ISSN 1983-4764

FIVE ARVEDI ESP LINES AT RIZHAO STEEL FOR HIGH-QUALITY HOT-STRIP PRODUCTION – FIRST LINE IS NOW IN OPERATION*

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Abstract
The Chinese steel producer Rizhao Steel is now focusing on the highly attractive local and export markets for high-quality, thin-gauge strip products. The first line of five Arvedi ESP plants began operations in the spring of 2015. The new casting-rolling complex is designed for a total annual production capacity of 11 million tons of high-quality, ultra-thin, hot-rolled strip products with widths of up to 1,600 mm and thicknesses down to 0.8 mm. The energy consumption and related costs are reduced by up to 45% compared with conventional casting and rolling processes. This also means a major reduction in CO2 emissions. During the project phase, the plant personnel from China received extensive training at the licensor's plant – Acciaieria Arvedi S.p.A. in Italy – to prepare them to deliver the best operational performance with the new state-of-the-art endless casting-rolling facility. The plant setup, the training and support program, as well as the latest results from the start-up are presented in this paper.
Keywords: Ultra-thin hot strip; Hot-rolled strip 0.8 mm; Endless rolling; High capacity TSDR.

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** Technical contribution to the 52° Seminário de Laminação – Processos e Produtos Laminados e Revestidos, part of the ABM Week, August 17th-21st, 2015, Rio de Janeiro, RJ, Brazil.*

1 INTRODUCTION

In China's saturated steel market, the steel producer Rizhao steel in Eastern China selected the Arvedi ESP (Endless Strip Production) process to vary its production to high-quality, thin-gauge hot-rolled strip. Following an initial investment in mid-2013 for two new Arvedi ESP plants, each with an annual production capacity of 2.55 million tons, a second order was placed with Primetals Technologies for the supply of three additional Arvedi ESP lines that will have a combined rolling capacity of 5.95 million tons of steel per year. The lines are designed for the production of different strip-width ranges: from 900 mm to 1,600 mm (three lines), and from 900 mm to 1,300 mm (two lines). In all five lines, strip is rolled to a minimum thickness of 0.8 mm. A wide variety of steel grades will be produced for a broad spectrum of steel products and industrial sectors.
Primetals Technologies is responsible for the engineering of the Arvedi ESP plants, and supplies mechanical equipment, media-control systems, technological packages and automation systems. The lines are controlled by completely integrated basic-automation (Level 1) and process-optimization systems (Level 2) for all casting and rolling operations.

2 OVERALL PLANT CONFIGURATION

The layout and the expected results of the five new plants are based on the plant design and performance of the existing Arvedi ESP production line at Acciaieria Arvedi SpA, which has been successfully operating in Cremona, Italy, since 2009.
The 180-m-long Chinese plants are far more compact than conventional casting and rolling mills. A short line length means that lower investments are required for land, civil works, buildings, piping, cabling and construction. Four plants are positioned pairwise in a mirrored arrangement with the drives installed on the outer side of two each line, and with the control pulpits and roll shops positioned between the line pairs (Figure 1). Liquid steel for the wider Arvedi ESP lines is supplied from new LD (BOF) meltshops with 300-ton converters, and for the narrower lines the steel will be delivered from existing converter meltshops with 63-ton converters.

2.1 Continuous Casters

The bow-type casters of all five lines perform continuous strand bending and unbending, and they are equipped with a straight mold for the casting of steel at thicknesses between 90 mm and 110 mm. Online strand-width adjustments are performed using DynaWidth mold-width adjustment technology. This solution allows the target strand width to be accurately met without the need for an edger. The casters are equipped with 11 strand segments each, and the metallurgical length of all casters is just over 20 m. Three high-reduction mill stands are installed immediately after the final caster segment in order to utilize the remnant heat energy of casting for the initial rolling step. In addition to major energy-cost savings, this enables perfect crown and wedge control to be achieved with work-roll bending, since the hot core of the cast strand is softer and therefore has a higher formability for shape control.

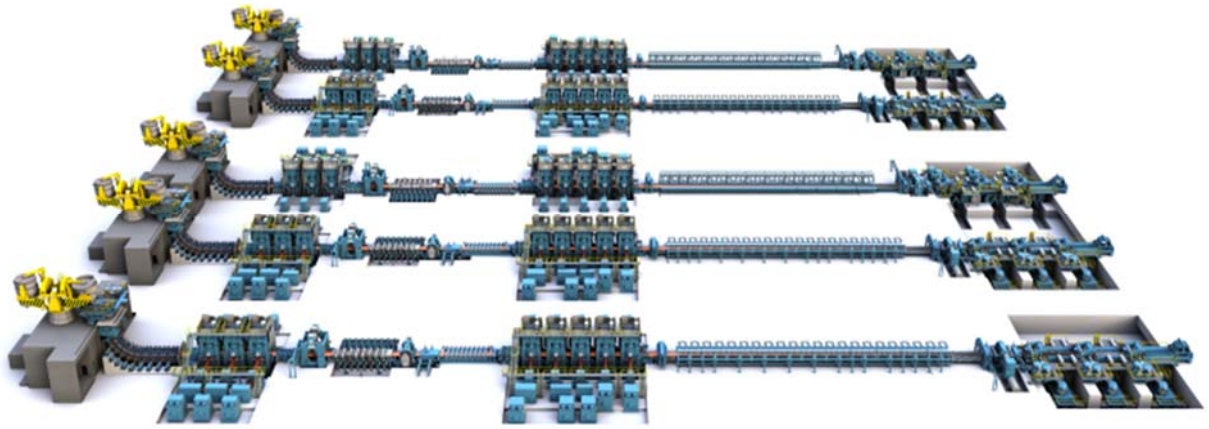

Figure 1. Schematic view of the five Arvedi ESP plants under construction at Rizhao Steel.

2.2 Induction Furnace

The intermediate strip exiting the high-reduction mill then enters the induction heater, which features a short length of only 10 m. This enables the strip to pass through the furnace in less than 15 seconds, which is decisive for minimum scale formation. Only one descaler – installed immediately before the five-stand finishing mill – is therefore required for the entire line. Unnecessary strip-temperature losses are thus avoided, allowing a more perfect control of the thermo-mechanical rolling parameters.

2.3 Finishing Mill

Following reheating and descaling, the intermediate strip then enters the finishing mill equipped with five 4-high finishing stands. Because strip shaping has already taken place in the high-reduction mill, only the first two finishing stands are equipped with SmartCrown rolls that are designed with a bottle-shaped roll contour. This serves as the basis for final rolling of perfectly flat strip by the last three finishing stands, which are outfitted with conventional work-roll contours. Long-stroke shifting of the work rolls under load, which is regulated by a wear-compensation model, maximizes the service life of the rolls before surface grinding is required. What's more, thanks to the endless mode of operation in Arvedi ESP plants, strip impact on the rolls – typical for batch-operated plants during strip-head threading – is eliminated. This aspect also contributes to a significant extension of the work-roll lifetime. For example, in a typical production sequence comprising 3,000 tons of liquid steel, a total of 170 km of strip – with a considerable portion of 1-mm gauge – is rolled by the final stand.

2.4 Strip Cooling and Coiling

Rolling is followed by laminar cooling after which tension-free cutting is carried out by a high-speed shear. The endlessly produced strip with coiled weights of up to 32 tons is distinguished by highly uniform geometrical and mechanical properties throughout its entire length. Because strip-head and -tail cropping is unnecessary with endless production, an average yield of more than 98% is achieved from liquid steel to the coiled product in Arvedi ESP lines.
The fully integrated automation system enhanced with an advanced tracking model ensures exact cutting procedures and coil scheduling in accordance with production

orders. The entire process, including all plant technology and automation systems, are protected by Arvedi and Primetals Technologies patents.

3 VARIED PRODUCT MIX

The product mix of the new Chinese plants will comprise low- and ultra-low- carbon steels, medium-carbon steels as well as high-strength low-alloyed (HSLA) and dual-phase steel grades.
Thanks to the constant process parameters of endless operation, particularly with respect to the strip-temperature profile, production of advanced steel grades is accomplished with a far higher degree of accuracy compared to conventional casting-rolling processes. For example, over-alloying is avoided during production of HSLA and pipe grades, which results in considerable cost savings for producers. The positive influence of endless operation on the metallurgical properties of the rolled strip is shown in a YouTube film, which can be accessed below via the QR code.

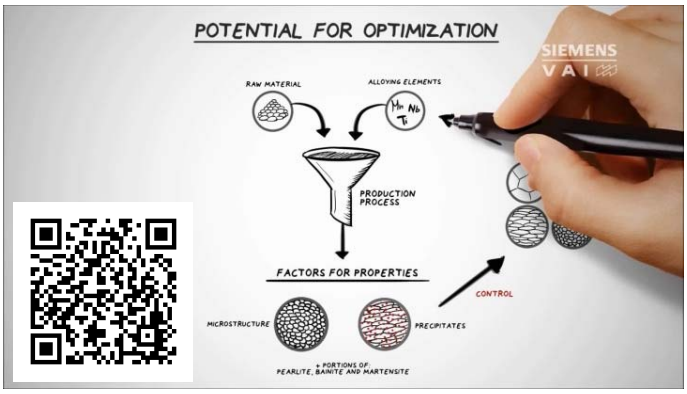

Figure 2. See why the Arvedi ESP endless production mode is superior for the production of new and advanced steel grades. https://www.youtube.com/watch?v=aoRS2VAWQy4&feature=youtu.be

4 COMPREHENSIVE TRAINING OF CHINESE PLANT OPERATORS

Quick ramp-up of the new Arvedi ESP lines to their designed production capacity was supported by comprehensive training of Rizhao's operational and maintenance personnel. Basic training comprised theoretical training at Primetals Technologies in Linz and Erlangen for mechanical, electric and automation equipment. This was followed by three weeks of theoretical and practical instruction at the Arvedi ESP plant in Cremona (Figure 3). In a second module with hands-on training, operators were involved with routine operational and maintenance practices for two months at the Arvedi plant in Cremona.

Figure 3. Rizhao steel operators during training at the ESP plant in Cremona, Italy

During the first year of operation at Rizhao Steel, onsite training and assistance is provided by specialists from Acciaieria Arvedi. The combination of experienced Arvedi experts and well-trained Rizhao personnel ensures reliable plant operations and the production of high-quality final products.

5 PROJECT EXECUTION

Executing such a complex project in 20 months is a master piece of project management and requires perfect cooperation between Rizhao Steel, main contractor, suppliers and erection company. As the new plants 1-3 are almost identical to the master plant in Cremona many drawings could be sent to the manufacturers within the first weeks of project start. Only this allowed to stick to the very tight time schedule. Also using mainly the same manufacturers as for the plant in Italy contributed to a smooth execution. As manufacturing took mainly place in China, transport times could be limited as well. And finally achieved the erection company under the guidance of Rizhao Steel the nearly impossible to install the whole plant from ground breaking to completion within 12 months.

Figure 4. From ground breaking to completion within 12 months

In parallel to the commissioning of Line 1, plant 2 was already close to finish of the installation, while groundbreaking for plant 3 took place end of 2014. Deliveries of equipment for line three have already started. Project work for plants 4 and 5 which are in the second plant complex is also progressing right on schedule.

Figure 5. Line 2 under erection while Line 1 is already under commissioning.

Generally the overall project plan foresees a very integrated project execution ending up with the startup of the last plant in 2016.

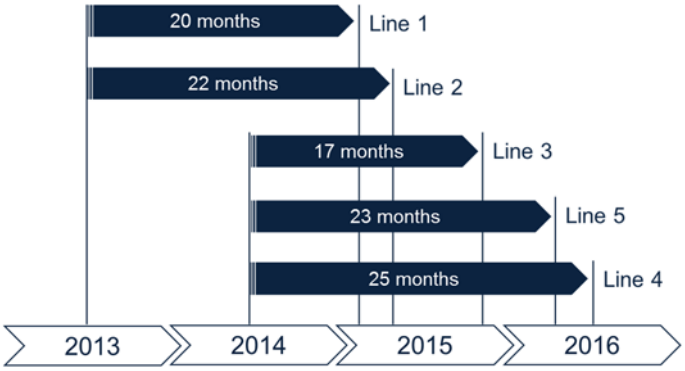

Figure 6. In shortest time to first coil.

6 A SUCCESSFUL START

After a project period of only 20 months the first coil on Line 1 was rolled in spring 2015. With the experience of the startup of the ESP line in Cremona, Italy in a first step the caster was started in combination with the high reduction mill and pendulum shear producing plates which are pushed and piled in the related section. After fine tuning of the coupling of caster and high reduction mill in the next step the finishing mill, laminar cooling and down coiler were included and combined allowing the plant to produce first coils in semi-endless and endless mode.

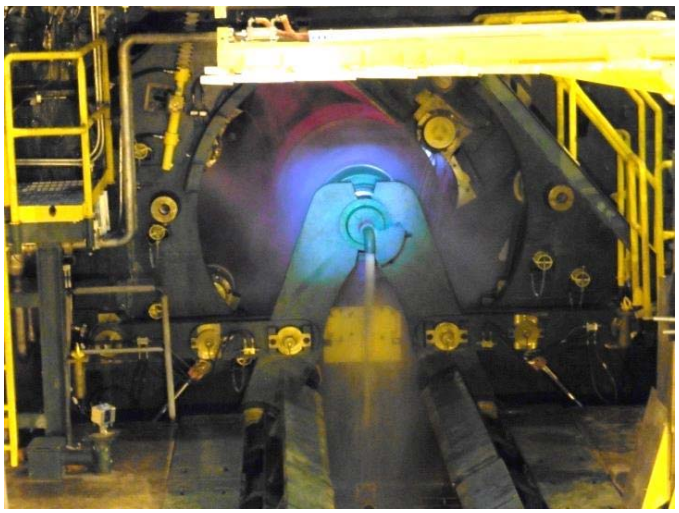

Figure 7. First coil produced on ESP line 1 in spring 2015.

Due to the well trained Rizhao operators the production was ramped up quickly. Minimum gauges below 1 mm were reached after 2 months of operation.

7 MEETING MARKET DEMANDS

The reliability and stability of the Arvedi ESP process has been well proven in more than five years of operation at Acciaieria Arvedi and now in China. A broad range of advanced steel grades are produced for a wide range of industrial applications. Thanks to the uniform and exceptional quality of the thin- and thick-gauge strip, the products command premium prices on the market.

Major cost savings result from the significantly lower energy consumption, reduced alloying requirements and high product yield.

8 CONCLUSION

From quality point of view the final products produced on an Arvedi ESP line are characterized by superior geometrical strip quality and flatness.
Outstanding surface quality is proven by a major European automotive supplier who tested the ESP-material on his cold rolling mill.
Very high strip homogeneity along its entire length is ensured as in endless operation no strip head or tail end are passing the machine. The cut happens just before the down coiler at the high speed shear and the strip never faces strip threading or tail out procedures as known from conventional batch operated processes. This also contributes to considerably extended work-roll lifetime. Due to the constant process parameters and strict strip temperature guidance a reduced consumption of alloys for production of advanced steel grades is noticed.
Excellent process stability is not only demonstrated on lowest mold breakout figures and cobble rates but can be seen also on the overall yield of more than 98% from liquid steel to coil.
With consideration to the numerous benefits offered by the Arvedi ESP process, the five new plants in China will provide Rizhao Steel with the basis for long-term business success in China and abroad.