STRIP PROCESSING LINES FOR AUTOMOTIVE QUALITIES

The SMS group as a systems supplier
MODERN AUTOMOTIVE GRADES

UTMOST DEMANDS ON PLANT TECHNOLOGY AND PRODUCT QUALITY

Steel remains the key material in automotive manufacturing, with the proportion of high-strength steels continuously rising in fierce competition with other materials. Parallel to this there is pressure on manufacturers to build lightweight, low-consumption vehicles, prompting the development of many new steel grades with optimized property mixes. Much favored here are more and more multiphase grades that combine high strength with high ductility. Both super-strong and easy to form, these steels need to meet top standards for use in motor vehicles. That applies to both material properties and surface quality.

and continue with surface-friendly annealing, zinc coating technologies, passivation, and preserving-oil application machines. Crucial for excellent material strength are sophisticated annealing and cooling strategies as well as skin-passing mills for optimal post-treatment.

Another aspect is cost-effectiveness ensured by high yields of steel strip in the right qualities. That takes fast production rates and large capacities as well as steep start-up curves for stable, reproducible production of all steel types, including automotive grades. High production plant flexibility is a further decisive criterion for adjusting the product range to changing market demands. This is possible, for example, with multipurpose lines that can be used either as hot-dip galvanizing or annealing lines with various strip cooling options.

SMS Siemag is the only company worldwide capable of meeting all these demands with the corresponding solutions. That’s because all products and services are available within the SMS group – from mechanical and process-technology components through furnaces and air knife systems to electrics and automation, control and measuring systems, and all the associated know-how.

Seeing that the automotive industry is the most important sales market and driver of new technology, steel producers must fulfill these requirements. Therefore, it is vital that strip processing lines for manufacturing valuable steel plate for internal and external parts (usually hot-dip galvanizing and annealing lines) are engineered to produce high-strength materials with flawless surfaces. Plants equipped for surface quality start with systems for cleaning and continue with surface-friendly annealing, zinc coating technologies, passivation, and preserving-oil application machines. Crucial for excellent material strength are sophisticated annealing and cooling strategies as well as skin-passing mills for optimal post-treatment.

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Proof of SMS Siemag’s competence in the planning, design/engineering, erection, and commissioning of automotive lines is provided by a whole host of successful projects. Specifically, since 2000, SMS Siemag has attracted 36 orders for automotive lines (as of 2014). This goes to show that leading steel manufacturers on all the major markets trust in the expertise, capacity, and know-how of SMS Siemag.
THE SMS GROUP
AS A SYSTEMS SUPPLIER

- Terminal equipment
- Cleaning sections
- Furnace technology
- Rapid cooling systems
- Selective preoxidation
- REBOX DFI® oxyfuel pre-heating zone
- Inductive heating equipment
- Zinc pot and zinc pot equipment
- Air knife systems
- Strip stabilizing systems
- Skin-passing mill
- Tension leveler
- Side trimmer unit
- Roll coater for passivation
- Electrostatic oiling machine
- Production know-how
- Electrics and automation
- Plug & Work integration tests
- Strip control and measuring systems
- Quality monitoring systems
### PERFORMANCE

<table>
<thead>
<tr>
<th></th>
<th>Galvanizing</th>
<th>Annealing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip width</td>
<td>750 - 2,080 mm</td>
<td>700 - 2,150 mm</td>
</tr>
<tr>
<td>Strip thickness</td>
<td>0.25 - 3.0 mm</td>
<td>0.25 - 3.0 mm</td>
</tr>
<tr>
<td>Process speed</td>
<td>200 m/min</td>
<td>450 m/min</td>
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<tr>
<td>Capacity</td>
<td>550,000 tpy</td>
<td>1,200,000 tpy</td>
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<tr>
<td>Products</td>
<td>CQ, DQ, DDQ, EDDQ, SEDDQ, HSS, HSLA, IF-HSS, IF-BH, CP, DP, TRIP, MS (only annealing)</td>
<td></td>
</tr>
</tbody>
</table>

Drawing on the combined strength of the companies in the SMS group, SMS Siemag supplies turnkey hot-dip galvanizing and annealing lines for automotive qualities from one source.

SMS Siemag, DREVER International, DUMA BANDZINK, Elotherm, EMG, FOEN, IAS, MET/Con
ADVANCED ANNEALING AND COOLING TECHNOLOGY

RAPID COOLING WITH GAS

The DREVER Ultra Fast Cooling System cools while perfectly preserving the strip form by hydrogen injection. It achieves cooling rates of up to 150 kelvin per second and millimeter of strip thickness. Even more convincing is the fact that this system requires no extra hydrogen, which makes it ideal for high-strength multiphase and TRIP steel grades with strengths of up to 1,000 megapascals. Furthermore, all this is possible with a reduced amount of expensive alloying elements.

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 strip thickness, enough for manufacturing tough dual and complex-phase as well as martensitic grades with tensile strengths of 1,500 megapascals and more.
ANNEALING CURVES

This comparison of typical annealing curves for different high-strength steels shows that production plants must offer considerable flexibility with regard to heat treatment. Using these various cooling systems, plants from SMS Siemag produce the latest high-strength steel grades for the automotive industry. That allows for lighter, fuel-saving vehicles.

START-UP CURVE

Our lines reach their full production capacity within a short time. That’s because of the perfect meshing of components from one source as well as the Plug & Work integration testing performed prior to commissioning. As an example, the hot-dip galvanizing line shown in this graph produced marketable products for the automotive industry right from the start, and was operating at maximum capacity after just a few months. Due to the fast start-up, the plant swiftly achieved the break-even point.
HIGH MATERIAL AND SURFACE QUALITY

ULTIMATE SURFACE QUALITY

The stand-out feature of SMS Siemag hot-dip 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.

STRENGTH MEASUREMENT

The IMPOC® measuring system from EMG – integrated in hot-dip galvanizing and annealing lines – continually checks the material’s tensile strength as well as yield strength during production. That allows the operator to immediately adjust process parameters whenever necessary. Non-destructive magnetic measurement shows that homogeneous material properties are achieved even at high tensile strengths. Today there is a growing number of automotive manufacturers who use this system for checking materials.

COATING PRECISION

A key quality characteristic of our hot-dip galvanizing lines is the accuracy of the coating thickness. Complying with narrow coating tolerances means you also save zinc and cut production costs. What mainly determines excellent coating precision is the efficient air knife system. Also significant here is zinc pot equipment tailored to the special requirements of the process as well as a strip stabilizing system that guarantees smooth strip travel and superb coating precision.
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 production conditions ensure a reaction to changing demands with the greatest possible efficiency. This is where automotive lines from the SMS group stand out because of their extreme flexibility due to the highly developed, tried-and-tested technologies and components that are applied. Integrated in the radiant-tube furnace from DREVER

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.

UNIVERSAL ANNEALING AND HOT-DIP 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.

ALL-PURPOSE LINE

To create maximum versatility, this line type features four different process routes. Following slow cooling, the steel strip can run through one or more of these routes. The line comes with two cooling systems (ultra-fast cooling and water-spray cooling) as well as a galvanization option. Furthermore, annealed materials can be re-heated in an overaging or tempering zone.
are 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.

There is even more the SMS group can do 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

STEEL PRODUCERS WITH AUTOMOTIVE LINES FROM SMS SIEMAG (EXAMPLES)

- Angang Steel Company, China
- Handan Iron & Steel, China
- Baotou Iron & Steel, China
- Bengang Steel Plates (Benxi), China
- Hyundai HYSCO, South Korea
- Shagang group, China
- Panzhihua, China
- Bhushan Steel, India
- PRO-TEC Coating Company, USA
- Ilva Cornigliano, Italy
- Shougang JingTang, China
- ThyssenKrupp Steel, USA
- MMK, Russia
- Nucor Steel, USA
- Severstal Columbus, USA
- US Steel Košice, Slovakia
- Baosteel, China
- Shougang Corporation, China
- Wuhan Iron & Steel, China
- Maanshan Steel, China
- Salzgitter Flachstahl, Germany
- Big River Steel, USA
NUMEROUS REFERENCES
Since 2000, SMS Siemag has attracted orders for a total of 36 turnkey lines for automotive grades (as of 2014).

HIGH-STRENGTH GRADES
Normally, the lines produce high-strength grades such as DP980 or TRIP980. Yet now, due to modern cooling technologies, the range of products also encompasses innovative dual and complex-phase as well as martensitic grades with tensile strengths upwards of 1,500 MPa.

HIGH SURFACE QUALITY
Crucial to steel for automotive bodywork is a flawless surface. The very best standard is termed C-surface, and it is produced for instance on the hot-dip galvanizing lines at Hyundai HYSCO, Baosteel, ThyssenKrupp Steel, U.S. Steel Košice, and Nucor Steel.

HIGH CAPACITIES
All the plants feature exceptionally large capacities. Take for instance the annealing lines for Bengang Steel Plates, Shougang JingTang, Handan Iron & Steel, and Angang Steel Company. They are each designed for a production of more than one million tpy. The annealing line at Hyundai HYSCO has for many years been producing over 100,000 t every full month (without public holidays).

MULTI-PURPOSE LINES
So far, SMS Siemag has built a total of eight lines in which the strip runs through different process components as required for different products. Included here are five universal annealing and hot-dip galvanizing lines as well as three continuous annealing lines with gas and water-based rapid cooling.

MARKET LEADERSHIP
The majority of market-leading automotive steel producers rely on SMS group technology.
REFERENCES

MAGNITOGORSK IRON AND STEEL WORKS, RUSSIA
Hot-dip galvanizing line and universal annealing and hot-dip galvanizing line

The two cold strip lines in the MMK plant in Magnitogorsk, Russia, together produce more than one million tons of high-quality steel strip, especially for automotive outer and interior parts. This is where SMS Siemag erected a pure hot-dip galvanizing line and a universal annealing and hot-dip galvanizing line for MMK. It’s a plant array that covers a very wide range of top-quality materials – from soft to high-strength grades – and produces two different product groups (annealed and galvanized) as required. Everything for the lines was supplied from one source: mechanics and hydraulics, furnace technology and air knives, and post-treatment.

Furthermore, SMS Siemag was responsible for the entire electrics and automation complete with Plug-and-Work integration tests. Both plants went on stream in summer 2012. As early as the end of November, MMK issued the final approval for the lines after an effective start-up phase.
Handan Iron & Steel, China
Continuous annealing line with record capacity

Engineered for an annual capacity of over 1 million tons, the annealing line at Handan is one of China’s largest plants of this type. SMS Siemag attracted the order for the almost 500-meter line in August 2008, and commissioning in September 2010 was two and a half months ahead of schedule.

To achieve this impressive capacity, the line is operated at a speed of up to 450 meters per minute and the maximum strip width is 2,080 millimeters. A special feature is the annealing furnace from DREVER directly connected to an ultra-fast cooling zone. This cools the strip extremely rapidly yet evenly, while retaining the strip shape and producing very good surfaces.

The integrated six-high skin-passing mill achieves a skin-passing degree of up to 3 percent and features rolling technologies such as CVC® intermediate roll shifting as well as work roll and intermediate roll bending. That’s where the strip gains its required surface and flatness properties.
REFERENCES

THYSSENKRUPP STEEL USA
Three automotive lines

Included in the supply scope of SMS Siemag for the ThyssenKrupp Steel USA plant in Alabama were two hot-dip galvanizing lines and one continuous annealing line for high-strength and high-ductility automotive grades. A further hot-dip galvanizing line produces materials for the household appliances and construction industries. There is similar equipment available in these two automotive hot-dip galvanizing lines that produce galvanized or galvannealed material for exterior and interior vehicle parts. Both lines feature a DREVER radiant-tube furnace and FOEN air knives. One of the lines is also equipped with a FOEN DEMCO® strip stabilization system.

The annual production capacity of each line is some 500,000 tons. It’s equally possible using this annealing line to produce an additional 700,000 tons of annealed steel strip per year, also destined for the automotive industry. Just as innovative is a design that allows our customer to upgrade this line to a universal annealing and hot-dip galvanizing line at any time. The lines went into production as from April 2011.
HYUNDAI HYSCO, SOUTH KOREA
Two universal annealing and hot-dip galvanizing lines plus one hot-dip galvanizing line

The first time Hyundai Hysco contracted SMS Siemag to erect a universal annealing and hot-dip galvanizing line was in 2005. It was a complex project, involving installation of the necessary components for hot-dip galvanizing in an existing annealing line and the construction of bypasses so that the line could be re-commissioned as an annealing and hot-dip galvanizing line in 2006.

Then, in 2012, Hyundai Hysco again decided on a very versatile plant solution and ordered another universal annealing and hot-dip galvanizing line as well as a pure hot-dip galvanizing line from SMS Siemag for its cold rolling complex in Dangjin, South Korea. Both lines successfully went into production in April 2013 and have since then been producing high-strength steels for Korean automotive manufacturers.

SMS Siemag supplied most of the mechanical and process-engineering equipment, including DREVER furnaces and FOEN air knives.

As early as May 2013, the plant produced 33,000 t of cold strip including deep-drawing and high-strength grades.

The steel strip is supplied to customers including Hyundai Motors and KIA Motors.
REFERENCES

SHOUGANG JINGTANG UNITED IRON & STEEL, CHINA
Two continuous annealing lines

Acting as a consortium leader, SMS Siemag 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 Siemag, 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 between us that the joint venture contracted SMS Siemag in 2011 to erect a tinplate annealing line and two electrolytic tin-plating lines in the plant.
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’s 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. Next up is water-spray cooling which 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.

PRO-TEC COATING COMPANY, USA
Continuous annealing line with rapid cooling and water-spray cooling system

It’s possible in some cases to save up to 40 percent of the weight. Not only responsible for the design and engineering of the mechanical equipment, SMS Siemag also supplied the entire electrics and automation.
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