighted to continue this cooperation”, said Dr. Carl Ludwig Theodor Wuppermann, Chief Financial Officer and Spokesman of the Board of Management at Wuppermann, during the signing of the contract in Leverkusen, Germany. SMS has already been successful in developing and putting Wuppermann's first hot-wide-strip pickling and continuous galvanizing line into operation in Moerdijk, the Netherlands. The new strip processing line went into operation in 2016 and processes approx. 500,000 tons of steel per year. The strip widths range from 400 to 1,650 millimeters and the strip thicknesses from 1.0 to 6.0 millimeters.



In the “heat-to-coat” hot strip galvanizing line, scale-covered hot strip is pickled, galvanized, and post-treated in an economically efficient process, so that a high-grade end product with a wide scope of applications is produced.

References

Pickling hot-strip galvanizing line for Nucor Steel

To Nucor Steel Gallatin, domiciled in Ghent, Kentucky, USA, systems supplier SMS group delivered a new „heat-to-coat“ pickling and galvanizing line, including engineering, process technology, furnace equipment, pickling and galvanizing technology as well as electrical and automation systems, all from one source.

The line was put on stream in September 2019 and since then, has continually increased capacity. Meanwhile, the

line produces even strips with so called galvanized surfaces. In a „heat-to-coat“ line this is a worldwide unique achievement. Right behind the air knives, the liquid zinc is inductively reheated and allows a zinc-iron alloy layer to develop. Even strips of maximum possible dimensions i. e. 6.35 mm thickness and 1,854 mm width can be produced with galvanized surfaces. This is another one of the line's unique features.





The latest generation of X-Pro® laser welding machine safely and quickly welds together the individual steel strips to produce endless strip. An efficient solid-state laser is used for this purpose.



The galvanized hot strip is used for a broad range of applications, in particular in the construction, transport and automotive industries.



The turbulence technology in the shallow tanks achieves a maximum pickling effect with a minimum of acid and energy.



FOEN® air knives continuously ensure a highly precise layer thickness. As soon as the galvanizing is completed, another induction unit can be run into the line. This enables Nucor Gallatin to produce so called galvannealed surfaces, which is a world first in a „heat-to-coat“ line.

Cold-strip Annealing and Galvanizing Lines

System supplier for annealing lines and galvanizing lines

Annealing lines and galvanizing lines from the SMS group are characterized in particular by the excellent quality of the end product, high efficiency and economy, as well as enormous capacities. In recent years various improvements and new technical solutions have been developed, particularly regarding line concepts, furnace technology, galvanizing technology and post-treatment.

It has been proven that SMS has the competence to design, engineer, erect and put into operation modern cold strip processing lines. Supported by the various specialized companies within the SMS group, which offer equipment and services for annealing lines and galvanizing lines (DREVER, DUMA-BANDZINK, Elotherm, EMG, FOEN, IAS, MET/Con), the lines are delivered from a single system supplier.



SMS group's strip processing lines feature large vertical strip accumulators which ensure a high and constant strip speed in the process section in order to achieve high capacities.



High and well-documented quality of the end-product is crucial for the economic success of a cold-strip processing line.

Production of automotive grades

Steel continues to be the most important construction material for the automotive industry, whereby particularly the share of high-strength steels in cut-throat competition with other materials is constantly increasing. As manufacturers are required to build light and fuel-efficient vehicles, many new steel grades with optimized combinations of properties have been developed. Multi-phase steels, which are high-strength and very ductile, are increasingly being used for car components. These high-strength yet easily deformable steels must meet the highest quality requirements for use in automobiles, whereby not only the material properties, but also the surface quality must be of a high standard.

Hence, strip processing lines for the production of high-quality steel plates for use in interior and exterior components (usually continuous galvanizing lines and annealing lines) must be set up to produce high material strengths and flawless surfaces. In the lines, account is taken of the stringent demands on surface quality. This commences with cleaning, which is followed by surface-friendly annealing, and high-grade coating technologies for the application of a zinc layer, passivation or preserving oils. Advanced annealing and cooling strategies are implemented, together with a skin-pass millstand for targeted post-treatment, in order to achieve outstanding material strengths.

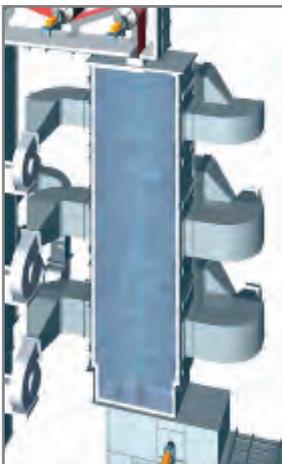


In automotive construction, a growing number of steels with higher strength and good forming properties are being used.

Furnace technology

UFCplus: Rapid cooling with gas

To reach highest cooling rates with gas cooling Drever developed the advanced gas jet cooling system *UFCplus*. With this cooling system higher cooling rates of up to 150 kelvin per second per millimeter are obtained by adding pure hydrogen to the cooling chamber without increasing the total hydrogen consumption of the line. A patented hydrogen migration technology limits the diffusion of hydrogen into the adjacent chambers. Thus, a hydrogen content in the cooling chamber of up to 50 % can be reached while keeping the hydrogen content in the other sections still under 5 %.



Intensive cooling with water

Alternatively, our Water Spray rapid cooling system involves immersing the strip in demineralized water while special nozzles spray it from both sides at high pressure. Here, the cooling rate is more than 1,000 kelvin per second and millimeter of strip thickness, enough for manufacturing tough dual and complex-phase grades and martensitic grades with tensile strengths of 1,500 megapascals and more.



PrOBO_x[®]-technology for pre-oxidation

Wettability problems in the conventional continuous galvanizing process due to high alloyed materials can be prevented by a specific oxidation and reduction process, for which SMS group offers the PrOBO_x[®]-technology. The PrOBO_x[®]-technology has become widely accepted as the best process for continuous galvanizing of high-strength steel grades with high silicon and manganese contents. For this purpose, on the strip surface targeted reference oxide layer is adjusted during the annealing process at temperatures between 600 and 700 degrees Celsius.



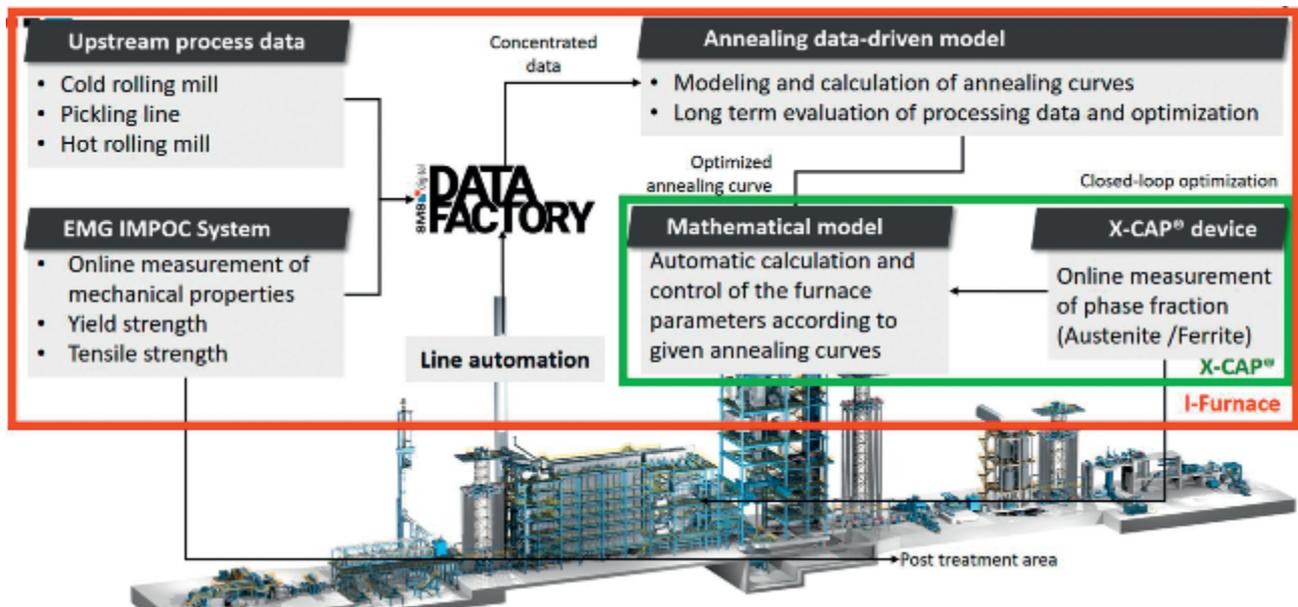
Intelligent furnace with X-CAP® technology

The production of modern AHSS grades places high demands on the thermal process in annealing and continuous galvanizing lines. In particular, the automotive industry requires homogeneous properties of the steel strips from coil to coil and along coil length. In order to achieve this, information on the micro structure of the strip is necessary to control the process and compensate possible deviations caused in the upstream processes.

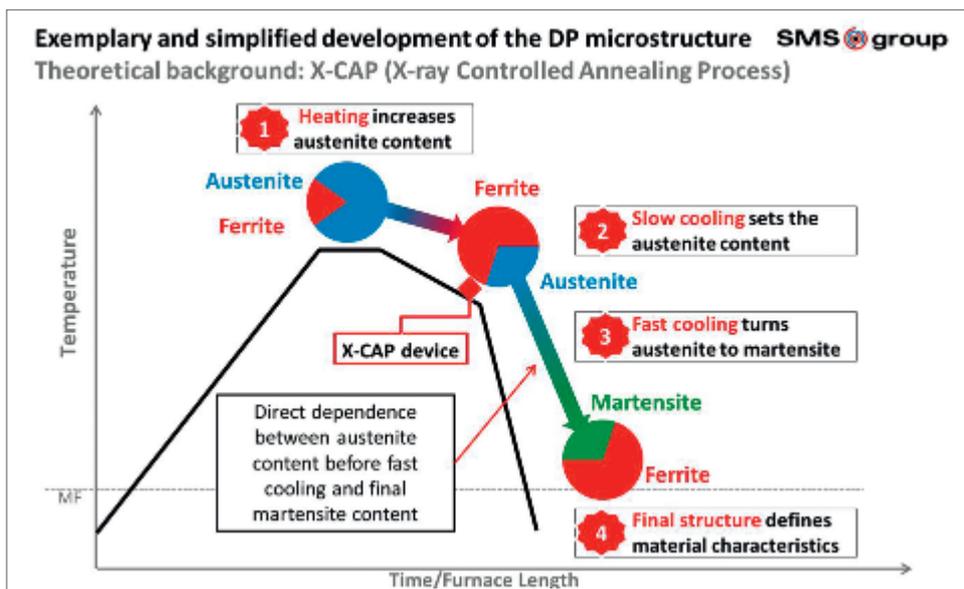
Therefore, SMS group developed the I-Furnace (Intelligent Furnace) including a smart annealing process and a production optimization model. Here, the combination of various tools leads to an optimized heat treatment and production process. Furnace control, online strength

measurement and a model to predict the material properties after annealing are combined and linked. However, control of the process with a measurement system in the exit section of the line, far behind the process, has a long reaction time and at that position final mechanical properties are already adjusted. Thus, a further measurement system including control model has been developed in addition to the already existing tools to complete the I-Furnace.

SMS group, Drever International and IMS Messsysteme jointly developed X-CAP® (X-ray Controlled Annealing Process) permitting the steel structure to be measured within the annealing process and hence the mechanical properties to be controlled in closed loop first time direct in the relevant process section.



The I-Furnace by SMS group has been completed by the newly developed X-CAP® system (in cooperation with IMS Messsysteme and Drever International).



The X-CAP® device measures the austenite fraction after the slow cooling process, thus providing reliable information on the mechanical properties of the final product and offering the possibility to directly control strength.

High material and surface quality

Ultimate surface quality

The stand-out feature of SMS continuous galvanizing lines is that they are capable of producing best surfaces (C-surface). This is a fundamental requirement because only materials of this quality can be used for automotive outer skins.



Drever quality snout

The production of modern AHSS grades places high demands on the thermal process in annealing and continuous galvanizing lines. In particular, the automotive industry requires homogeneous properties of the steel strips from coil to coil. Dross and dust in the snout area lead to major surface defects in galvanizing lines. In many cases, due to these defects it is impossible to produce high surface qualities like automotive exposed steel grades.

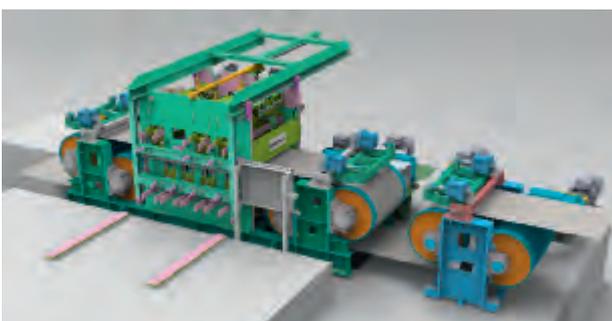
With the Drever QualitySnout the production of defect-free surfaces can be supported due to a comprehensive concept including several innovative features. These features ensure zinc dross removal, zinc dust prevention, and atmosphere sealing.

Of prime importance is the efficient cleaning device, which removes dross and impurities from the bath surface inside the snout and keeps the snout damp clean. A special snout cross adjustment system compensates any misalignment of the snout. Thus, the overflow dump is always adjusted parallel to the zinc level and homogeneous removal of zinc dross is ensured. Additionally, the wet H_{Nx} system and the preheating system for protective gas prevent formation of zinc dust. The roll sealing device separates the snout area from the furnace and prevents the migration of all remaining zinc dust into the furnace atmosphere. Furthermore, this device supports strip guiding, which results in less vibrations of the strip while entering into the zinc bath. A special flap-sealing device located at the upper part of the snout is used during line stops to seal the furnace atmosphere when the pot is away.

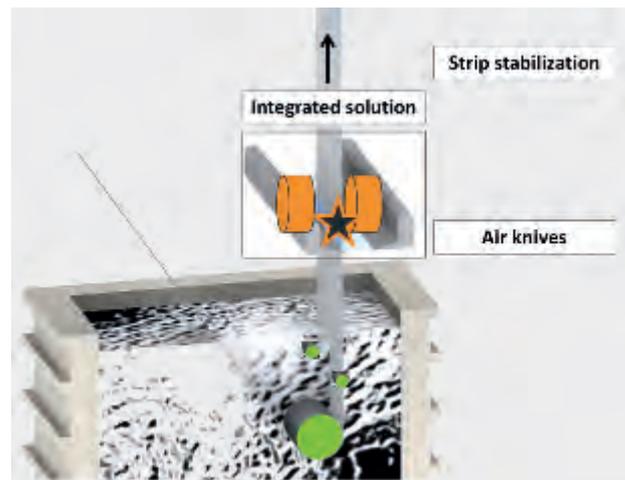
Tension leveler for high-strength steel strip

In strip processing lines, tension levelers minimize irregularities such as waviness, cambers or length- and cross-bows by a combined tensioning and leveling action to create a flat final product. Market demands for higher material strengths lead to exacting changes in machine technology. One aspect is higher forces in stretching and bending. SMS group has developed tension levelers for cold as well as hot strip lines, that are capable to level steel strip with yield points much higher than 1,000 megapascals. The machines are also suited for installation in existing plants to make these facilities meet future material requirements.

The newly developed tension leveler TL-40-V490 for high-strength cold strip is designed for strip tensions up to 550 kN. These strip tensions are capable of leveling third-generation AHSS grades. The machine is equipped with two bending roll units of 40-millimeter roll diameter to ensure intense bending action. Furthermore, three correcting roll units are integrated to eliminate length- and crossbows in high-strength grades. The special arrangement makes sure the operating area is not coupled to the correcting area. Adjustment of the rolls as well as quick opening are achieved fully hydraulically, which permits the parameters to be flexibly adapted and thus to avoid non-flat areas. Material grades not to be leveled may pass the machine without contact. A special exchange system allows to quickly change the leveler cassettes during ongoing production.



High and well-documented quality of the end-product is crucial for the economic success of a cold-strip processing line.



The integrated solution combines the air knife system with a strip stabilization system.

Integrated solution air knife systems

In principle, electromagnetic strip stabilization systems feature electromagnets arranged on both sides of the strip at the same height above the air knives. A position measuring system is installed below on each magnet position and continuously measures the position to the strip in a non-contact manner. The strip position determined by this sensor is compared to the reference position. Due to this deflection the electrical current is prescribed to the stabilization coils on the top or bottom side and results in a magnetic attraction of the steel strip. This way the cross bow of the steel strip is minimized and vibrations are reduced. Consequently, the distance of air knife lip to strip surface can be reduced. To satisfy today's requirements on surface quality, an integrated solution has been developed which brings air knife and strip stabilization closer together.

Strip stabilization systems are a necessary feature in modern continuous galvanizing lines, since the requirements on process and surface quality are continuously growing due to various reasons. New industrial standards require closer tolerances, especially for the automotive industry. For example, the new European standard for the automotive industry (VDA 239-100) demands a single-area test instead of the formerly used three-area test. Thus, the standard is stricter since small deviations have a stronger impact on the evaluation. In addition, the surface quality in general has to be higher and more homogeneous, which is only possible with a stable strip run in the air knife. For an economic production, the yield of top-quality material has to be high. Hence, the processing speed must be as high as possible and cut-outs because of poor quality after thickness changes have to be avoided. At the same time, resources should be saved to keep operational costs low. This can be achieved by a reduction of over-coating and by lowering the wiping pressure due to the closer distance between strip and nozzles.

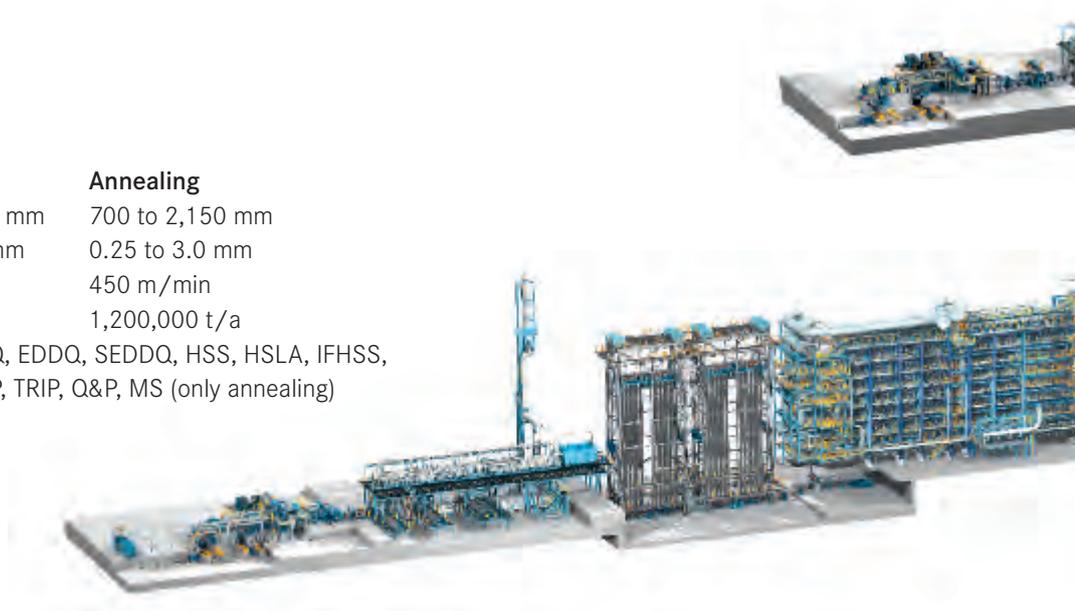
Line types – annealing lines and galvanizing lines

Automotive-lines

The annealing lines and the continuous galvanizing lines are the most important cold strip processing lines for the production of automotive grades, whereby both high-level exposed surface quality and high-strength materials are required.

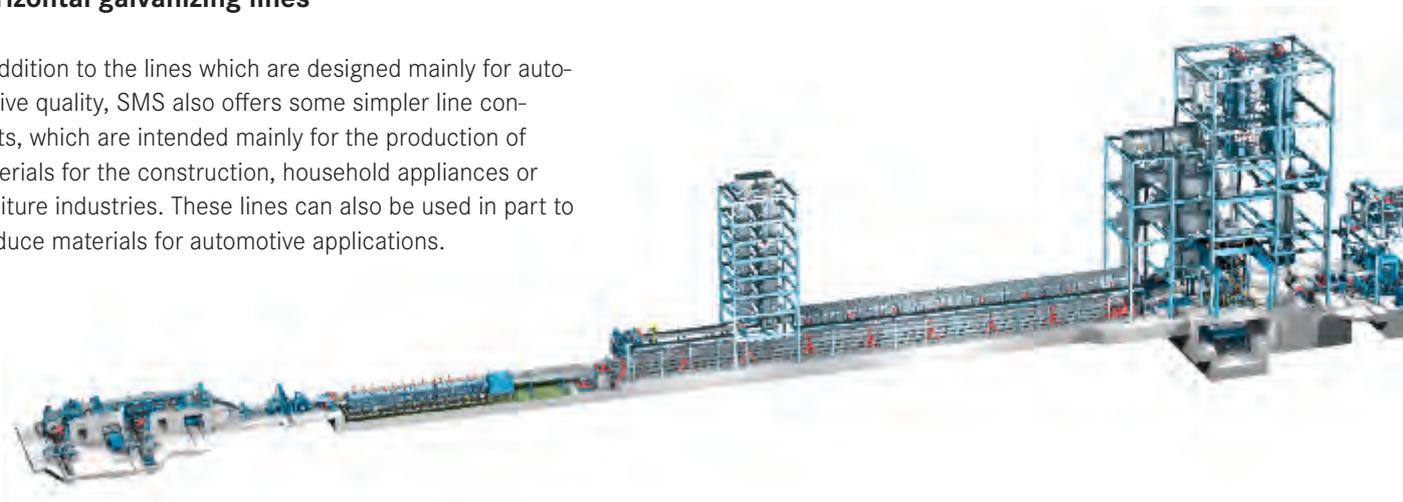
Typical technical data

	Galvanizing	Annealing
Strip width	750 to 2,080 mm	700 to 2,150 mm
Strip thickness	0.25 to 3.0 mm	0.25 to 3.0 mm
Process speed	200 m/min	450 m/min
Capacity	550,000 t/a	1,200,000 t/a
Products	CQ, DQ, DDQ, EDDQ, SEDDQ, HSS, HSLA, IFHSS, IF-BH, CP, DP, TRIP, Q&P, MS (only annealing)	



Horizontal galvanizing lines

In addition to the lines which are designed mainly for automotive quality, SMS also offers some simpler line concepts, which are intended mainly for the production of materials for the construction, household appliances or furniture industries. These lines can also be used in part to produce materials for automotive applications.





Continuous galvanizing line



Continuous annealing line



Batch annealing furnaces

Batch annealing furnaces serve to anneal and cool cold strip coils in the batch mode. They are able to process several coils simultaneously.



Multi-purpose lines

Flexibility and cost-effectiveness

More than ever, cost-effectiveness and flexibility are the main demands manufacturers make on strip processing lines. These two aspects are profoundly interdependent in a constantly changing market environment. Flexible pro-

duction conditions the greatest possible efficiency in reacting to changing demands with. This is where automotive lines from the SMS group stand out because of their extreme flexibility thanks to the highly developed, tried-and-tested technologies and components that are applied. Integrated in the radiant-tube furnace from DREVER are

Universal annealing line with rapid cooling and water-spray cooling

Apart from an ultra-fast cooling zone with cooling rates of up to 150 kelvin per second and millimeter of strip thickness, this type of line comes optionally with a water-spray cooling system that achieves cooling rates in excess of 1,000 kelvin per second and millimeter. This makes it suitable not only for the high-strength grades that require rapid cooling, but also for martensitic and dual-phase steels with tensile strengths of 1,550 megapascals and more.

- Annealing line rapid cooling mode
- Annealing line water-spray cooling mode



Universal annealing and continuous galvanizing line

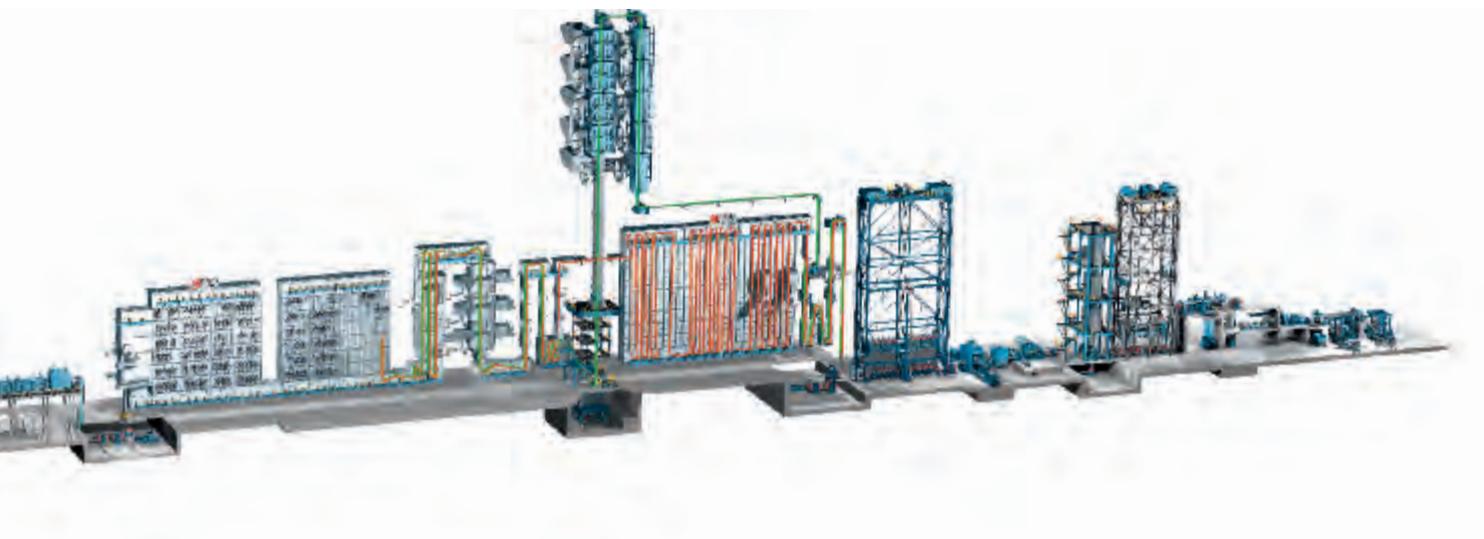
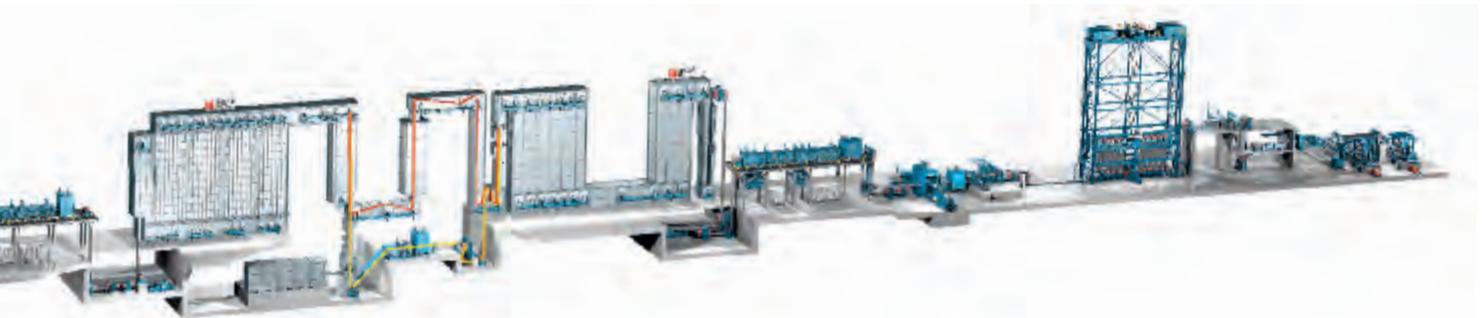
Here is a special type of line in which the cold strip first goes through recrystallization annealing, then moves on to either a zinc bath or an overaging zone. You benefit from a flexible line that produces two different product groups (annealed and galvanized) in extremely high-quality.

- Continuous galvanizing line mode
- Annealing line rapid cooling mode



adjustable annealing curves, high cooling rates, and special surface preparation technologies. It meets all the requirements for annealing and subsequently coating a large range of products, including modern high-strength steel grades. Systems for changing the zinc pot as well as state-of-the-art air knives provide the option of different strip coatings.

SMS group can do even more for you – for instance in the field of post-treatment: with flexible components for setting a whole range of product properties. Universal cold strip lines that offer different processes for the strip, depending on current requirements, provide even more flexibility.



References

Shandong Iron and Steel Rizhao, China



Complete cold rolling complex.

Two continuous annealing lines and one continuous galvanizing line for automotive grades

The cold strip produced is refined in two annealing lines and one continuous galvanizing line to create high-quality end products. A special feature of the lines are the powerful Drever radiant tube furnaces. Among other things, they are equipped with an ultra-fast cooling system permitting extremely high cooling rates to be achieved and thus the production of high-strength grades for the automotive industry. To prepare the strip for the annealing process, a multi-stage cleaning zone is integrated in each line entry section. To prevent any coating imperfections resulting from selective oxidation of alloying elements, the furnace in the continuous galvanizing line features ProBO_x[®] pre-oxidation technology. Further, the continuous galvanizing line includes a FOEN air knife system to precisely meet the required layer thickness and thereby satisfy the extremely high surface quality demands of the automotive industry.



The FOEN air knife system for precise layer thickness.

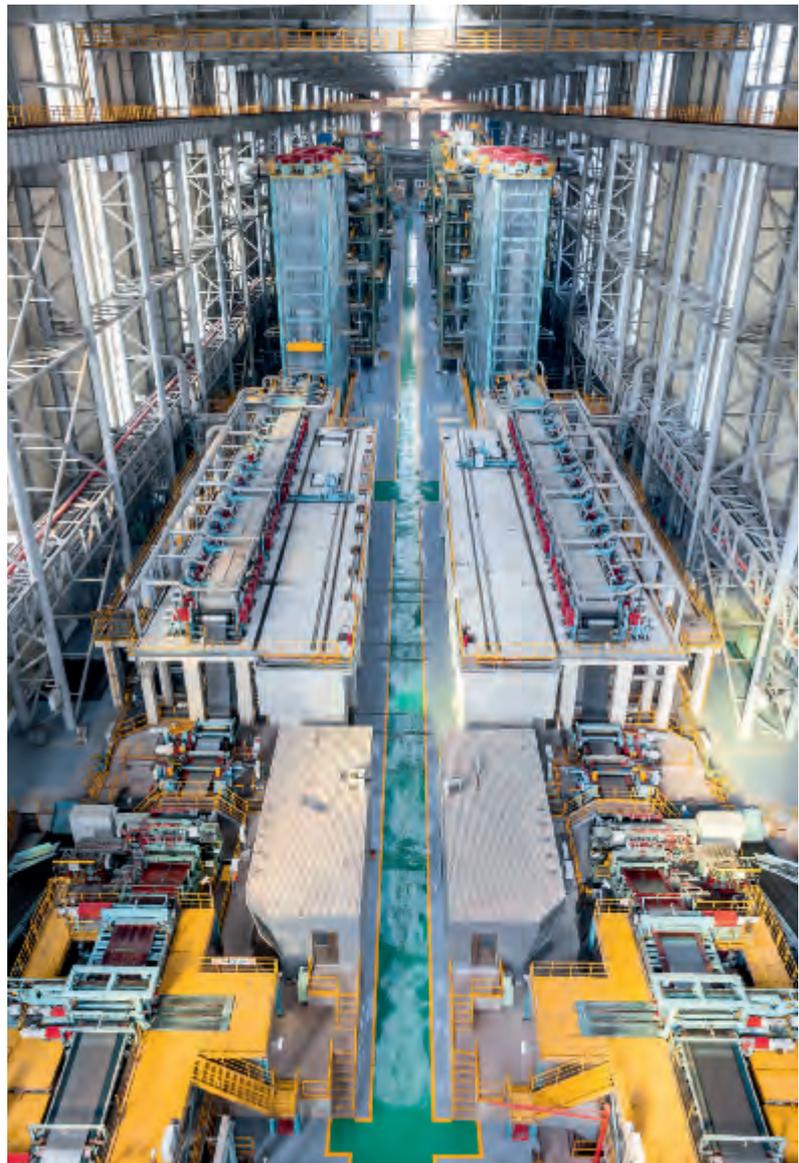
The annealing lines are designed for an annual capacity of 950,000 respectively 650,000 tons of steel strip. A further portion of 400,000 tons of steel strip per year can be heat-treated and provided with a zinc layer in the continuous galvanizing line. The totally two million tons of surface-finished cold strip comes in widths of between 900 and 1,850 millimeters and final thicknesses from 0.3 to 2.5 millimeters. The portfolio comprises material grades CQ, DQ, DDQ, EDDQ, SEDDQ, BH, HSLA, HSS, DP, TRIP, with tensile strengths of up to 1,000 megapascals being achievable.



ProBO_x® technology allows for flawless zinc coating of high-alloy high-strength steel grades.



ProBO_x® technology allows for flawless zinc coating of high-alloy high-strength steel grades.



2,000,000 tons of cold strip are processed in two annealing lines and one continuous galvanizing line to create high-quality end products for the automotive industry.

References

Salzgitter Flachstahl GmbH, Germany

Continuous galvanizing line for high-strength material

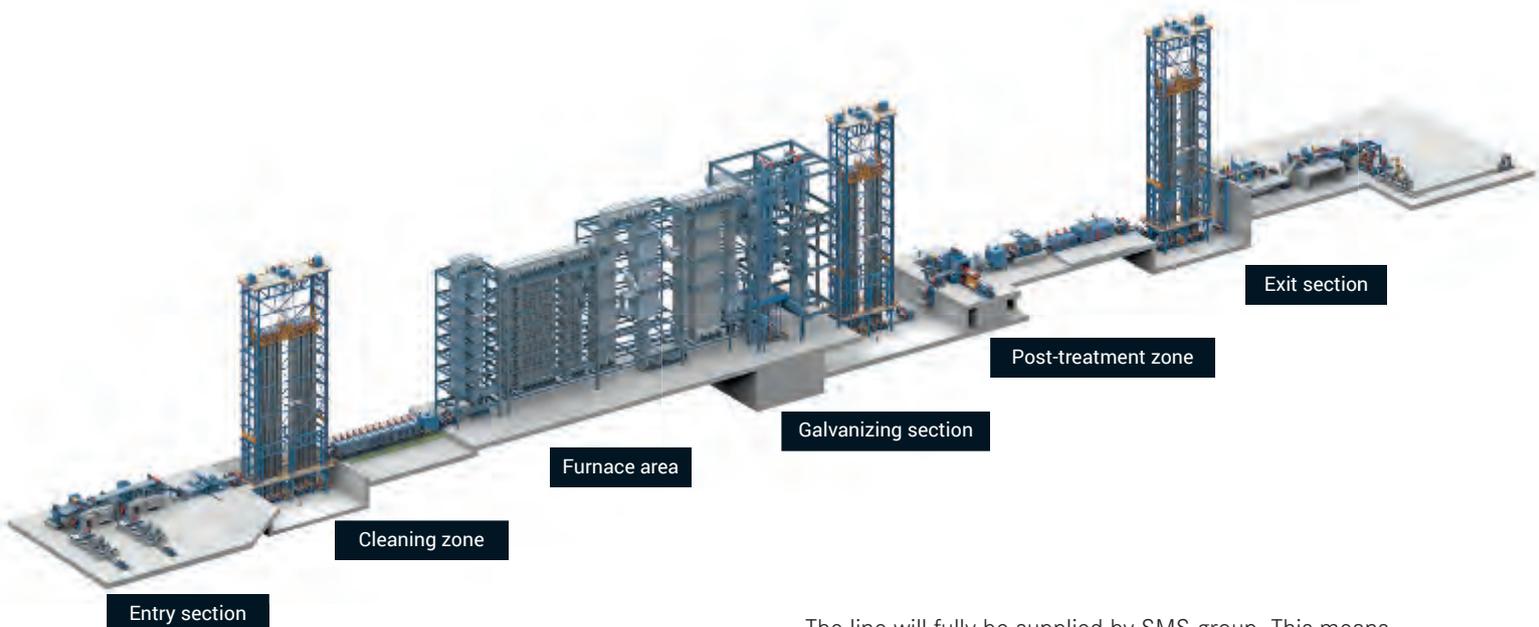
Salzgitter Flachstahl GmbH (SZFG), a subsidiary of Salzgitter AG, has launched its “Hot-Dip Galvanizing 3” (FV3) project and one of its largest single investments of the last decade at the Salzgitter location. For plant engineering, the company selected SMS group as project partner. In addition to supplying all main components, SMS will also be responsible for erection and commissioning.

The new production facility, with an annual capacity of 500,000 tons, supplements SZFG’s already existing continuous galvanizing lines. “This project is a key component in the strategy of Salzgitter Group that focuses on qualitative growth in the steel strip business and will help us strengthen our market position as a producer of premium products for national and international customers in the automotive industry,” explains Prof. Dr.-Ing. Heinz Jörg Fuhrmann, Chief Executive Officer of Salzgitter AG. FV3 is scheduled to start operation in 2022 and will then



This galvanized DP1000 steel coil presented at METEC in Düsseldorf was made available to SMS group by Salzgitter AG.

produce third-generation AHSS (Advanced High-Strength Steel) grades for chassis and body applications which play an important part in lightweight automotive construction and in vehicle security.



The line will fully be supplied by SMS group. This means that all mechanical and process technological components, including furnace, air knives as well as X-Pact® electrical and automation systems will be supplied from one source. In addition, the supply scope comprises erection and commissioning services.

References

Steel Dynamics, Inc., USA

Continuous galvanizing/galvalume line

Steel Dynamics, Inc. has awarded SMS group an order covering the supply of a complete steel production line for its Sinton location in the state of Texas. For cold and hot strip galvanizing, the plant will be equipped with a continuous galvanizing line (CGL) that includes a horizontal Drever furnace heated by a direct-fired and a radiant-tube zone. The line will be prepared for the later installation of an ultra-fast gas cooling section to allow high-strength steel to be produced in future.

The scope of supply also includes a DUMA-BANDZINK air knife system, which ensures a homogeneous and precise zinc layer thickness and guarantees high surface quality. A change system with two zinc pots will allow the strips to be coated with a conventional zinc layer or an aluminum-zinc alloy.

For post-treatment, the line will be equipped with a four-high skin-pass mill stand, a tension leveler, and two horizontal shuttle-roll coaters, as well as with an oiling machine in the exit section.

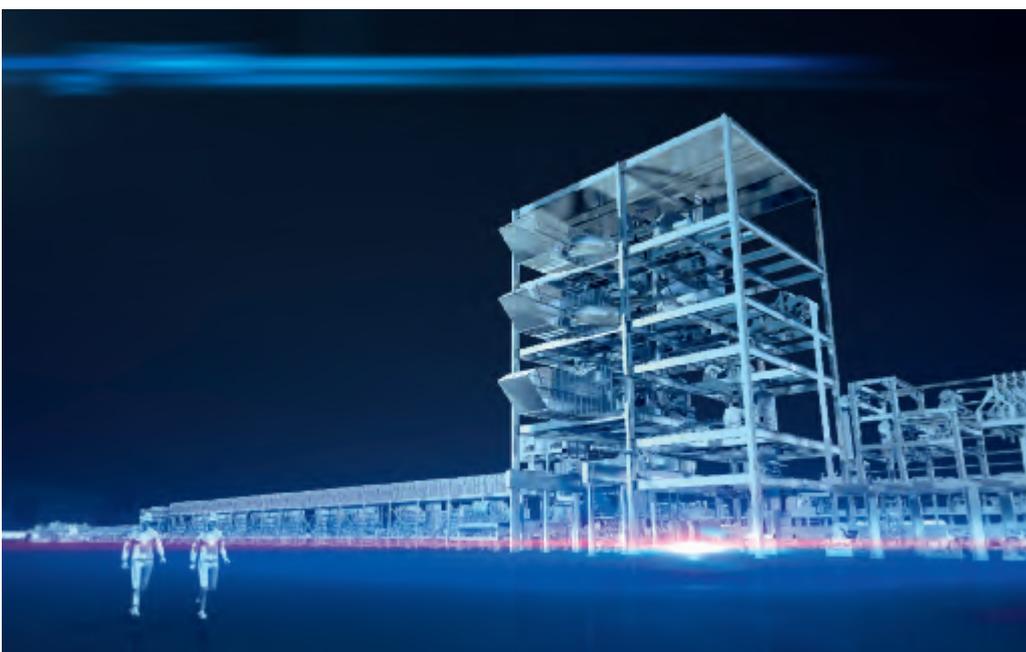
The galvanizing line will be able to process strip with a thickness of up to 0.16 in (4 mm) and a width of up to 76 in (1,930 mm). Its annual capacity will be 524,000 short tons (475,400 mt).

As in the pickling line, the automation system of the CGL will be the SMS X-Pact® automation system on the hard-ware platform Siemens S7. The X-Pact® basic automation system for the terminal equipment, process equipment, as well as the furnace automation with furnace model, will be linked by a proven system realized in many lines during the last years.

Technical data

Continuous galvanizing line

Strip width	38 in - 76 in (965 - 1,930 mm)
Strip thickness	0.01 in - 0.16 in (0.25 - 4 mm)
Entry speed	900 ft/min (274 m/min)
Process speed	650 ft/min (198 m/min)
Exit speed	900 ft/min (274 m/min)
Annual production	524,000 short tons (475,400 mt)



References

PRO-TEC Coating Company, USA

Continuous annealing line with rapid cooling and water-spray cooling system

Since 2013, the annealing line at PRO-TEC in Ohio, USA, has been producing high-strength and ultra-high-strength steel strip used to make interior components for cars, SUVs, and trucks. Included here is a Drever annealing furnace with two cooling systems.

What is special about this modular design is that it offers two alternatives downstream of slow cooling: the ultra-fast cooling system with a cooling rate of up to 120 kelvin per second and millimeter of strip thickness, and the water-spray cooling system with a cooling performance of more than 1,000 kelvin per second and millimeter of strip thickness. Water-spray cooling is necessary to produce grades such as martensitic and ultra-high-strength qualities with a tensile strength of over 1,500 megapascals. These steels are mainly used for manufacturing crash-resistant major components in the passenger cell.



The commissioning team celebrates the first high-standard coil.

It is possible in some cases to save up to 40 percent of the weight. Besides being responsible for the design and engineering of the mechanical equipment, SMS group also supplied the entire electrical and automation systems.



The line produces some 500,000 t of high-strength steel strip per year.

References

Shougang Jingtang United Iron & Steel, China

Two continuous annealing lines

Acting as a consortium leader, SMS group built two continuous annealing lines for Shougang Jingtang on the man-made Caofeidian Island in north-east China. The first line was ordered as recently as 2007 and started production at the end of 2009. Then the second line, ordered in 2008, went on-stream five months ahead of schedule in December 2010. Together, the plants are designed to process almost two million tons of cold strip per year from the pickling line/tandem cold mill also supplied by SMS, with most of this material going to the automotive industry. Both lines achieved a successful production start with an excellent start-up curve.

Shougang Jingtang is a joint venture between Shougang and Tangshan, which rank among China's largest steel producers. It was partly due to the good cooperation



Right from the second day, commercial-standard strip was produced.

between us that the joint venture contracted SMS group in 2011 to erect a tinplate annealing line and two electrolytic tin-plating lines in the plant.



The Shougang Jingtang plant can anneal some two million t of automotive cold strip per year.

Color Coating Lines for Carbon Steel

Organically coated plate is now standard in the customer world and is being used increasingly wherever aesthetics are required in addition to corrosion resistance. Aside from the construction industry, the biggest buyers of coated plates are household and electrical appliance manufacturers. But ready-coated plates are being used increasingly frequently in the automotive industry. Contrary to coating individual pieces, the continuous coating of steel strips – coil coating – creates considerably more economical products. The plates can be reshaped into products by customers without having to repaint them.

Depending on the requirements regarding corrosion protection, formability, temperature stability, desired color, degree of gloss and surface hardness, a cold rolled or galvanized thin sheet with various layers is provided, whereby very different configurations and designs of the coater are used. In the paint coating lines, different coaters are generally used for the conversion coating, the base coat and the varnish. All coaters are controlled so that the fluid media are applied evenly and in the desired thickness.



For some products, the hardening oven can be fueled completely by the energy reused from the evaporated solvents.

Furthermore, the color coating lines are characterized by an environmentally friendly catenary or floatation oven for hardening the paint coat, to which an RTO plant (Regenerative Thermal Oxidation) is connected. Thus, the energy from the drying of the evaporated solvent is transferred back into the process.



A regenerative incineration system (here with three chambers) burns the solvent-containing air and regains the energy produced.

Two color coating lines for Severstal

Severstal's new color coating line in Cherepovets, Russia, was successfully put into operation at the end of 2011 and production quickly increased in the following months. After only a few weeks, salable material was already being produced by the plant, which was delivered by SMS. The new plant is of identical design to the SMS color coating line that went into operation at Severstal at the end of 2005. Besides the very high process speed, the highlights of the line are the roll coaters and the high-performance drying ovens. In the future, a further 200,000 tons per year of hot-dip or electrolytically galvanized cold strip will

be color coated in western Russia. The strips are mainly used in the construction and household appliances industries. In the plant, the strip surface is cleansed by spray and brush degreasing in a cleaning section. A vertical roll coater applies a conversion coating to the prepared surface, which is then dried. Then the strip is prime-coated in a back-up roll coater and passes through a low-emission catenary hardening oven. The strip can then be coated with a finish coat in two back-up roll coaters and hardened in another curing oven. All the coaters have high-precision control for the precise and consistent application of media. In addition, the strips can be provided with a protective film in the exit section.



Color-coated strip in the strip accumulator at Severstal.



In the vertical coater, the strip is prepared for the next coat with a conversion coating.

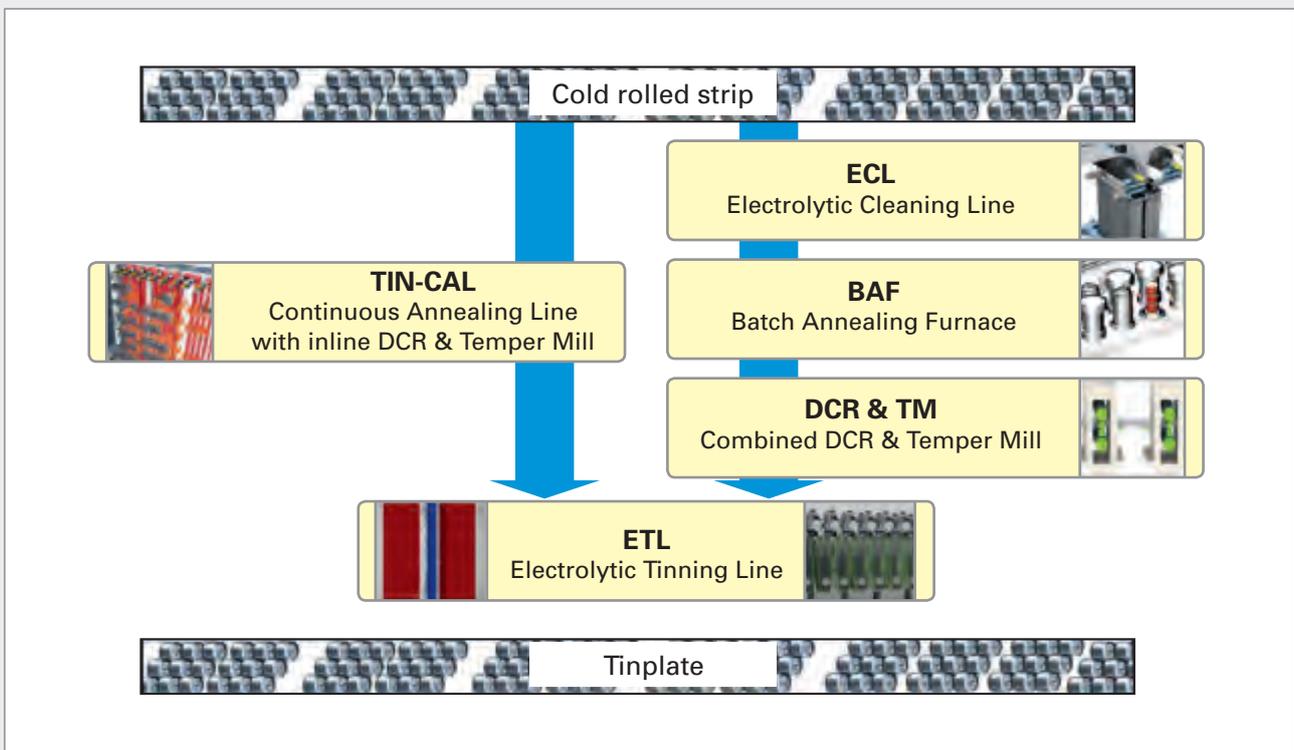


In the exit section, the strips are gently coiled by a belt wrapper and then removed.

Tinplate Production

The SMS group offers innovative, technical solutions at all steps of tinplate production for the efficient processing of cold strip into packing material. All the necessary treatment facilities can be delivered from a single source, including mechanical and processing equipment, furnace technology, electrical and automation systems and production know-how. The electrolytic tinning lines are fitted with soluble anodes, which create significant economic, ecological and process-engineering advantages.

Generally there are two different process routes for the production of tinplate. In the conventional route the cold-rolled strips are cleaned in an electrolytic cleaning unit, moved to a batch annealing furnace for recrystallization annealing and then surface-treated and reduced in an offline skinpass mill stand. In the other route – which is often used for higher capacities – all the process steps take place in a continuous tinplate annealing line with an inline skin-pass mill stand. Finally the material is coated with tin on an electrolytic tinning line.



The SMS group offers innovative technical solutions at all steps of the production of tin plate.

Tinplate

Electrolytically tinned ultra-thin sheet (tinplate) is a cold-rolled, recrystallization-annealed and, in some cases, reduced thin sheet made of carbon steel onto which a firmly adhering tin coating has been applied by an electrolytic process. The tin coating protects the base material against corrosion and, furthermore, acts as an excellent primer for subsequent painting, provided that proper



surface-treatment has been carried out. Due to the main application of tinplate being packing material, it is also known as “packaging steel”. Tin cans for foodstuffs, pet food and beverages are a main area of application. Packaging for chemical-engineering products and spray cans for aerosols are also made from this thin material. Furthermore, closures such as lids and crown caps are often made from tinplate.



Electrolytic tinning

In electrolytic tinning, the tin is applied to the strip surface by electrochemical precipitation, in which the strip travels through an acid electrolyte. The electrolyte acts as an ionic conductor because chemical processes occur due to the directed movement of the ions at the electrodes



during the transfer of the charge. The thickness of the tin layer can very easily be adjusted via the magnitude of the electric current and via the processing time, which depends directly on the strip speed. Very thin layers of just a few μm can thus be applied very precisely. Depending on requirements, differing layer thicknesses can also be applied to the strip sides.



Tinplate line concept

Tinplate continuous annealing line

The annealing of the cleaned strip followed by reduction and surface treatment provides the material in the annealing line with the material and surface properties necessary for tinning and subsequent processing. The very thin material (up to 0.1mm) is processed on the lines at very high speeds (up to 750 m/min). The product range comprises all grades and also contains the

qualities T2.5, T5 and DR 10, which cannot be produced by batch annealing. The strip cleaning section has efficient process components including spray and electrolytic cleaning cells. The radiant tube furnace is the heart of the plant and is recognized for its low resource consumption. Due to precise furnace control, the process follows the specified annealing curve exactly.



Electrolytic tinning line

The significant process steps in an electrolytic tinning line are cleaning, leveling, pickling, tinplating, remelting and passivating. All of these process steps must fulfill high requirements in order to guarantee the surface quality of

the end material. SMS offers various innovative technologies for tinning lines, which increase the ecological and economic efficiency of the plant. (see following pages)



Two 4-high skinpass mill stands are integrated for post-treatment. The first skinpass mill stand adjusts the mechanical-engineering characteristics of the strip by a thickness reduction. The second creates a defined strip surface structure.



Tinning technology

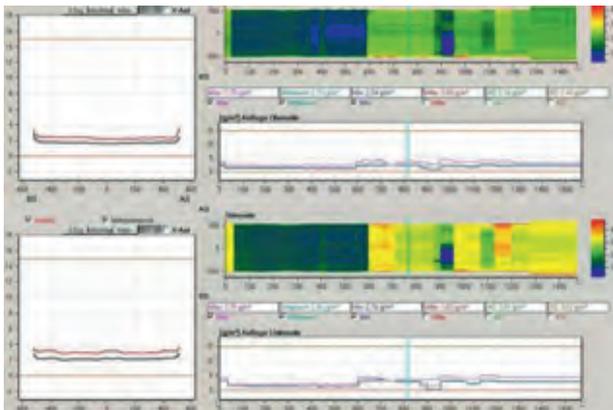
Soluble anodes

The use of soluble anodes results in significant economic advantages compared to using insoluble anodes. Simply by reducing tin loss caused by sludge formation and paying lower prices for tin, it becomes possible to save up to 2.7 million euros per year. Moreover, there are no costs for dissolving the tin nor reconditioning the anodes. A further benefit are stable tinning conditions, given the parallel anode arrangement with the anode width being adapted to the strip width without the use of edge masking.



Closed-loop tin layer thickness control

More than 200 measuring units are installed along the tinning line. In combination with the real-time measurement of the tin layer thickness, the line is operated in the so-called closed-loop mode. This makes it possible to constantly monitor and set all line parameters and to guarantee the best possible product quality and production efficiency. Up to 5 % of the tin can be saved by a more precise adjustment of the tin layer thickness.



Reflow technology

The induction unit, which can be adjusted vertical to the direction of strip travel, is very important for the surface quality. Due to a 100 % induction the heat transport takes place contact-free, consistently and without the formation of "wood grains". Because the induction unit can be moved vertically, the heat-treating time can be correctly adjusted for all process conditions.



Evaporator

The contaminated rinsing water generated by tinning and passivation is split up into a concentrate (electrolyte) and a distillate (rinsing water) in an advanced evaporator system and is reused in the process. Operating expenses are significantly reduced by this closed-circuit material flow. Moreover, the evaporators are heated by vapor compression from the process vapor itself.



Preconditioning cell

The preconditioning cell is a special process component through which the strip travels right before entering the first tinning cell. Here, the strip is pre-activated and the last iron hydroxide particles are removed. This ensures that the iron content in the electrolyte remains at a stable low level.



Anode casting plant

An anode casting plant casts the anodes at a consistent temperature without tin loss. The fully automated casting process produces perfectly shaped, high-purity tin anodes from the anode remnants and tin billets.



References

Tinplate production at Shougang Jingtang in China

Tinplate has been produced at the Shougang Jingtang works on Caofedian Island since October 2013. SMS erected a tinplate annealing line with an inline DCR rolling mill, an offline DCR rolling mill, and two electrolytic tinning lines on the artificially created island off the coast of the Chinese province Hebei. A total of almost 500,000 tons of high-grade tinplate can be produced in order to fulfill the growing demand for packaging material in China.

Tinplate continuous annealing line with reducing/skinpass mill

The tinplate annealing line has a capacity of more than 435,000 tons per year. An outstanding feature of the line is that it can reliably process very thin strips (down to

0.12 mm) under stringent quality demands and at very high speeds (up to 750 meters per minute). A component of the annealing line is an inline DCR mill (Double Cold Reduction), which consists of two 4-high millstands, with CVC®plus and other tried-and-tested technologies, such as work roll bending, multi-zone cooling and DS system. This skin-pass rolling mill combines a thickness reduction of up to 42 percent in the first stand with skin-passing in the second mill stand. The flexible and technically fully equipped plant can be used either for wet or for dry skin-passing. In the exit section of the line, an electrostatic DUMA-BANDZINK oiler provides the strip with a preserving oil film.



A total of almost 500,000 tons of high-grade tinplate can be produced by the two tinning lines for the manufacturing of packaging material.

Offline reducing/skinpass mill

In order to further reduce and skin pass annealed material in a batch process, SMS delivered an offline CVC®plus DCR mill with equivalent technical equipment to that of the inline DCR rolling mill. On this line, not only tinplate but also strip made of standard steel, are re-rolled and skin-passed. The yearly capacity of the offline DCR rolling mill amounts to more than 420,000 tons.

Electrolytic tinning line

With a total yearly production capacity of 475,000 tons, the two identical electrolytic tinning lines can tinplate all the material from the previously mentioned plants.



These products will serve to meet the growing demand for packaging material on the Chinese market.

In both electrolytic tinning lines, tin is distributed on the strip surface by means of an electro-chemical precipitation process, while the strip moves through an electrolyte in nine vertical tinning cells. Shougang Jingtang decided to use soluble anodes due to the economic advantages offered by them. Furthermore, all the modern equipment for tinning lines that SMS supplies, are integrated in to the line, such as a preconditioning cell, an evaporation unit, anode casting equipment and a vertically traversable reflow unit.



A special side-trimming shear straightens the strip edges prior to the tinning process.

References

Tosyali Toyo, Turkey

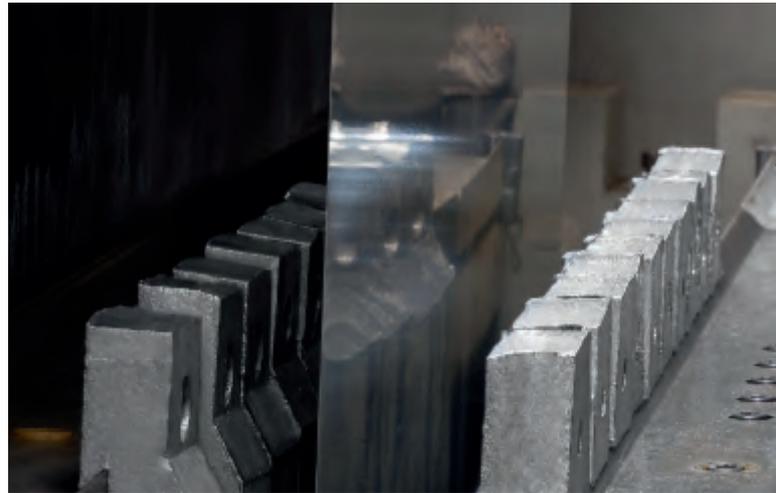
Tosyali Toyo produces with new electrolytic tinning line from SMS group

SMS group supplied the line completely for the Turkish-Japanese joint venture between Tosyali Holding and Toyo Kohan. The line is designed for the production of 255,000 tons of tinplate per year. During the process a very thin steel strip gets electrolytically coated with a fine layer of tin as corrosion protection. The final material is used for the production of cans or other packaging for beverages, food or aerosols.

SMS group delivered this line as a system supplier for Tosyali Toyo and was responsible for mechanical and process technology as well as electrics and automation. Furthermore, an advanced evaporation system for rinse water treatment and electrolyte recovery as well as an anode caster complemented the supply scope.

The line is equipped with the soluble tin anode technology which has proven economic, ecological and process technology-related advantages. Highlight features of this technology are low tin consumption, stable tinning conditions for optimum product quality and precise process control.

The line features a great number of high-performance equipment units. In the entry section, a side trimming shear with scrap baller is integrated. The strip gets prepared for tinning in a cleaning, tension levelling and pickling section. The tin coating section contains one pre-conditioning cell and six electroplating cells. The applied tin layer gets subsequently treated in a fully inductive heating reflow-system. Finally the strip is passivized and dried. Along the tinning line, various measuring units are installed to ensure constant process supervision and control. In combination with the tin layer thickness measurement, this achieves the best possible product quality and production efficiency.



The new electrolytic tinning line of Tosyali Toyo is equipped with soluble anodes due to its economic, ecological and process technology-related benefits.



Tosyali Toyo produced the first coil on its new electrolytic tinning line.

The line is designed for strips with a gauge of 0.12 to 0.60 millimeters and widths ranging from 700 to 1,270 millimeters. At a process speed of up to 450 meters per minute the strips are coated with thin tin layers, whereas in the entry and exit sections 650 meters per minute can be attained. The grades manufactured are T1 to T5 and DR6 to DR10 materials.

References

MMPZ – Miorskij Metalloprokatnyi Zavod, Belarus

SMS group built a new industrial complex for the production of tinplate for MMPZ in Miory, Republic of Belarus.

SMS group supplied all essential production equipment for the new facility, including the complete rolling and strip processing lines and the X-Pact® electrical and automation systems. In the first stage of expansion, equipment for an annual capacity of 150,000 tons was implemented. It serves Miory Steel to produce tinplate grades T1, T2, T3, DR7 and DR8 as well as thin sheet grades CQ and DQ. In the course of further expansion, capacity is planned to be increased to 240,000 tons. With its rolled products, Miory Steel meets the needs of the packaging industry as well as the demand for cold rolled thin sheet. The majority of the production is in-tended for export, especially to Russia and other CIS countries (Commonwealth of Independent States) and to the European Union.

SMS group's scope comprises a reversing cold rolling mill, an electrolytic cleaning line, a batch annealing facility, a two-stand DCR (Double Cold Reduction) mill, an electrolytic tinning line plus one packaging line each for sheet packages and coils. Ancillary systems will be constructed by the Russian company MetProm. After commissioning, SMS group will continue to support MMPZ by providing user know-how.

Electrolytic Cleaning Line (ECL)

The cleaning line comprises vertical process tanks for spray cleaning and electrolytic cleaning, each being followed by horizontal brush cleaners. A four-fold cascade rinsing system and a hot-air drying system complete the process. In addition to giving the cleaned strip an excellent surface quality, the line is characterized by low media and energy consumption. The vertical, electrolytic cleaning method ensures that even fine impurities are removed.

Electrolytic Tinning Line (ETL)

The purpose of the electrolytic tinning line is to provide the very thin steel sheet with a fine layer of tin to protect it against corrosion and thus to produce high-quality tinplate. MMPZ decided in favor of a line using soluble tin anodes. Being the market leader in this technology, SMS has demonstrated the economic, environmental and process-technological benefits by means of several lines built so far. These benefits include a reduction of tin consumption and stable process conditions which, combined with precise process control, result in a high-quality final product. The line features numerous high-performance components that impress by their environmental compatibility, efficiency, operational safety and flexibility. The entry section integrates a side trimmer with edge scrap wrapper. In preparation for the tinning process, the strips run through a cleaning section, a tension leveler and a pickling section. The tinning unit comprises six tinning cells. After the tin layer has been applied, it is treated in a fully inductive reflow heating system to improve the surface quality. Finally, the strip is passivated, dried and oiled. Numerous measuring units are installed throughout the line to ensure permanent process monitoring and control in co-action with the layer thickness measuring system. This makes sure the end product has best possible quality and the line operates efficiently. The rinsing water from the tinning process is conditioned in a state-of-the-art evaporator system thus saving further operating costs.

The line is designed with respect to a future extension to increase capacity and improve process quality. So, it will be possible to subsequently integrate a preparation cell, two additional tinning cells and a height adjustment for the reflow unit, among others.



Processing Lines for Electrical Silicon Steel Strip

SMS group supplies processing lines for the production of silicon steel from non-grain oriented grades to high-permeable grain oriented grades. The lines are completely supplied from a single source, including mechanical, process and furnace technology as well as electrical and automation systems and process know-how. Furthermore, all lines feature special equipment tailor-made for the particular requirements of silicon steel strip.

Process know-how

SMS group offers process support for all grades and production routes. This covers both metallurgical and design activities as well as support during commissioning and operation. The experts involved look back on long production experience and offer full parameter

sets from steelmaking to final processing. This ensures safe production also of difficult and high-quality grades. Furthermore, operational costs can be minimized, for example through greatly reduced use of alloying elements.

Silicon steel grades and applications

There are two groups of silicon steel strip (also known as electrical steel strip): non grain-oriented (NGO), and grain-oriented (GO). In NGO electrical strip, the iron grains are distributed in such a way that the material has largely the same magnetic properties in all directions within the sheet plane. That is why NGO electri-

cal strip is mainly used in rotating machines with alternating field orientation. In GO strip, the grains are sharply oriented in one direction. Due to the high permeability and lower losses in this preferred direction, GO electrical strip is typically used in static machines such as transformers.



Grain-oriented electrical strip is used in energy-efficient transformers.
(© Dieter Schütz/PIXELIO).



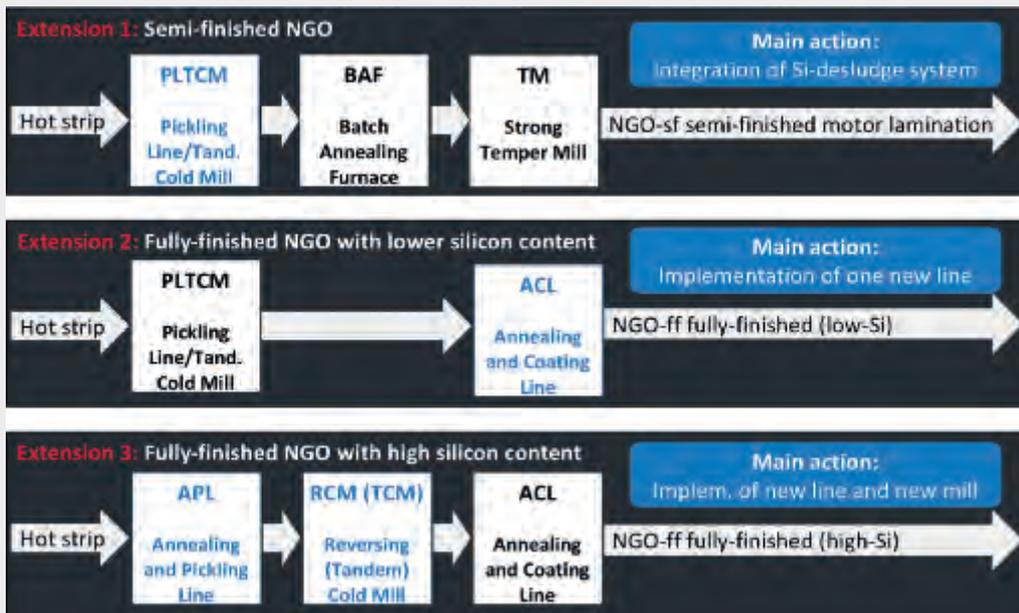
Non grain-oriented electrical strip is used in wind turbines for electricity generation. (© Thorsten Wengert/PIXELIO).

Production route – non-grain oriented silicon steel strip

The simplest way to produce electrical steel is the production of non-grain-oriented motor laminations material. It's possible via a pickling line/tandem cold mill, a batch annealing furnace and a temper mill. This is more or less standard equipment in a steelmaking plant. Since the high silicon content leads to silicon sludge occurrence during the pickling process a proper desludge system should be available in the pickling line. This can normally be integrated into an existing line within a small revamp.

Starting from this equipment it's also relatively easy to process fully-finished non-oriented material with low silicon content. It just needs one new line; an annealing and coating line. In the annealing and coating line, the internal microstructure is adjusted during the annealing process and the strip surface is then provided with an insulating layer depending on requirements.

The next extension step is the integration of an annealing and pickling line as well as a reversing cold mill. Due to the high silicon content the hot strip material has to be annealed before it gets pickled and cold rolled.

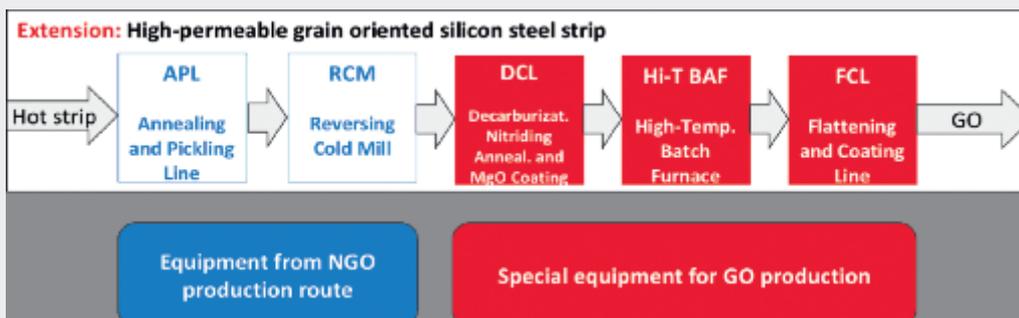


Production of non-grain-oriented electrical steel in three extension steps.

Production route – grain oriented silicon steel strip

The strip production route for high-permeable grain-oriented electrical steel starts with annealing and descaling of hot strip. This happens in a special annealing and pickling line. This is followed by cold rolling, primary recrystallization together with decarburizing, nitriding and magnesium oxide coating as well as secondary recrystallization for attaining the final orientation of the microstructure and the cleanliness of the material. Cold rolling normally takes

place in a reversing cold mill. In the decarburizing and coating line also the nitriding step is included. Some process routes require an intermediate annealing line too. For secondary recrystallization a special high-temperature batch annealing furnace is needed which anneals the material with temperatures up to 2,200°F (1,200 °C). The process is usually concluded by thermal flattening and final coating.



Production route of grain-oriented electrical steel starting with hot strip.

Non-grain Oriented Processing Lines

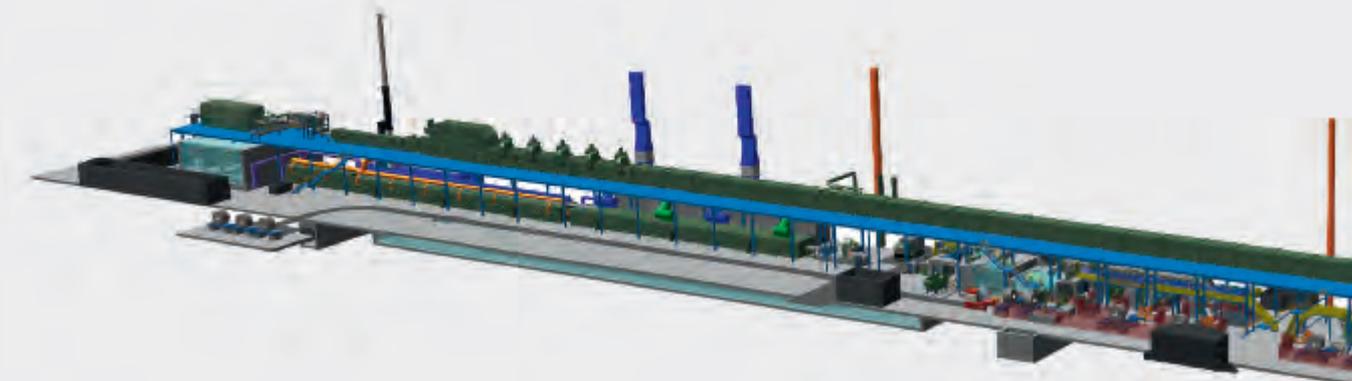
The most important processing line for fully-finished non-grain oriented (NGO) material is the annealing and coating line (ACL). One highlight is the recrystallization furnace with advanced water cooling and a hydrogen content of up to 100 %. Also important is the roll-coater technology with closed-loop thickness control. For contactless drying of the coating, a floatation furnace with a high specific heat transfer is installed.



Roll coaters coat the strip precisely with an insulating layer.



Horizontal strip looper in an annealing and coating line for NGO silicon steel strip.



In an annealing and coating line the material is cleaned, recrystallized and coated with an insulation layer. A decarburization function is necessary in the furnace if the carbon content of the material is higher than approx. 30 ppm; it is important to reduce the carbon content to avoid magnetic overageing.

Drever furnace in the ArcelorMittal annealing and coating line

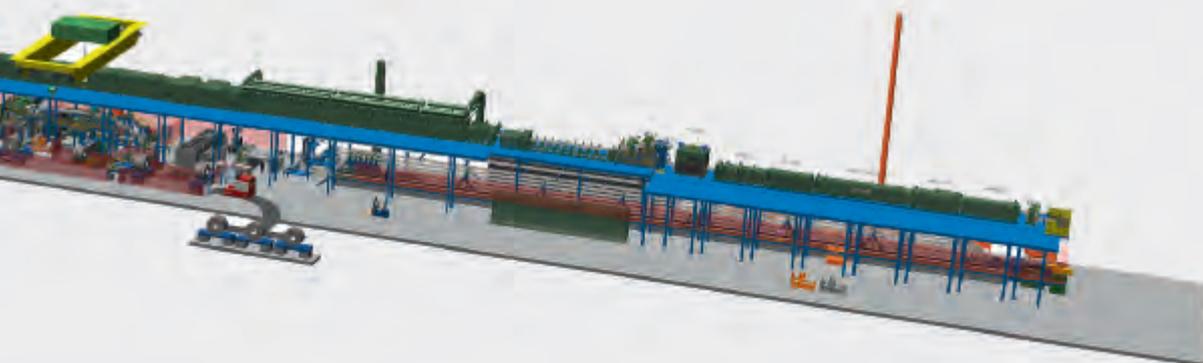
In its new annealing and coating line, ArcelorMittal St-Chély d'Apcher, France, processed the first coil in March 2013. Thanks to good preparation by all participants, the commissioning was done quickly within a few weeks. Already one month after the furnace had dried out, the production reached the nominal rate. With the new line, ArcelorMittal St-Chély d'Apcher is drastically increasing



The horizontal furnace by Drever in the new annealing and coating line for St-Chély d'Apcher.

its production capacity of high-grade non-grain-oriented electrical steel strips (NGO). Among other products, the furnace processes the newly developed iCARE™ material by ArcelorMittal which helps automakers to create environmentally friendly mobility solutions for a greener world.

In the annealing and coating line, the internal microstructure of the electrical steel strip is adjusted during the annealing process. The material is then provided with an insulating layer. The strip is heated up to 1,100°C by means of inductors and electrical heating elements in the horizontal annealing furnace. The atmosphere in the furnace comprises a nitrogen-hydrogen mix whereby the furnace can be operated with hydrogen content up to 100 %. This reducing atmosphere helps to achieve a particularly oxide-free and clean strip surface, which is important for a high-quality material grade. Furthermore, the careful and slow cooling of the material is important for the microstructure. For this reason, the strip is first cooled down at a very accurate cooling rate in the slow-cooling section and then in the quick-cooling section. Due to the high annealing temperatures and the very high hydrogen content in the furnace, ArcelorMittal achieved very good material properties right from the start. Especially the core losses are already at the level of those attained by the best producers in the world.



References

Shougang Zhixin Qian'an Electromagnetic Material, China

SMS group to supply two annealing and coating lines for electric steel strip to Shougang in China.

Shougang Zhixin Qian'an Electromagnetic Material, China, has awarded an order to SMS group for the supply of two annealing and coating lines for electric steel strip. The lines will expand the annual production capacity of fully-finished non-grain-oriented electric steel strip with high silicon content at the existing production location in Hebei province by 360,000 tons. In both annealing and coating lines, the internal microstructure of the cold rolled material will be adjusted during the annealing process and the material then be provided with an insulating layer. The steel will mainly be used for the production of motors and generators to meet the increasing demand for efficient and effective electrification in China. SMS group is thus making a contribution to the mobility of the future. The contract was completely negotiated and concluded via digital media, due to travel restrictions. Commissioning of the lines is scheduled for 2022.

In addition to designing the mechanical and process equipment and to the manufacture of various core components, SMS group's supply package also includes the supervision of part of the local manufacturing scope and of equipment installation and commissioning. Furthermore, SMS group is to supply the X-Pact® electrical and automation system.

Due to its magnetic properties, electric steel strip, also called silicon steel strip, is widely used in electrical engineering. With its advantageous magnetic properties, it contributes to improve the energy efficiency in electrical systems and thus helps to save resources. In non-grain-oriented strip, the grain orientation is irregular so that the material features isotropic properties. It is therefore used in rotating machines such as electric motors and generators. The material is especially used for electric vehicles, where high-quality electric steel strip determines the efficiency of the drives.

In both lines, the process includes cleaning, annealing, coating and drying of the material. Therefore, the lines will feature, besides the terminal equipment, cleaning sections, annealing furnaces, coating sections and drying ovens. The terminal equipment will comprise entry and exit sections as well as horizontal loopers.



Horizontal strip looper in an annealing and coating line for non-grain oriented electric steel strip.

References

thyssenkrupp Steel Europe, Bochum, Germany

SMS group was awarded to supply an electric strip annealing and insulating line.

thyssenkrupp Steel Europe (TKSE), Germany, has placed an order with SMS group covering the supply of an annealing and insulating line for electric strip. With this investment, thyssenkrupp is going to renew core elements of its production network in order to meet future customer requirements. For this purpose, the focus of activities at the Bochum site will be on e-mobility. From 2024 on, the new annealing and insulating line will turn out more than 200,000 tons per year of non-grain-oriented electric strip which will mainly be used to produce efficient electric motors and generators for electric vehicles, for example. In the annealing and insulating line, the structure of the cold rolled strip will be recrystallized during the annealing process. Thereafter, the material will be provided with an insulating layer.

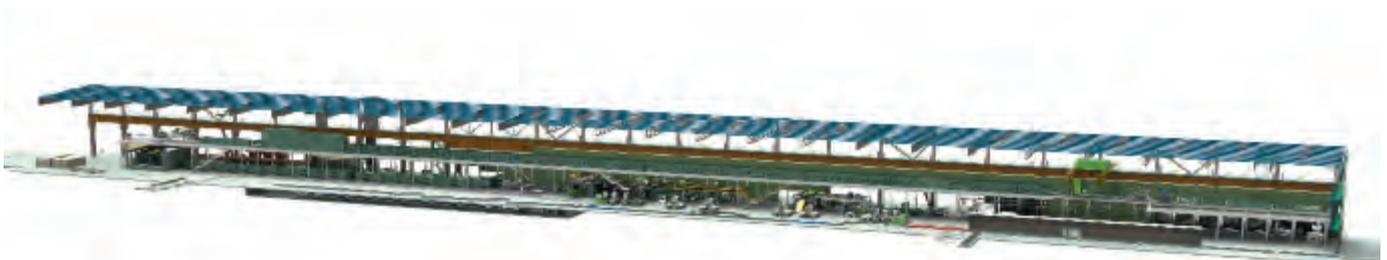
In addition to the entry and exit ends with horizontal loopers, the line will be equipped with an effective cleaning section, annealing furnace, coating section and drying furnace. The finished material will have a width from 700 to 1,350 millimeters and a thickness between 0.2 and 1.0 millimeters.

SMS is to supply the complete line, including all mechanical equipment, process technology, furnace technology as well as electrical and automation systems. The scope further includes line installation and technical assistance in the commissioning phase. An outstanding feature of the line is its resource-saving processes and the high degree of automation and digitalization.

The new facility will be integrated in an existing hall and arranged over several floors. For layout and plant planning, the 3D model of the line was transferred to a 3D game engine allowing a full 360-degree view. Thus, potential collision hazards could be detected at an early stage and it was possible to check and optimize concept suitability. In the upcoming phase of implementation, the 3D model will be particularized and, in the spirit of a transparent planning process, be advanced jointly with thyssenkrupp.

The technological heart of the line is the heat treatment and coating process. For heat treatment a resource-saving Drever furnace will be installed able to map an optimized annealing curve. Using the intelligent furnace concept (I-Furnace) it will be possible to predict material data, such as magnetic properties, with the aid of data-driven models, and thus to intervene in the production process in a prescriptive way. The required data will be prepared in the SMS DataFactory. This concept will help attain high material quality, an improved CO₂ balance and finally low production costs.

For the coating process, two horizontal roll coaters and a flotation furnace will be integrated in the line, with the furnace drying the insulation layer free of contact and without any flaws. Another special feature is the modular, custom-tailored electrolytic cleaning section. Its innovative X-Pact® high-current switch-mode power supply units will ensure more sustainability, energy and CO₂ savings as well as reduced costs involved in maintenance, installation, commissioning and repair. Intelligent digital systems like Smart Alarm and Genius CM® will optimize the production and maintenance process and hence boost line productivity.



Grain Oriented Processing Lines

– Line Concepts

The production of grain-oriented silicon steel involves several strip processing lines, mainly the annealing and pickling Line (APL), the decarburizing and coating Line (DCL) and flattening and coating Line (FCL).

Annealing and Pickling Line (APL)

In the annealing and pickling line grain-oriented as well as non-grain oriented hot strip is annealed and descaled. Special components are the side trimmer with edge warming, the furnace and the turbulence pickling tanks with special silicon desludging system.



Decarburizing and Coating Line (DCL)

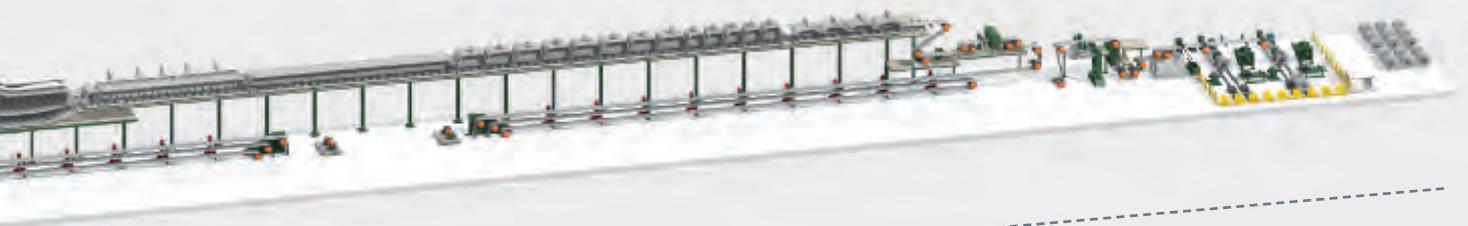
During decarburization annealing in the DCL, the atmosphere is humidified in the soaking section of the furnace to reduce the carbon content and thus avoid magnetic aging of the product. As an option, the furnace can serve also for nitriding. After annealing, the strip is coated with water-based magnesia slurry in a horizontal coater with closed-loop thickness control, temperature control and special conditioning of the coating solution.



Flattening and Coating Line (FCL)

In the flattening and coating line the goal is to apply and dry the tension-active solution and to improve strip flatness. A horizontal coater with thickness control and accurate conditioning of the coating solution applies the isolation coating. A special feature is the filtration of the MgO solution, leading to a 90 % reduction in water consumption. The drying furnace is divided into a radiant-tube section for drying and a direct-fired section for sintering. The thermal flattening takes place in a horizontal furnace with tight strip tension control to avoid negative impact on final properties and to ensure improved flatness.

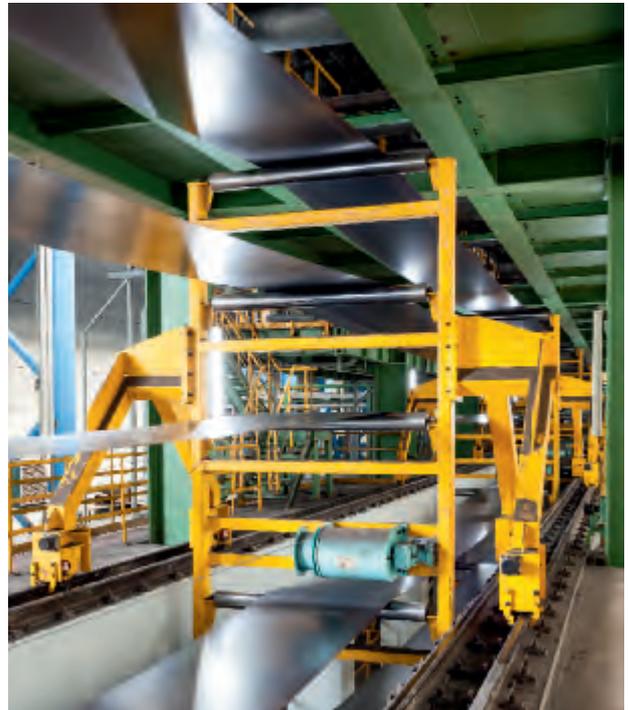




References

Seven silicon steel processing lines for Shougang, China

For Shougang Qian'an, China, SMS group had supplied seven lines for NGO and GO silicon steel strip by 2013. The annual output of GO strip including highly permeable material adds up to 180,000 tons. Besides the mechanical equipment, the scope of supply comprised the complete engineering and the manufacture of the electrical and automation systems as well as the supervision of erection and commissioning of all lines.



The hot strip is initially annealed and descaled in two annealing and pickling lines that are capable of processing grain-oriented and also non-grain-oriented grades. The cold rolling process is followed by recrystallization and decarburization in three decarburizing and coating lines which also serve to apply a layer of magnesium oxide to the strips to prevent them from sticking to each other during the subsequent long-term high-temperature treatment needed for metallurgical reasons. Together with an insulation varnish, this serves to introduce inherent stresses and hence improve the magnetic properties. Two flattening and coating lines were established for final thermal leveling and for the application of an insulation coating.

The grain-oriented silicon steel strip substantially contributes to the energy efficiency of electrical systems, e.g. energy-efficient transformers require grain-oriented electrical sheets with very low core losses.

All lines are equipped with horizontal loopers, including strip trolleys which permanently support the strip and thus help prevent damage to the strip surface.



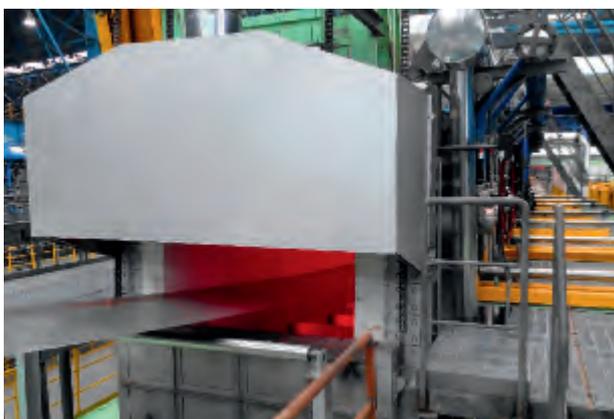
References

Two furnaces for WISCO's new flattening and coating lines

ARES Industrial Furnace (Tianjin) Co., Ltd., a member of SMS group, supplied two furnaces for Wisco's new two flattening and coating lines in China. These two lines are used to enhance the production of HGO grades with an annual of around 180,000 tons. Both furnaces were successfully commissioned in 2012. Without a stop for the first five months after start-up, both furnaces have been operating and produced, among other grades, HGO materials in the low-temperature mode. The furnaces feature new technologies for thermal flattening as well as for cooling, which improve surface quality and process control.



Catenary furnace for contact-free drying of the insulation layer.



Strip entering the drying and sintering furnace, which is divided into a radiant tube section and a direct-fired section.



Furnace for thermal strip flattening.

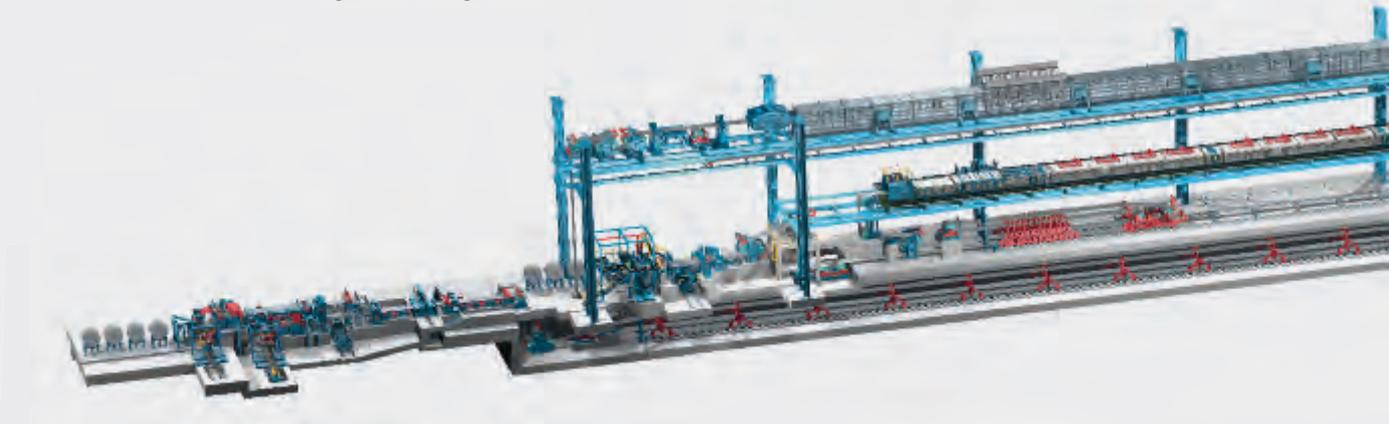
Processing Lines for Stainless Steel

Powerful processes for stainless steel strips

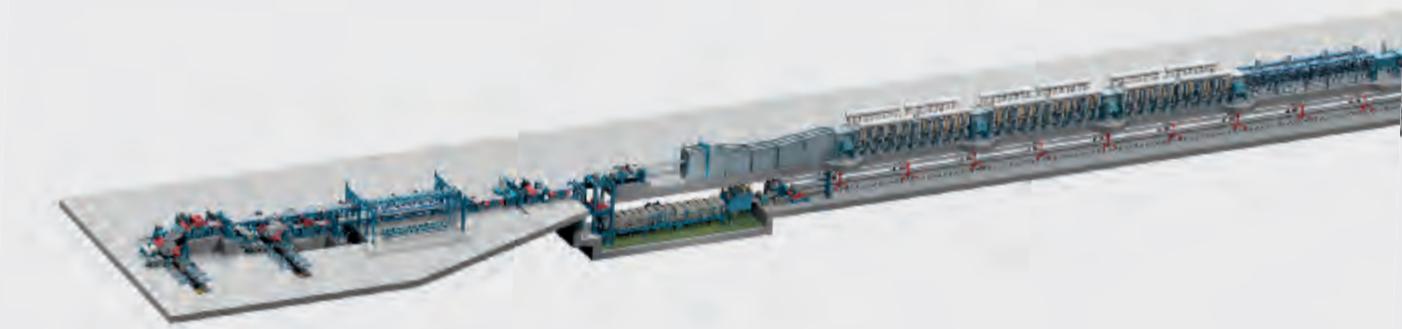
SMS group offers perfect concepts for all treatment stages of stainless steel strip characterized by efficient furnace and descaling technology, sophisticated production models and powerful environmental technology. All this leads to low production costs, high energy efficiency and outstanding environmental compatibility. Another advantage: SMS group supplies the complete lines from one single source with integrated electrical and automation systems.

Line concepts

SMS supplies all significant line types for stainless steel strip processing from annealing and pickling lines for hot or cold strip to integrated rolling, annealing and pickling lines as well as continuous tandem cold mills and bright annealing lines.



Hot-strip annealing and pickling lines: After hot-rolling the strip is annealed and descaled and then wound into a coil and rolled in a cold rolling mill.



Cold-strip annealing and pickling line: The cold-rolled strip is annealed and pickled once more-though now under different process conditions.



Stainless Steel Strip Processing Lines – Furnace Technology

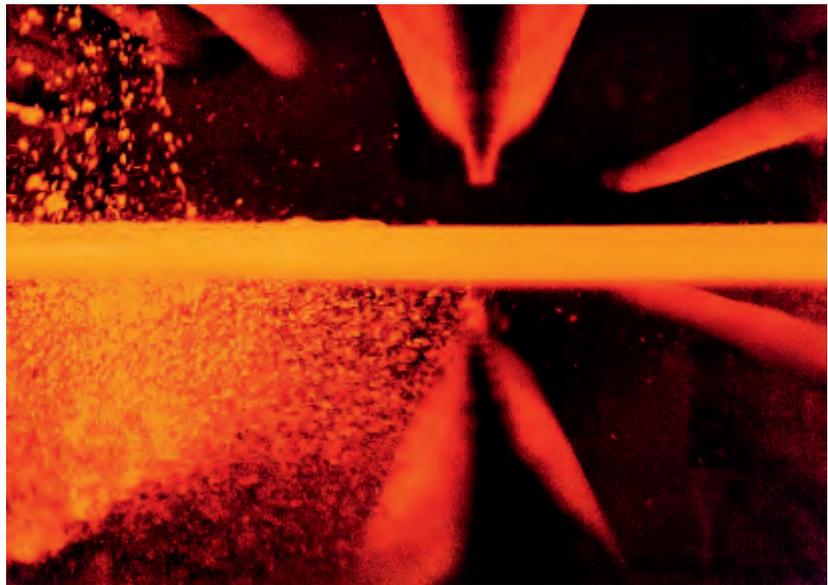
The Drever furnaces are designed to optimize energy utilization and environmental compatibility. The strip is pre-heated in a radiation zone which operates with the exhaust gases from the downstream heating furnaces. To increase the thermal efficiency, the combustion air is preheated in a recuperator using exhaust air. The process parameters are set and controlled by a mathematical model over the entire annealing cycle, which is also combined with the pickling model to match up and optimize both processes. More than 40 Drever furnaces for stainless steel strip processing have been ordered since the year 2000 worldwide.



The support rolls in the furnace are designed as easy-to-maintain “carousel rolls” and can be changed within 15 minutes without disturbing operation.

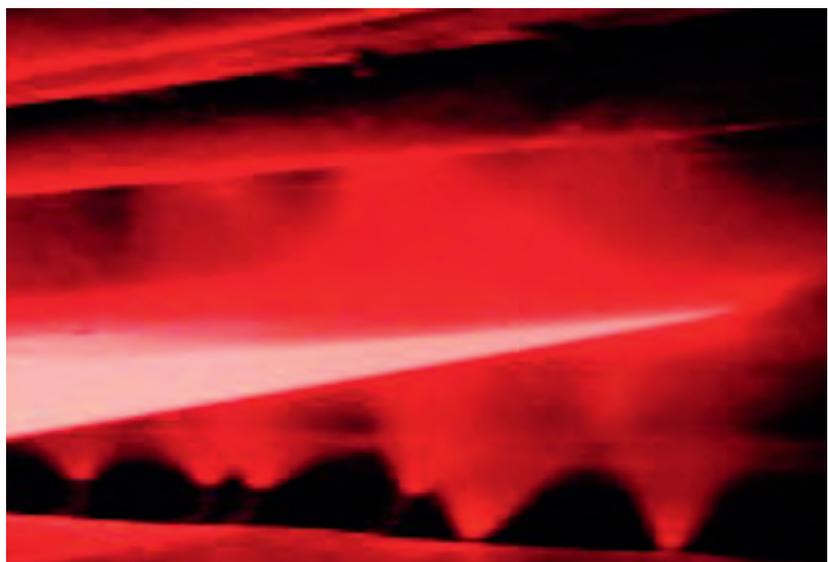
Water cooling for hot-strip

In hot-strip processing, special water cooling technology ensures better strip quality due to faster cooling and better control of the last heating zone. The efficient system results in a shorter cooling section and massive electrical savings. Furthermore, the impact on the environment is minimized because there are no dust emissions and no vibrations or noise.



Mist cooling for cold-strip

The mist cooling technology reduces the length of the energy-consuming air-cooling section and eliminates the final cooling performed by water, since this can generate cooling buckles. In total, 17 annealing and pickling lines have been equipped with mist cooling sections. Electrical energy is saved thanks to reduced blower motor power and exhaust motor power. Moreover, water consumption can be reduced drastically. This adds up to annual operational savings which significantly reduce production costs.



Stainless Steel Strip Processing Lines – Pickling Technology

The pickling process stands for high surface quality with minimized energy and acid consumption.

The acid concentration in the pickling tanks is continuously adapted to the type of material handled. A pickling and dosing model ensures a consistent pickling quality and minimizes acid consumption. To reduce energy consumption to the lowest possible level, the model is coupled with the furnace control model.



Special equipment

To support the pickling process the strip surface is subjected to abrasive cleaning by means of oscillating washing brushes. These brushes are a new development and specifically tailored to ensure efficient cleaning and a longer brush service life of up to 40 %.

The environment-friendly and cost-saving technologies for water and air treatment ensure the effective use of all resources in conformity with the toughest requirements. To prevent nitrogen oxide from escaping via the exhaust air system of a pickling facility, a DeNOx system with selective catalytic converters is installed. A fully automated acid purification unit and an electrolyte recovery system reduce the costs for fresh chemicals and operational expenditure.



Turbulence pickling

The specially designed turbulence pickling tank is characterized by a low volume of acid. Sludge deposits are minimized by the use of spraying lances in the entry, exit and side sections and by a patented tank bottom design. The

patented immersion cover forms the top surface of the pickling channel and thus ensures efficient sealing of the pickling tank. This results in lower evaporation losses, which in turn enables considerable savings due to the reduced consumption of energy and acid.

Electrolytic pickling

The electrolytic pickling section is characterized by the efficient utilization of energy due to the high electrolyte flow velocity and the proven design with separated electrodes. High operating efficiency is thus guaranteed since

only small losses occur between cathode and anode, which results in 10 % lower energy consumption. Spraying lances in the entry and exit sections and further nozzles in the side section enable high circulation of the pickling medium and minimization of sludge deposits.

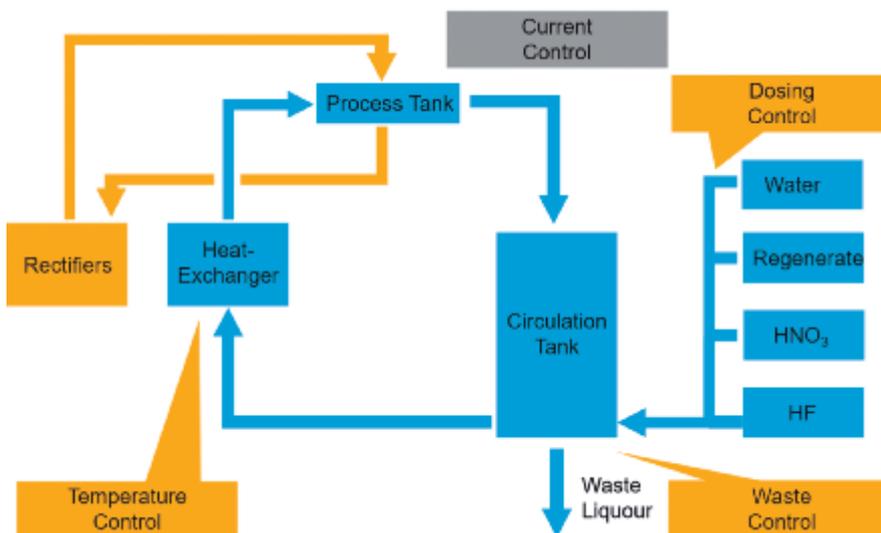


X-Pact® Stainless Steel Pickling model Optimal strip surface quality at minimized resource consumption

Pickling of stainless steel aims at good strip surface quality with minimized resource consumption. The SMS group's stainless steel pickling model takes care of these requirements:

In electrolytic processing of the stainless steel strip, control of current density is a major lever for reduced energy

consumption and minimized carbon footprint. In sulphuric acid pre-pickling or in mixed-acid pickling, bath temperature and composition are controlled. An optimal process range, adjusted to the material requirements, is maintained. Dosing set points are generated for all pickling liquor circuits and new acids can be used as well as sustainable regenerated acid. Removal of dissolved metal is handled by control of the waste acid flow. The short dosing cycles enable tight process windows and minimize resource consumption compared dosing based on laboratory acid measurements only.



The machine learning module automatically adapts model parameters, so that good agreement between model simulation and analyzed acid samples is established. Checks of parameterized flow rates also indicate potential clogging of pipes or pump issues.

The stainless steel pickling model can work independently or in combination with furnace control models, if pickling is performed in a combined annealing and pickling line.

X-Pact® Stainless Steel Pickling model.

References

Aperam Stainless, Belgium

Aperam starts-up new stainless steel line supplied by SMS group.

March 2021 saw the successful commissioning of the new annealing and pickling line at Aperam Stainless Belgium with the production of the first marketable coils of AISI304 austenitic steel grade. The line at Aperam's Genk plant in Belgium was supplied by SMS including mechanical equipment, process technology, furnace technology, electrical equipment and automation controls.

Installation and commissioning under the restrictions given by the global pandemic was an extraordinary challenge, which the teams of Aperam and SMS – working in close partnership – mastered successfully.

The line processes both austenitic and ferritic grades. With the commissioning of state-of-the-art and future-oriented plant technology, Aperam enlarges its product range by adding material grades for the most demanding applications and improves lead-time and flexibility to meet the upcoming market demands.



The teams of Aperam and SMS group worked in close partnership to achieve production of the first coil.

Higher efficiency increases cost competitiveness and helps realizing Aperam's environmental targets.

The line stands out due to its high degree of automation and resource-saving processes. This new annealing and pickling line represents the second line at Aperam's Genk works supplied by SMS.



The powerful furnace from Drever International, member of SMS group, is designed for the resource-saving and efficient processing of cold strip.

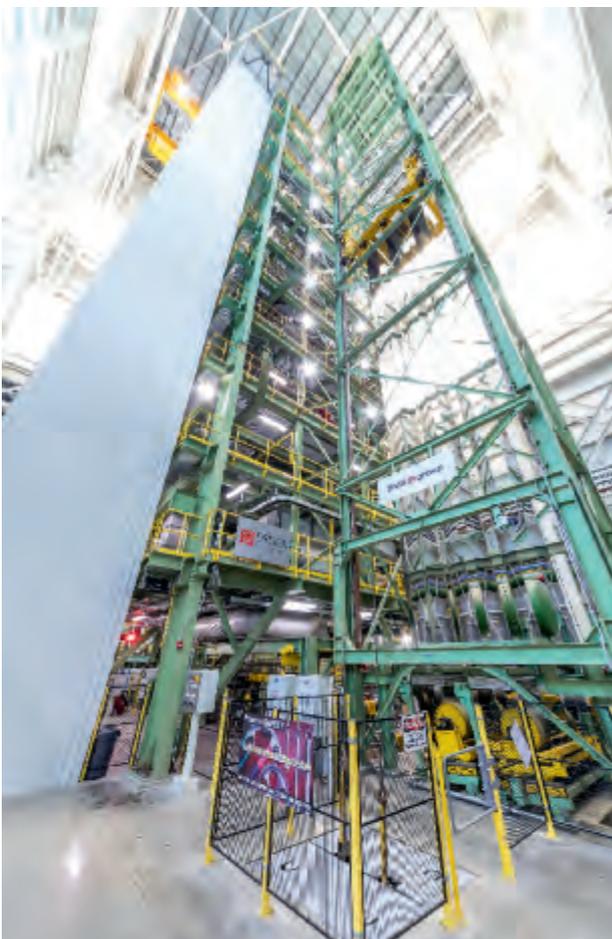
References

Most modern bright-annealing line at NAS, USA

In the bright-annealing line the strip first runs through the cleaning section. This step is followed by recrystallization annealing in an oxygen-free inert gas atmosphere with high hydrogen content, in an all-electric vertical furnace from Drever International, a company of SMS group. The annealing process is performed at a temperature of up to 1,250 degrees Celsius in an inert gas atmosphere (up to 90 percent hydrogen) under overpressure to thus generate a perfect glossy surface. The exit section of the facility is equipped with a four-high skin-pass stand and a tension leveler for strip post-treatment. A side trimmer serves for strip edge straightening and cuts the strip to the desired width.



In a two-stage cleaning section, the cold rolled strip is efficiently freed from rolling oil and other dirt particles.



In the entry and exit sections, maximum strip speed reaches 75 meters per minute, whereas in the process section the material goes through at maximum 50 meters per minute.

The technological highlight of the bright-annealing line is the all-electric vertical furnace from Drever International. Due to its high efficiency, the energy consumption of about 220 kilowatt hours per ton is 60 percent lower than that of a conventional line concept with muffle furnace.

Aluminum Strip Processing Lines from the System Supplier

SMS group offers aluminum strip processing lines tailored to suit the needs of the international market. One unique selling feature is the ability to supply the modularly designed lines including several high-performance components completely from a single source. That means high-performance process components, powerful and efficient furnace technology, reliable mechanical equipment as well as electrical and automation systems are available from a one stop shop.

This way the innovative process lines and components can be used to produce a broad spectrum of high-quality aluminum alloy strips for a wide variety of applications – efficiently and cost-effectively.

Multiple applications and various efficient line types

There are multiple uses for the final products, above all in fields such as the packaging, building, furniture, automotive and aerospace industries. Increasingly successful in recent years, SMS group has built several new aluminum strip processing plants and is performing complex revamps. Furthermore, SMS group attracted new orders for all the major types of processing lines.

Highlights

- **Market leadership**

The majority of market-leading strip metal producers rely on SMS group technology.

- **High product quality**

Significant for all aluminum strip processing lines is the high-quality of the final product. Thus, the processing lines are especially equipped to ensure flawless surfaces and homogenous material characteristics.

- **Flexible production**

Flexible production conditions allow a quick reaction to changing market demands with the greatest economic efficiency. SMS group has built several multi-purpose lines with changeable process routes.

- **System supply**

SMS group is capable to deliver almost all lines completely from one single source. This means, you get everything you need out of one hand and without any interface problems.

- **Production know-how**

SMS group offers process support for all materials and qualities. This covers both metallurgical and design activities as well as support during commissioning, operation, quality control and certification.

- **Ecoplants**

All aluminum strip processing lines are designed to keep resource consumptions as low as possible. All technologies and processes are continuously evaluated in order to improve eco-friendliness.

- **Project Management**

A professional project management according to latest knowledge and international standards ensures in combination with modern design methods, a consistent and reliable fulfillment.

Numerous References

Since 2000, SMS group has attracted orders for more than 25 aluminum strip processing lines including all important line types.

Aluminum producers using SMS strip processing technology (examples)

- AMAG Austria Metall
- ASAŞ Alüminyum
- Coil Gmbh
- Ma'aden Aluminium
- Madar Coil Coating
- Tianjin Zhongwang
- Shandong Nanshan
- Henan Zhongfu
- Hydro Aluminium
- ELVAL
- Hulamin
- Euramax Coated Products
- Asia Aluminium Group
- PROLASMA
- Aleris

- **Manufacturing**

The set-up includes several modern and well equipped manufacturing locations worldwide to ensure a high level of quality control and short distances to the customers.

- **Modernizations**

Comprehensive services and experience for revamps. Starting from the exchange of single machines up to major modernization of complete plants with several measures.

- **Industrie 4.0**

SMS group uses intelligent production and process models for strip processing lines which are deeply integrated in the automation system and coupled with each other.

Heat and Chemical Treatment Lines

Introduction

Light weight construction material for vehicles and airplanes

The use of aluminum as a light weight construction material in automobiles and also in the aviation industry continues to be on the rise. Subsequent to the cold rolling process, the aluminum sheets have to undergo a heat treatment to regain formability as well as the required material strengths. Especially the heat treatment and the cooling of the strip play a major role. To increase flatness the strip has the possibility to run through a tension leveler. The strip surfaces must be cleaned before they are coated. The chemical treatment prepares the strip for transportation and further processing. These processes can take place separately in different facilities or combined in a heat and chemical treatment line, which can provide financial benefits.

Floatation furnace technology

The furnace and cooling technology is the heart of the process. The strip enters a floatation furnace where it is guided sinusoidal in a contactless floating mode. It is heated up and kept at the required strip temperatures in time, so the aluminum-alloy obtains their structure. Especially 2xxx and 7xxx aerospace alloys require high cooling rates of some 400 kelvin per second. For 6xxx automotive alloys mostly moderate but flexible cooling rates between 25 and 100 kelvin per second are necessary. The cooling process is executed as a combination of water and air cooling. A mathematical model calculates the necessary settings for the annealing and cooling process under consideration of the mechanical properties.

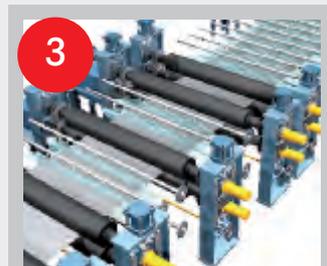
After the furnace, some alloys pass through a tension leveler to improve the required strip flatness. Depending on the material requirements the machine is able to operate



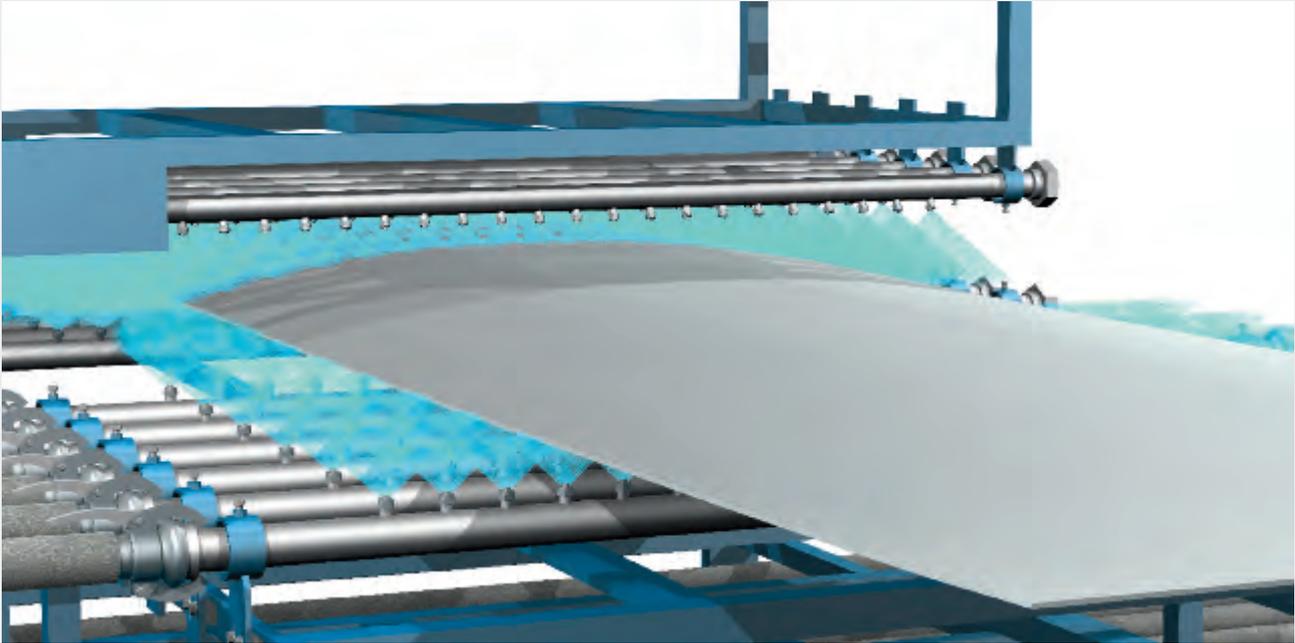
Annealing & Cooling



Tension Leveling



Cleaning



The lines feature a high-performance floatation furnace for aluminum automotive qualities. Important for the product quality is the water-quench which ensures at the same time high cooling rates and good strip shape. Stable strip shape is ensured by a pre-defined cross-bow. A special sealing unit prevents pre-mature cooling. Another special feature of the furnace is the eco-friendly process control. Operation is controlled by a physical process model and a production planning model with physical transient state calculation.

without switching the leveling cartridge in either stretch bending or pure stretch mode. The settings are specified by a physical process model.

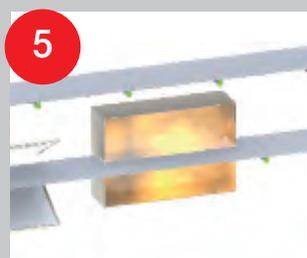
In the following spray cleaning process the remaining surface impurities will be removed and the strip surface will be activated. Here special nozzles are used to avoid clogging and the nozzle bars are switchable for higher process flexibility.

Passivation with roll or spray coaters

Subsequently, a chemical coating is precisely applied onto the strip surface by a vertical or horizontal roll coater. The strip is coated evenly on each side with predefined surface thicknesses. Alternatively, a spray passivation can be used instead of roll coating. Passivation creates a uniform and dense layer of aluminum oxide on the surface (sealing layer). This layer serves several purposes: It improves the corrosion protection of the strips and thus protects them from undesirable corrosion.



4
Chemical
Treatment



5
Aging



Main process steps to process cold rolled aluminum alloys into finished automotive or areoplane strip products.

Heat and Chemical Treatment Lines References

Ma'aden Aluminium, Saudi Arabia Heat and chemical treatment line

For the new aluminum works of Ma'aden Aluminium, a joint venture between Ma'aden and Alcoa in ras Al Khair, Saudi Arabia, SMS group supplied all equipment including electrical and automation systems from one source. The new heat and chemical treatment line provides the cold rolled aluminum strip with optimum metallurgical properties and surface coatings. The line permits Ma'aden to produce both soft-annealed 5,000-series alloys for structural and interior parts as well as precipitation-hardened 6,000-series alloys for exterior parts.

A highlight of the facility is the modular-designed floatation furnace. The strip passes the furnace without contact on an air cushion generated by nozzles and is uniformly heated up to 570 degrees Celsius. Mathematical-physical process models ensure a precise temperature control in the heating zones to set the desired metallurgical properties in the strip.

To produce automotive grades such as 6,000-series alloys, high cooling rates are required, and for this reason a combined water quench system with subsequent air cooling has been installed.



The new heat treatment and chemical coating line is designed to process cold rolled aluminum strips. The strips are provided with optimum metallurgical properties and surface coatings as demanded for applications in the automotive industry.



Entry section: two payoff reels ensure the line is continuously fed with strip. The entry side coilers as well as those in the exit section are equipped with manipulators and spool handling system. A downstream stitcher connects the strip heads and tails to an endless strip.



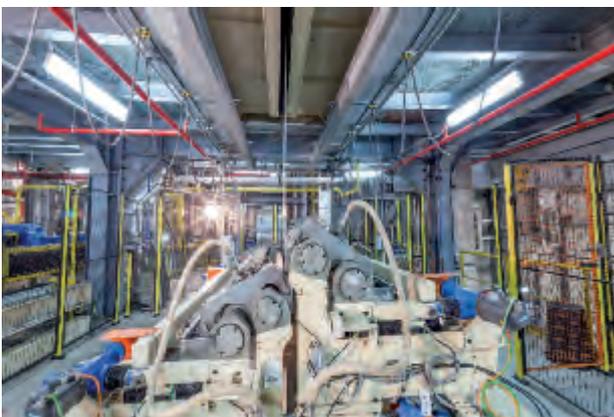
A highlight of the line: the floatation furnace with water quench and floatation air cooler. The strip is transported contact-free, heated to over 550 degrees Celsius and then selectively cooled by air and water. This contactless strip transport makes sure the surfaces are free from scratches.



Having a force of 50 tons, the tension leveler can be operated in two modes, without changing the cassettes, depending on the material used: in the stretch bending mode and in the pure stretch mode. The result is an excellent flatness of the strips produced.



The next step is the cleaning section where rolling oils, other impurities and aluminum oxides are completely removed from the strip surface at minimum media consumption. This section comprises one alkaline and one acid spray cleaning zone each followed by cascade rinsing.



Chemical coating or passivating is an essential process determining the quality of automotive alloys. In the vertical roll coater, the organic coating medium is applied to both strip sides by a pickup roll and an applicator roll. Convection dryers, air coolers and high-performance cooling rolls ensure the coated strip is uniformly treated.



The heat-treated and chemically coated automotive plate arrives at the coiler with belt wrapper. The high-quality aluminum strips are coiled on spools. The complete process is controlled and supervised by the X-Pact® electrical and automation systems from SMS group.

Heat and Chemical Treatment Lines References

AMAG Rolling, Austria **Mechanical equipment for a heat treatment line**

SMS supplied the complete mechanical equipment for the continuous heat treatment line of AMAG Rolling in Ranshofen, Austria. Integrated in this line were, among others, the payoff reel area, a tension leveler, a trimming shear unit, the inspection equipment as well as the coiling and

banding stations. All the components are successfully operating since 2007 and processing strips of aluminum alloys of the 2xxx, 6xxx and 7xxx series. Beside many applications in the automotive industry, the materials are also used in the aircraft and sports industries.



Exit section of the heat treatment line of AMAG Rolling.

Hydro Aluminum, Germany

Floatation furnace for a heat and chemical treatment line

In 2000 for the first time a new floatation furnace was supplied to Hydro-Aluminum in Grevenbroich, Germany within the shortest delivery period for the combined line (heat treatment and chemical coating line) for processing aluminum alloys for the automotive industry as well as for coating aluminum strips for the food industry.

In 2008, a new floatation annealing furnace with downstream cooling equipment was supplied for a continuous heat treatment line for the production of 5xxx and 6xxx alloys.

Aleris Aluminum Duffel, Belgium

Process engineering for a heat and chemical treatment line

SMS supplied the complete process engineering of the heat treatment and chemical treatment lines for Corus Aluminum (now Aleris Aluminum Duffel) in Duffel, Belgium. Here a cleaning section and an alkaline and acidic pickling line for de-oxidation was installed with rinsing and drying equipment respectively. A vertical roll coater with downstream drying equipment is used for passivation. Among others, aluminum alloys of the 5xxx and 6xxx series for the automotive field are produced since commissioning of the line in 2001.

AMAG Rolling, Austria

Heat and chemical treatment line

AMAG rolling GmbH, Austria, has placed an order with SMS group for the supply of a cold rolling mill, a heat treatment line with a connected passivation section, a high-bay warehouse and a packaging line. Thus, numerous key assets of the AMAG 2020 investment project, dedicated to the set-up of production facilities for cold rolled premium aluminum strips and sheets, will all be supplied by SMS group.

The technological highlights of the heat treatment line and the connected passivation section are the floatation furnace with high-performance water cooler, the resource-saving process technology and the compact layout. During the heat treatment in the floatation furnace and the cooling process of the water quench, the strip receives the mechanical properties specified by the customer. The final chemical coating process (passivation) gives the strip the perfect condition for the downstream processing steps. Passivated strips are requested primarily by customers from the automotive industry.



The new heat and chemical treatment line, which SMS group supplied for AMAG, is one of the most advanced lines of this kind worldwide.

Color Coating Lines

Introduction

High-grade coatings in efficient lines

In color coating lines the aluminum strip is covered with a high-grade coating. One instance of use of the material is the foodstuffs industry, for example for beverage cans. Further major fields of application are the construction and automotive industries as well as producers of household appliances. The different fields of application need different protective surface finishes and constant further development of the coatings. SMS group offers solutions for all coatings and market requirements as well as sophisticated process components for the process steps crucial for quality.

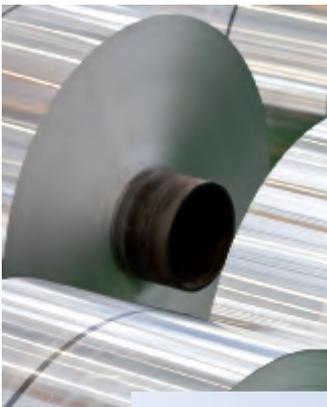
Several coating layers on a clean surface

Input products are normally cold rolled aluminum strips, to which rolling oil adheres. After tension leveling, the surface is cleaned and the top oxide layer is removed in

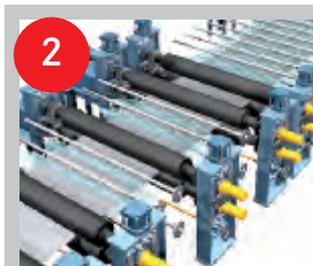
a comprehensive and customer-specific process. The pretreatment of the aluminum strip is concluded by chromating and passivation. Here, a vertically arranged roll-coater is used. The advantage of the roll coater is that a more uniform conversion coating is applied to both sides of the aluminum strip. The coating is dried in a convection strip dryer.

Depending on the final use of the material, in some lines a primer-coater deposits a paint bond. Finally, one of two integrated finish-coaters deposit the finishing paint coat. The primer and the finishing paint coatings are each separately dried in an efficient convection oven.

The flue gases of the oven are burned in a regenerative thermal oxidizer system (RTO). Depending on the solvent content in the exhaust air, the afterburning system and even the furnace itself can be operated without additional energy input (autothermal mode).



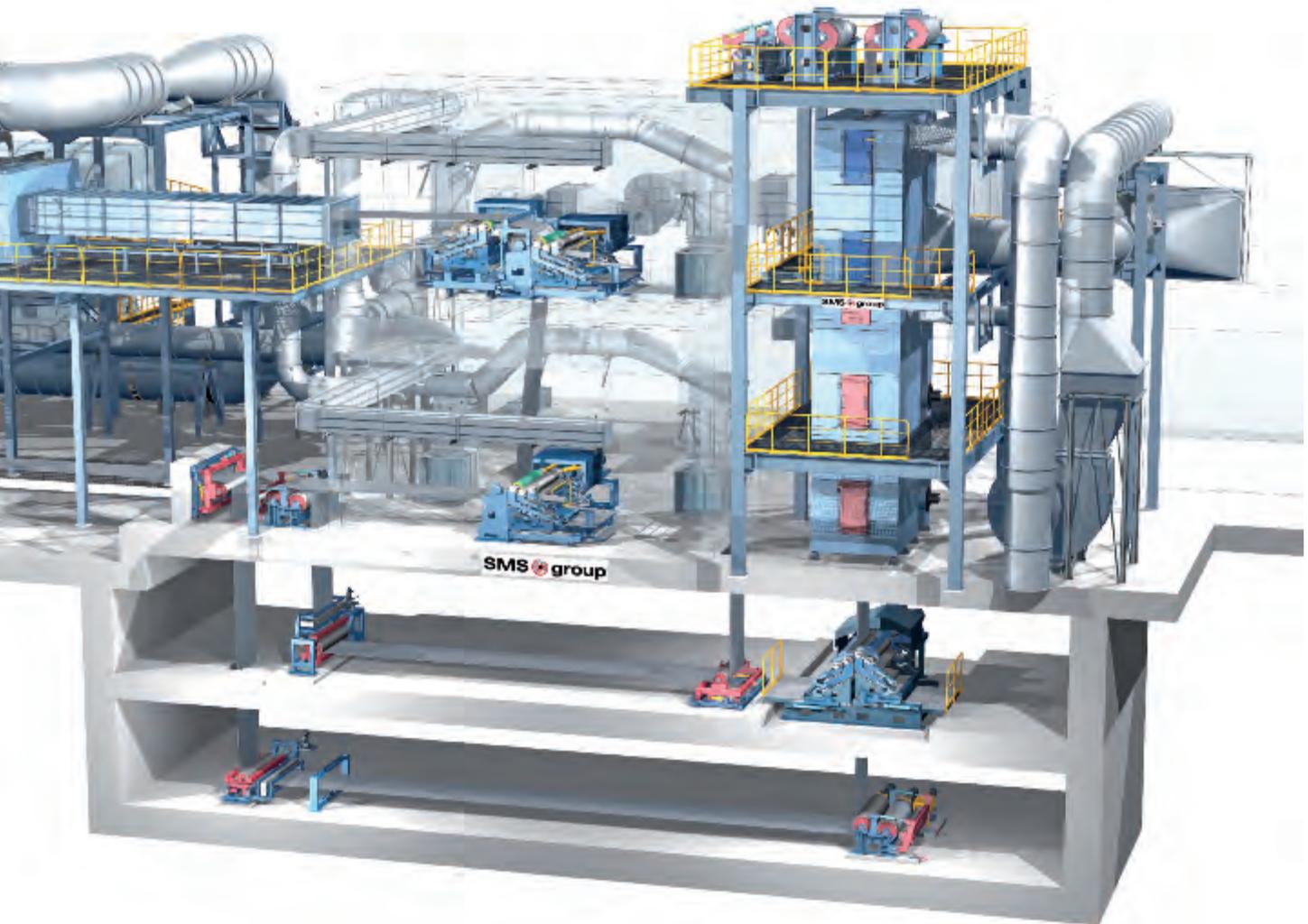
Tension
Leveling



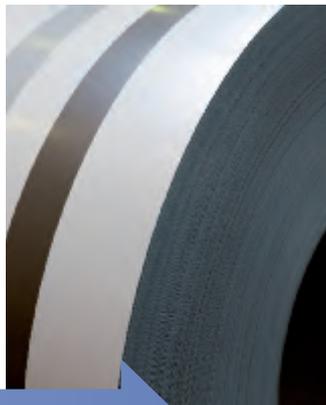
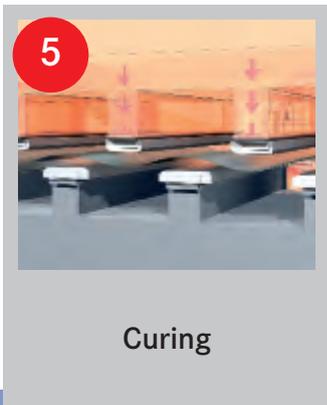
Cleaning



Chemical
Coating



An outstanding feature of color coating lines from SMS group is the compact coating process – the chemical pre-treatment section, the subsequent strip coating process and the drying oven are perfectly harmonized.



Main process steps to process color coated products out of cold rolled aluminum coil material.

Color Coating Lines

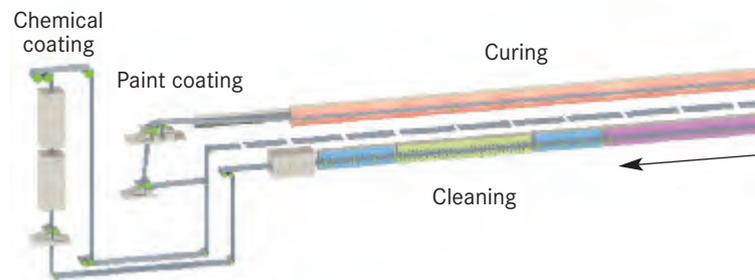
Line Concepts

Different concepts for different applications

Color coating lines differ depending on the final use of the material. For example, material for the building industry often requires three coatings (passivation, primer, paint) while can-end stock grades only need two layers (passivation, paint). Furthermore, can end material is normally thinner and the material for architectural applications is thicker.

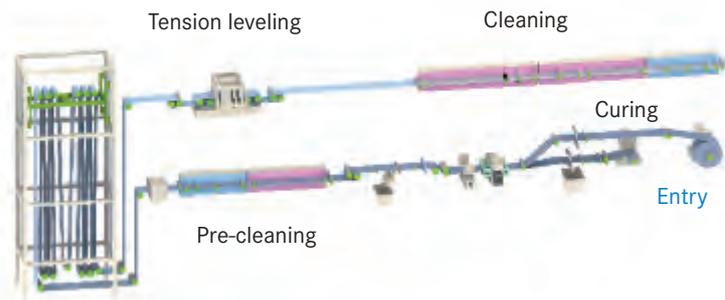
Color Coating Line (CCL) for can end stock (exemplary layout)

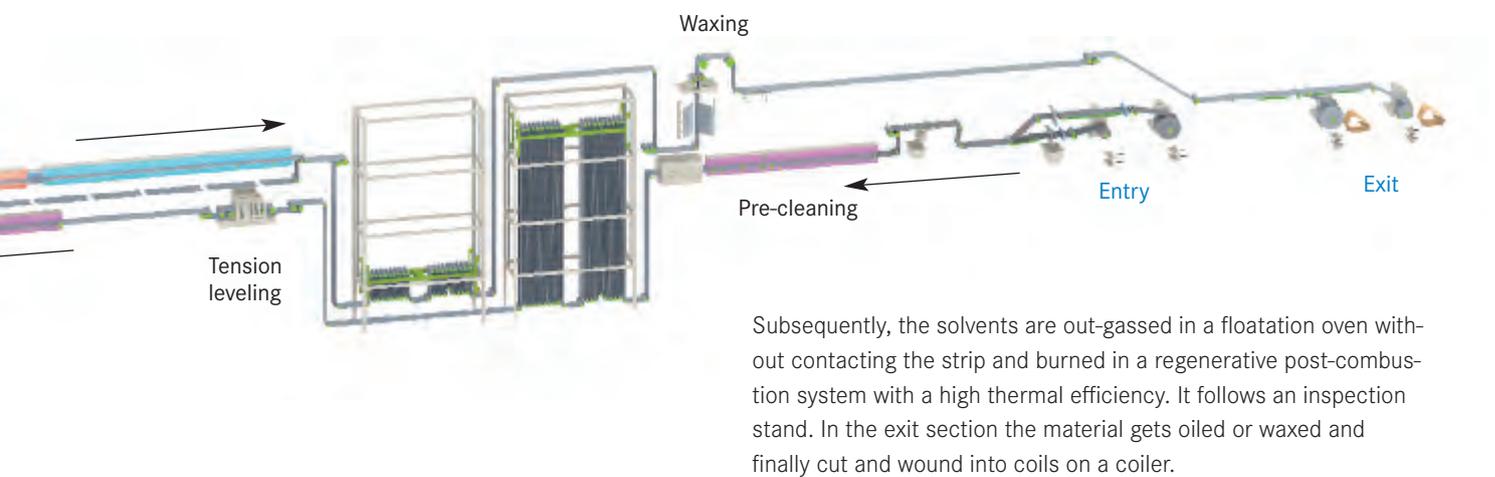
The strips enter the line alternately from two payoff reels, are joined by a stitcher into endless strip and side trimmed. Cleaning takes place in a pre-cleaning and a main cleaning section, in between the material gets tension leveled. A vertical roll coater applies the passivation layer on the aluminum strip surface, which is followed by drying. Two back-up roll coaters are installed for the color coating operation as such. The strip is coated on one or both sides with fast color changes being possible as well.



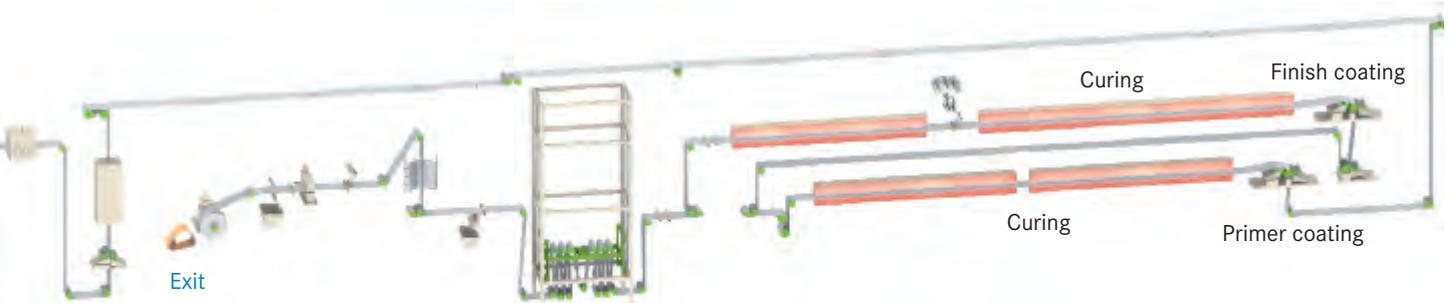
Color Coating Line (CCL) for building industry and household appliances (exemplary layout)

The strips enter the line alternately from two payoff reels, are joined by a stitcher into endless strip, side trimmed and pre-cleaned. After the strip leaves the vertical looper a tension leveler removes any unflatnes and the strip surface is cleaned again in a spray and brush degreasing unit. Next, a vertical roll coater applies the passivation layer, and this is followed by vertical drying. Then a back-up roll coater (primer) adds an adhesion or bonding agent and the strip goes through the first horizontal curing oven.





Subsequently, the solvents are out-gassed in a floatation oven without contacting the strip and burned in a regenerative post-combustion system with a high thermal efficiency. It follows an inspection stand. In the exit section the material gets oiled or waxed and finally cut and wound into coils on a coiler.



In two back-up roll finish coaters, the strip is coated with a top coat that hardens in the second horizontal furnace. The next station is a vertical looper. Downstream of this is an inspection stand that checks the strip before it is oiled, cut and wound into coils on a coiler.

References

Color coating line for can material at Henan Zhongfu, China

On behalf of Henan Zhongfu Industrial Co., Ltd. a color coating line for thin aluminum strips to produce can material has been established in China - complete including all mechanical, process-technological and thermal equipment plus electrical and automation systems.

Color coating lines from SMS group allow for high-quality coating of aluminum strip suited for direct processing to final products. Precise coatings with excellent surface quality and resource-saving as well as energy efficient operation are the characteristics of these color coating lines. The material Henan Zhongfu is producing on its new line is mainly for can ends.

This involves the highest demands in terms of food industry certification. Depending on the type of beverage, most different paints have to be applied with an accuracy of one thousandth of a millimeter.

The line was designed for the flexible use of solvent- as well as water-based paints for a wide product portfolio. A further outstanding feature is its ability to coat ultra-thin strip at high speeds. The line is equipped with all necessary machines and devices and has numerous components ensuring a further increase in material quality. From mechanical equipment to electrical and automation systems, all were supplied by SMS group from one source.



A heated, vertical roll coater is integrated in the exit section allowing a layer of wax to be applied to the strip as an option.



Everything in the line is geared to maximum surface quality. That is why the strip treatment process starts with thorough alkaline pre-cleaning and rinsing. Prior to coating, a second cleaning process takes place in the main cleaning section. There, the layer of oxide is removed by means of alkaline and acid solutions, and the surface is activated for coating. A preparatory chemical is applied in the chemcoater.



Cleaning the solvent-containing exhaust air by the regenerative thermal oxidizer is a prime example of recovering energy in a highly efficient and cost-effective way. To this end, post-combustion of the extracted solvents takes place in a three-chamber system with catalyst blocks. Hot air is fed to the drying oven through a heat exchanger with the result that once this process has been initiated the oven operates in autothermal mode without feeding additional energy, provided however, the solvent content of the paint is high enough.



Another highlight of the line is the floatation oven with downstream cooling section. Over a length of more than 100 meters the strip is kept floating, dried and cooled.

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