CSP TECHNOLOGY AND RELATED OPERATIONAL STATUS[1]

Christoph Klein[2]

Abstract

The market for hot strip is undergoing a phase of massive changes. Slab thickness have been adjusted to match the required entry thickness in hot strip finishing lines, casting and rolling speeds have been harmonized to such an extent that all the process stages can work to full capacity in two-strand operation. Furthermore, innovative technologies such as thin strip rolling or new cold rolling and strip processing concepts have been added in the hot rolling stage as well as in downstream processes. There have been many technical developments in recent years that have led to increased productivity and cost reductions. The CSP technology developed by SMS Demag and launched some 15 years ago has crucially changed hot strip production .Taking into account the plants still in the planning and assembly phases, CSP technology has already reached a capacity of more than 42 million t / year.These figures impressively reflect the success of CSP.

Key-words: CSP technology; SMS Demag; Strip rolling.

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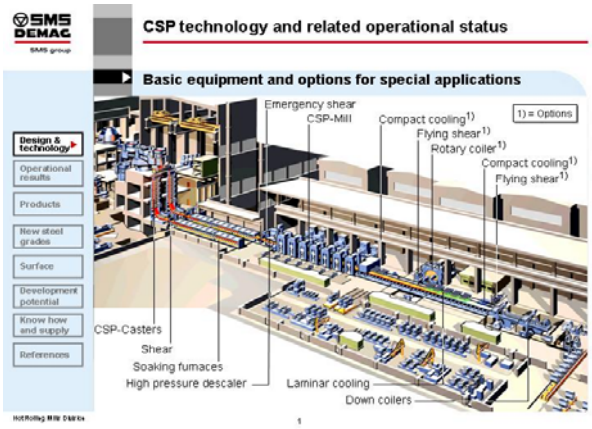


Figure 1. Basic equipment and options for special applications.

CSP technology has undergone a continuous and consequent development. Today the production of all kind of steel grades is possible on CSP.
Due to the requested flexibility with regard to strip dimensions, steel grades and rolling campaign planning, a variety of new plant elements and technologies has been developed and integrated into the CSP process.
New plant elements like:

- Compact cooling
- Flying high speed shear
- Rotary coiler

can be integrated into the CSP layout. Facilities, extending the ability to a wider product range or product sizes.

CSP technology today provides the technical solutions required to satisfy the demands for flexible production scheduling.

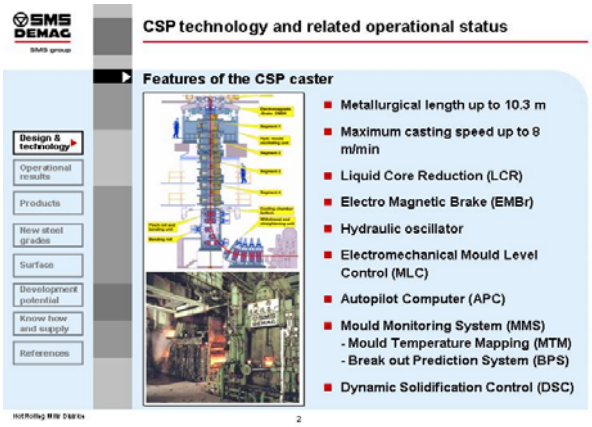


Figure 2. Features of the CSP caster

The technological controls and process models of the CSP caster are continuously being improved for achieving highest operational reliability and product quality.
The development of the mould level control, the hydraulic mould oscillation, LCR adjustment and the dynamic solidification control aided in increasing the throughput, increasing the number of steel grades and improving the slab quality as well as proper adjustment of slab thickness in respect to the rolling conditions.

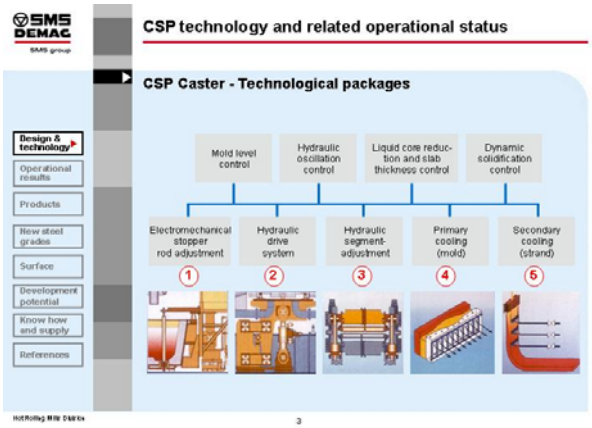


Figure 3. Technological control packages caster.

To ensure constant mould level as well as mould content
To ensure optimum adjustment of oscillation curves in relation to casting speed
To ensure adaptation of slab thickness to the final strip thickness as well as to optimum selection of slab thickness to the throughput
To ensure optimum solidification conditions as well as max. slab temperature at casting machine exit

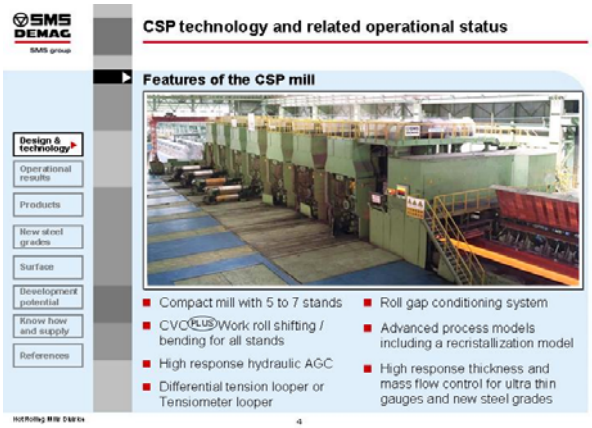


Figure 4. Features of the CSP mill.

In line with the market requirements the hot rolling process underwent a large scale of developments.
Thin strip rolling is typical for the CSP process. Variable thin slab thickness, constant temperature and/or rolling speed enable reliably achieving thinnest final thickness at best tolerances and stable operation.
Due to the fact that as the high deformation rates for the ultra thin final gauges the control of mass flow becomes more decisive new technological control systems have been developed.
Technological packages like:
High dynamic thickness control for fast response on mass flow changes.
Dynamic CVC plus with extended adjustment range for even more flexibility in controlling profile, flatness and contour of rolled strip
Interstand flatness control, utilized by segmented looper which measure the strip tension across the strip width between mill stands

For the manufacturing of API linepipe grades or ferritic rolled low carbon grades, new Pass schedule calculation model including the microstructure model indicating the recristallization behaviour during rolling are now available to set up the mill for thermomechanical or ferritic rolling strategies.
As a standard feature the overall package offer a grater freedom in planning the rolling campaigns and improve the rolling stability of extreme products no matter whether in respect to size or grade.
Today these developments are an integral part of the rolling technology

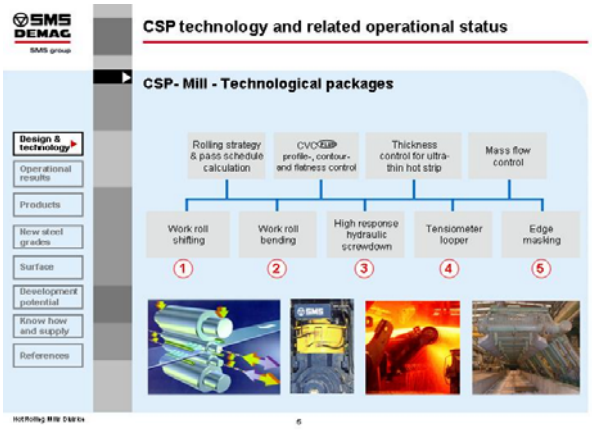


Figure 5. Technological packages CSP mill.

To ensure excellent profile and flatness values as well as high flexibility in rolling scheduling
To ensure smallest thickness tolerances even at ultra thin gauges
To ensure stable thin gauge operation by efficient interstand flatness control
To ensure best cold flatness of cooled hot strip

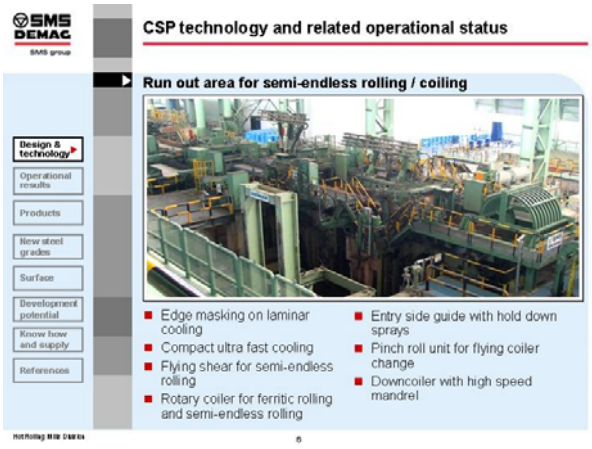


Figure 6. Runout area for semi-endless rolling / coiling.

High-speed cooling equipment in the hot strip mill exit end or upstream of the coiler system enable a higher flexibility in conjunction with the laminar cooling.
With a compact cooling system cooling rates up to 400 K/s can be realized. Together with a laminar cooling line where cooling rates between 30 – 50 K/s are typical a greater flexibility regarding cooling curves and cooling rates is possible.

This is of advantage when producing highly demanding steel grades, like multiphase steels and fine-grain / high-strength construction steels.
Edge masking systems are used to safeguard good cold flatness at the cooled hot strip.

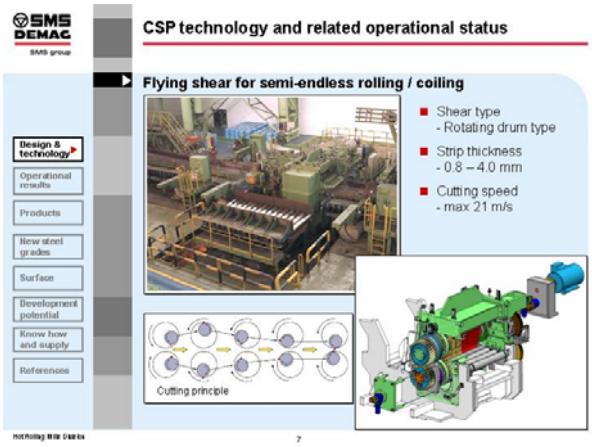


Figure 7. Flying shear for semi-endless rolling / coiling.

For semi-endless operation we developed the high-speed shear for strip speeds up to 21 m/s, arranged ahead of the coiler. This shear cuts in a flying mode the overlong rolled strip into the pieces needed for the relevant coil.
A weight-saving construction in conjunction with only one drive, synchronizing the drum rotation and cutting adjustment is the key for precise cobble free cutting at high speed. This design is a very important issue in respect to stable semi – endless operation.
On the one hand, semi – endless rolling has been developed to minimize the cobble risk inside the rolling mill during ultra thin gauge rolling. On the other hand the cutting of the fast running strip ahead of the coiler station shall not lead to a new unsafe process step during semi endless operation.
The operation of the new SMS Demag high speed shear at CSP plants Maanshan and Lian Yuan show excellent operation results.

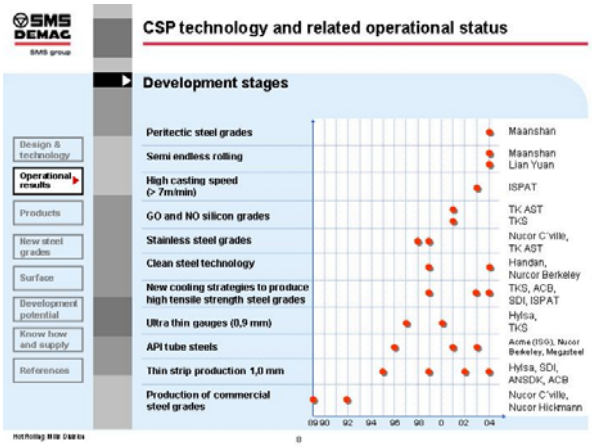
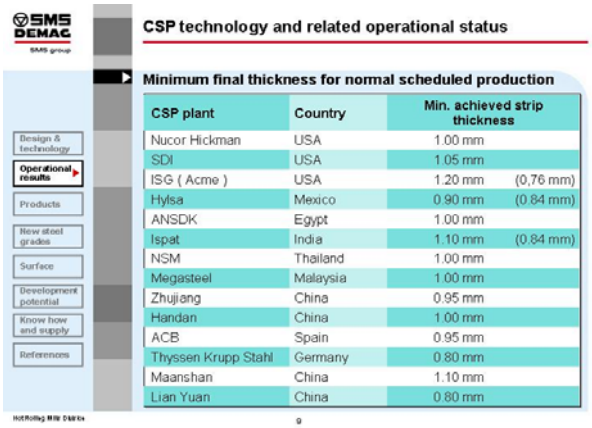


Figure 8. Development stages of CSP

CSP technology evolved in line with market demands and the requirements of our customers. Here are the various stages:

- production of commercial steel at Nucor C'ville / Hickmann in the US
- followed by the development of ultra-thin strip at Hylsa in Mexico
- production of API tube steels at ACME, today ISG Riverdale in the US
- innovative cooling strategies using intensive cooling equipment with downstream rotary coiler for producing top grain structures at Thyssen Krupp Stahl in Duisburg, Germany
- development of clean steel technology at Handan in China and Nucor Berkeley in the US
- and stainless steels at TKS in Italy
- GO and NO silicon grades at TKS in Germany and Italy
- Dual phase and other multi phase steels at ACB in Spain, TKS in Germany, SDI in the US and ISPAT Dolphi in India
- High casting speeds to at ISPAT Dolphi in India
- API linepipe grades for extreme deep temperature application at MEGASTEEL in Malaysia
- Further trials on Peritectic grades production at MAANSHAN in China with the result of successful casting carbon grades up to 0,11% C

as well as other, high-quality steel grades. Current goals are not only developing product variety, but also tapping the potential of higher production and new steel grades. These developments are accompanied by a clear trend toward ever lower production costs, shorter construction times and commissioning times.
Today CSP hot strip is used either direct or as further processed cold strip in almost any industrial further applications.
This is possible thanks to the ability of CSP to cover all process needs for the various steel grades.



CSP plant	Country	Min. achieved strip thickness	
Nucor Hickman	USA	1.00 mm	
SDI	USA	1.05 mm	
ISG (Acme)	USA	1.20 mm	(0,76 mm)
Hylsa	Mexico	0.90 mm	(0.84 mm)
ANSDK	Egypt	1.00 mm	
Ispat	India	1.10 mm	(0.84 mm)
NSM	Thailand	1.00 mm	
Megasteel	Malaysia	1.00 mm	
Zhujiang	China	0.95 mm	
Handan	China	1.00 mm	
ACB	Spain	0.95 mm	
Thyssen Krupp Stahl	Germany	0.80 mm	
Maanshan	China	1.10 mm	
Lian Yuan	China	0.80 mm	

Figure 9. Minimum final thickness for regular scheduled production

Compared to other hot strip production lines, the final thickness on CSP plants are considerable thinner.
The adjustment of an adapted thin slab thickness, an ideal temperature level and temperature gradient during rolling ensures a lower and more constant resistance to forming as with other productions methods.

The figure shows a selection of different CSP plants in operation and the minimum final strip thickness which are achieved there.

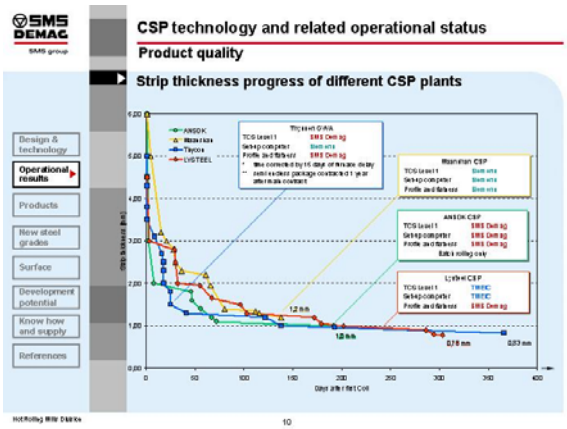


Figure 10. Strip thickness progress on different CSP plants.

The development to thin final gauges during the commissioning of CSP plants is extremely fast compared to other hot strip production lines. Within the scheduled short start up time both the target production and target thickness are achieved.

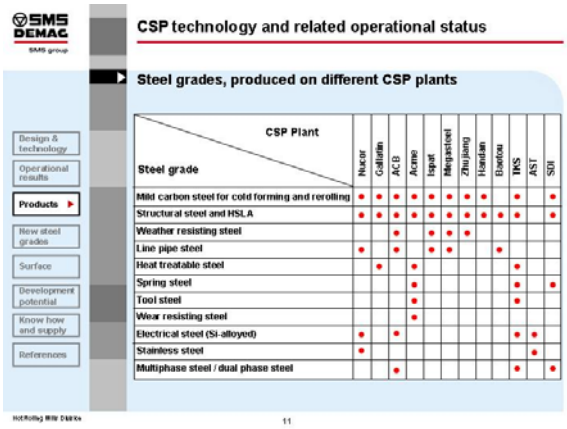


Figure 11.Steel grades produced on different CSP plants.

Today the CSP technology allows the production almost all common steel grades in flat-rolling production.
Soft, low-alloyed steels for onward processing in the cold rolling mill or for the direct use certainly are the largest portion of production.
Other important steel grades are the low-alloyed and micro-alloyed construction steels, stainless steels, high-strength carbon steels, siliconised electric steels and multiphase steels.
The latter category is gaining more and more importance.
Due to the uniform temperature distribution in the strip, these steels can be ideally produced in the CSP mill.

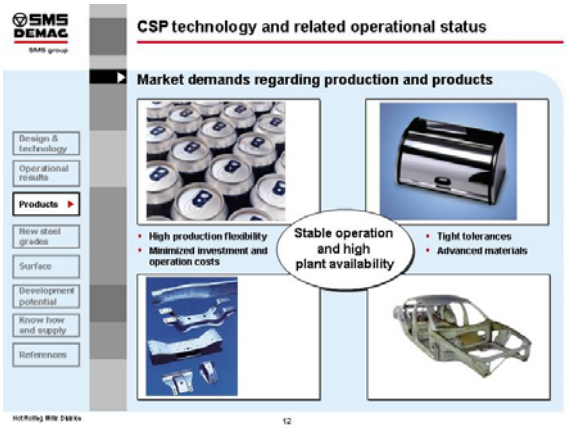


Figure 12. Market demands and products application.

Today CSP hot strip is used either direct or as further processed cold strip in almost any industrial further applications.

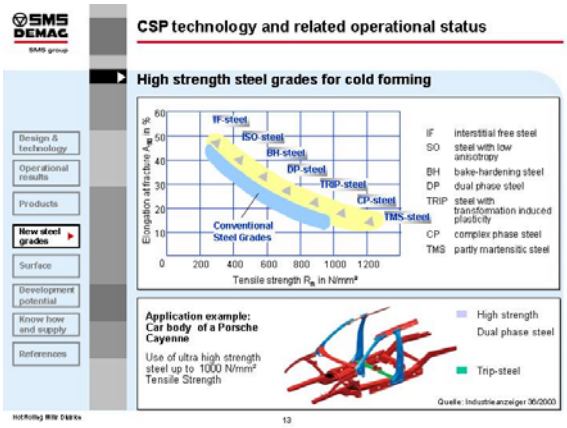


Figure 13. High-strength steel for cold forming.

The existing potential for the enhancement of the CSP product range and for improving the material properties is more and more utilised.
Typical examples for this are the further development of micro-alloyed steels with regard to yield point and notch impact strength, and the important group of multiphase steels for which beside the increase of yield point and tensile strength the good shapeability are given priority.
Dual-phase steels are today industrially produced on the CSP plants ACB, TKS and SDI, just to name a few.

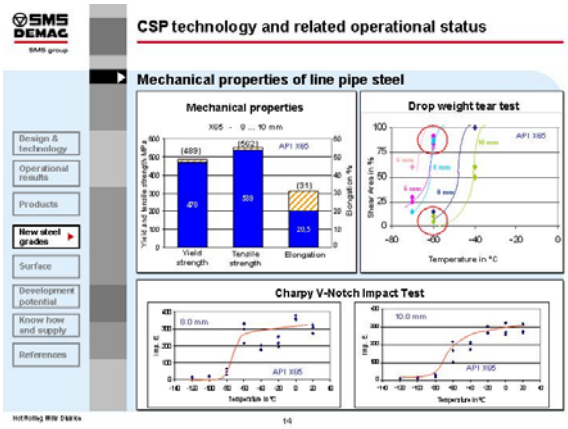


Figure 14. Mechanical properties of line pipe steel.

The CSP process is suited to produce API line pipe grades in the thin and medium thickness range with the required mechanical properties for low-temperature application.
The mechanical properties values reached fulfil and are over the standards.

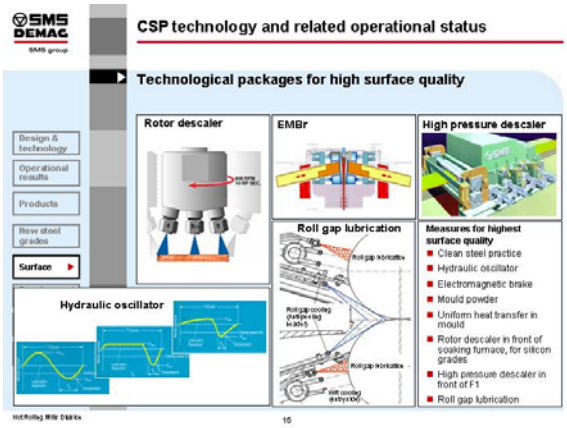


Figure 15. Technological packages for high surface quality.

The surface quality is one of the most important quality parameters in hot strip production. For ensuring this quality in the critical points of the process, proven technologies were developed further. The parameters considered to achieve best surface quality are being adjusted through the whole process from steel making to coiling. The manufacturing of clean steel, the minimisation of oscillation marks, slab descaling as well as roll conditioning facilities for maintaining the work roll surface respectively the strip surface quality are today in operation in CSP plants.

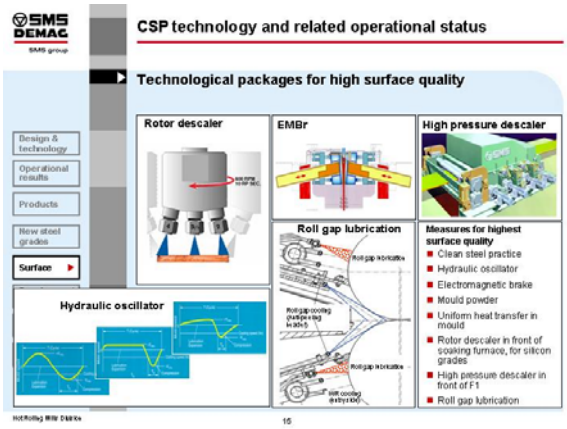


Figure 16. Further potential of the CSP process.

The development of CSP started about 20 years ago. The first plant went into operation 1989.
Until today the CSP technology has gained an established position in hot strip production.
Technological developments have permanently improved the production process, leading higher yields and lower operating costs. The product range is constantly being extended and the product quality improved.
The figure above shows examples for current and future development potential of the CSP technology.

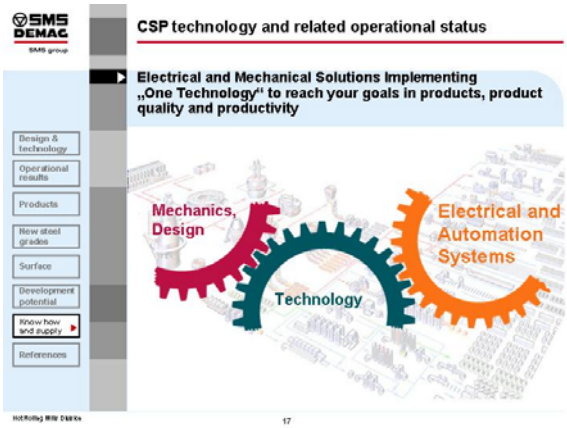


Figure 17. Portfolio SMS Demag.

In order to reach best performance and highest quality of product produced with your plant, of the plant itself it is of essential advantage to combine all competences under one responsibility.
SMS Demag provides all the required know how for engineering, design, manufacturing, erection and commissioning for the process, equipment and electrics & automation. CSP plants where this complete supply out of our hand could be realized show the greatest performance and best product quality results to the full satisfaction of our customers.

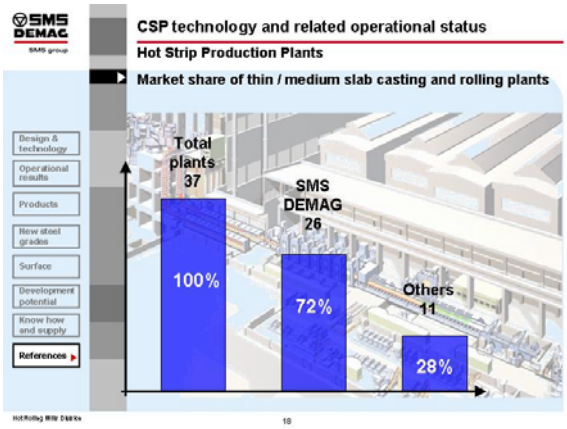


Figure 18. References and Market share.

A total of 36 thin slab rolling plants has been built, and SMS Demag holds a market share of more than 72 %, having sold 26 CSP plants with 42 casting strands. This is ample proof of SMS Demag's clear market leadership. Excluding medium-thick slab rolling plants from this calculation results in an even larger market share for SMS Demag.

TECNOLOGIA DA PRODUÇÃO DE TIRAS COMPACTA E A CORRESPONDENTE SITUAÇÃO OPERACIONAL[1]

Christoph Klein[2]

Resumo

O mercado de tiras à quente está passando por uma fase de grandes mudanças. As espessuras das placas têm sido ajustadas para atingir as dimensões exigidas nas entradas das linhas de laminação, porque velocidades de lingotamento e laminação precisam operar em harmonia para que os processo possa operar com capacidade plena e em dois veios. Além do mais, tecnologias inovadoras como a laminação de tiras finas, novas linhas de laminação a frio e conceitos de processamento de tiras têm sido agregadas aos novos estágios de laminação á quente bem como aos processos subsequentes. Esta combinação trouxe muitos desenvolvimentos tecnológicos nos últimos anos o que resultou em aumento de produtividade e redução de custos. A tecnologia CSP desenvolvida pela SMS Demag e estabelecida no mercado por mais de 15 anos mudou crucialmente a produção de tiras à quente. Levando em consideração as plantas ainda em fase de planejamento e montagem, a tecnologia CSP já atingiu a capacidade de mais de 42,0 mio t/ano. Estes números impressionantes refletem o sucesso da tecnologia CSP.

Palavras-chave: CSP tecnologia; SMS Demag; Laminação de tiras.