Back to the future with CSP® technology

Twenty-five years after the supply of the first CSP® plant, the pioneers in thin slab technology, Nucor Steel and SMS group, recently modernised the CSP® plant in Berkeley, South Carolina, which has been in operation for 18 years. The development enables production of wider and thinner strip, together with lower energy consumption.

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Thin slab technology, launched by SMS group in 1989 under the name Compact Strip Production (CSP®), was immediately recognised by Nucor Steel, USA, as a massively significant advance in strip manufacturing, and the world's first CSP® plant was commissioned in Crawfordsville, Indiana, USA in 1989. Plants in Hickman, Arkansas and Berkeley, South Carolina, followed in 1992.

It is recognised that even ground-breaking technologies need to advance, and so in 2013/14 SMS group upgraded the Berkeley plant, the first such CSP upgrade since 1989. The project was completed in just a few weeks with a cost-optimised modernisation concept especially for Nucor, and which was designed to expand the product range, increase flexibility and reduce energy consumption. A computer-generated schematic is shown in *Figure 1*.

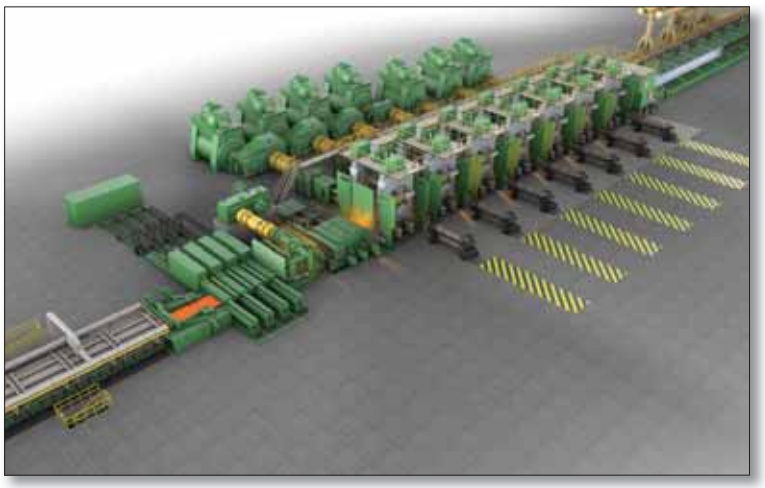

Fig 1 **Computer-generated plant schematic**

BERKLEY UPGRADE

The key features of the upgrade are as follows:

- Modifications to one of the two CSP® casters so that thickness of the slabs in one caster can be infinitely adjusted between 48mm and 63mm, coupled with a 200mm increase in slab width
- Installation of an induction heating system between the equalising furnace and rolling mill entry
- Addition of a seventh stand to the CSP® rolling mill and improved automation and strip dimension control systems
- Strip width increased from maximum of 1,680mm to 1,880mm

Caster These enhancements comprised modifications to one of the two CSP® casters, and the renewal of the X-Pact® electrical and automation systems. The caster was fitted with new moulds, a new four-cylinder oscillation system, which has the benefits of variable mould movement (sinusoidal, asymmetric, trapezoidal, etc), and dynamic adjustable parameters (frequency and stroke depending on casting speed), markedly wider segments and a new bending and straightening unit.

Thanks to the implementation of the Liquid Core Reduction (LCR 3) module in the containment zone, the thickness of the thin slabs can be infinitely adjusted during casting between 48mm and 63mm.

Although increasing the casting width by 200mm was definitely a challenge at the beginning of the project, the implementation eventually did not pose any major problems thanks to the good planning and successful collaboration.

The casting speed was increased from 5.1m/min to 5.5m/min and, with the new maximum slab width, the output was also increased.

Induction furnace In a standard CSP® plant, the cast slabs pass through a tunnel reheating/equalising furnace prior to mill entry. This installation is the first such development with the installation of an induction heating system supplied by SMS Elotherm between the equalising furnace and the rolling mill entry. To make this possible, the existing tunnel furnace was shortened by approximately 6.5m.

Fig 2 **Mill control room**

Fig 3 **Run out table cooling**

This solution provides two advantages: first, it reduces the equalising furnace temperature, so reducing energy and operating costs and, second, it increases plant flexibility and helps increase the range of steels produced.

The starting point for this development was the fact that very few products made on a CSP® plant need the maximum tunnel furnace temperature, and altering furnace temperature between grades cannot be done easily or quickly. The combination of a gas-heated tunnel furnace and an inductive heating plant makes it possible to reduce the tunnel furnace temperature to a lower base level. Those products requiring a higher entry temperature can then be heated, as required, by the inductive system and without compromising process stability or product quality. This also enables Nucor Steel to achieve greater reductions per pass in the rolling mill and to expand its mix of products in the thin gauge range, so improving competitiveness in the market for premium flat steel products.

An additional benefit is that, with a lower furnace temperature, non-water-cooled transport rollers can be used inside the tunnel furnace. These dry rollers reduce the heat losses in the furnace compared to the water-cooled variants, and help to reduce overall energy consumption by 40%.

Rolling mill A seventh finishing stand was installed, enabling the minimum gauge to be reduced. The new stand features CVC® plus technology, as with the original stands F1 to F6. The mill also received a new X-Pact® level 2 automation system, including shape, contour and flatness control systems, as well as a cooling model, thus enhancing strip shape and dimensional control. *Figure 2* shows the mill control room and process control displays. Although a 200mm width increase is significant, no changes were needed to mill stands or roll width as the plant was originally designed with sufficient capability.

Figure 3 shows the run out table cooling section of the mill.

CONCLUSIONS

Twenty-five years after the supply of the first CSP® plant, SMS group recently modernised Nucor Steel's 18-year-old CSP® plant in Berkeley, South Carolina. The development enables production of wider and thinner strip, together with lower energy consumption. With this concept, it is possible to expand the product mix and reduce the energy consumption of any CSP® plants. The specific plant features and conditions, such as width, must be taken into account. MS

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