Cold rolling of advanced high strength steel with the S6-high solution from ANDRITZ

In response to the ever-increasing demand from the automotive industry for thinner and stronger cold rolled strip steels, ANDRITZ Sundwig developed the S6-high system. This patented system provides the capability to roll thinner gauges, even at 1,000MPa or higher, yield strength. The overall design and some specifics for a Baosteel plant are described.

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Baosteel and ANDRITZ Metals

Light weight, fuel economy and car safety are the key trends and topics for the automotive industry and, due to the latest weight optimisation efforts in automotive engineering, steelmakers are constantly being asked to develop new, higher strength steels.

Within the production chain and technology of high strength steel manufacturing, cold rolling is a key process stage but, until now, rolling advanced high strength steel (AHSS) with a tensile strength of at least 1,000MPa in a cold rolling mill has proved very problematic.

Classic cold rolling mills in 4- or 6-high configurations are limited in rolling this kind of steel at the thinner gauges currently required due to the large work roll diameters used in such mills, regardless of whether a tandem or single-stand arrangement is chosen.

The S6-high rolling mill – a development by ANDRITZ Sundwig – is the solution for cold rolling of AHSS. ‘S6’ stands for supported small work rolls. As Figure 1 illustrates, S6-high is capable of producing thinner gauge strip across the strength range than conventional 4- or 6-high mills, and utilises smaller diameter work rolls.

THE S6-HIGH SYSTEM

Development Development of the patented S6-high system began in the late 1990s, and the first S6-high cold rolling mill was supplied in 2000. Before its development, ANDRITZ Sundwig supplied the Z-high system under licence from Sendzimir, but due to the market requirements this system was accepted only by a limited number of customers in the German/European markets so ANDRITZ Sundwig started its own development work to meet customers’ needs. At that time, development was driven by the need to find a cold rolling process for both high carbon and stainless steels.

With development of the third generation of AHSS for the automotive industry, the importance and field of application of the S6-high cold rolling mill has
increased, with interest from leading Chinese, European and American steelmakers.

Key features One special feature of the S6-high rolling mills design is the use of side-supported work rolls as illustrated in Figure 2. This patented system stabilises the work rolls using hydraulic lateral support equipment which is operated mechanically, thus preventing lateral excursion of these rolls. The diameter of the S6-high work rolls is only about 30% of typical 4- or 6-high work rolls and is double the diameter of work rolls usually found in a 20-high rolling mill (for comparable strip widths). These smaller work rolls, combined with the rugged, solid-stand and open design of the lateral support, facilitates high pass reduction and the transfer of high rolling torques for rolling AHSS grades.

As well as producing thinner strip, the enhanced shape meter system with its specific pre-settings for the S6-high mill, actuator tilting, intermediate roll shifting, and intermediate roll bending, ensures that the customer’s desired strip flatness is also achieved.

More special features of the S6-high mill offer distinct economic advantages, such as the large work roll diameter range, the hydraulically position-controlled adjustment of the screw-down cylinders, and the side support cylinders in mill-fixed side support beams, separation of the intermediate rolls and side support cassettes, and the large side support bearing design to withstand high horizontal side support forces.

The very efficient strip drying system enables a safe rolling process up to the maximum rolling speed.

A fully automatic roll change robot can change the work rolls, intermediate rolls and side support rolls, providing substantially shorter rolling mill set-up times and, even more importantly, permitting contact-free roll change within the shortest possible time.

Some of the key design features are shown below:

- Deformation-optimised housing geometry
- Hydraulically position-controlled adjustment via fast long-stroke cylinders, exchangeable as a complete structural unit
- High screw-down speeds
- High control dynamics
- No interdependence between intermediate rolls and side support cassettes due to separate arrangement and mill-fixed beams
- Individual and simultaneous roll change possible due to mill-fixed side support cartridge design for work roll, intermediate roll and side support rolls
- Mill-fixed intermediate roll bending – positive and negative
- Mill-fixed intermediate roll axial shift arrangement for influencing the strip shape in the edge zone
Short work roll and intermediate roll change times by means of quick-change device
Patented strip cooling system for high cooling efficiency
Cooling plates with zone cooling and strip guiding
Wide range of roll diameters by using automatic pass line adjusting system
Larger side support rolls
Larger side support bearings
Higher horizontal forces are possible
Larger work roll diameter range Z-high mills
Fast change from S6-high mode to 4-high mode

56-HIGH MILL AT BAosteel

Baosteel, the largest steel producer in China, decided in 2013 to install an S6-high cold rolling mill in order to alleviate a long-term resource gap in cold-rolled hard coil, increase the high-strength steel rolling capacity, improve the cold-rolled product microstructure and create greater economic benefits.

Special focus was the production of high-quality products with excellent strip shape and strip thickness control and consistency. A 3D schematic of the plant is shown in Figure 3 and the S6 stand is shown in Figure 4.

The single-stand, S6-high cold rolling mill has been operating successfully since the middle of 2015 and, within just two years of production, the product mix of Baosteel’s high-strength steel manufacturing workshops has changed dramatically. When production began, the share of dual phase DP980 high-strength steel was only 20%, but has now increased to 80%. This is also an indication of increasing worldwide demand as well as Boasteel capability to produce it. The first coil produced is shown in Figure 5.

Some key features of the plant and product are shown in Table 1.

CONCLUSIONS

ANDRITZ Sundwig’s response to the ever-increasing demand from the automotive industry for thinner and stronger cold rolled strip steels, has been to develop the S6-high system. This patented system provides the capability to roll thinner gauges, even at 1,000 MPa or higher, yield strength, than conventional 4- or 6-high mills. An example installation at Baosteel China illustrates that providing the plant capability generates increasing demand for these grades. MS

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<table>
<thead>
<tr>
<th>Strip width</th>
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<tr>
<td>Strip thickness</td>
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<td>Tension reel power</td>
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</table>

Fig 5 Baosteel’s first coil celebration

Table 1 Key S6-high plant features and product details