Slab caster upgrades and modernisation

With relatively low expenditure for upgrading compared to a new build, it is possible to dramatically improve caster productivity, flexibility and product quality. Modernisation can range from substitution of single components with state-of-the-art technology and automation upgrades to complete caster revamping projects. Three different slab caster modernisation projects are described that show examples of the benefits derived from the installation of the latest technological solutions.

Authors: Gerald Hrazdera, Reinhold Leitner, Oliver Schulz and Peter Juza
Siemens VAI

Siemens VAI, one of the world’s leading suppliers of continuous casting machines, has developed a modular concept of the casting machine featuring technological packages for the critical parts of the caster (see Figure 1). Our revamping expertise ranges from substitution of single components with state-of-the-art technology and automation upgrades to complete caster revamps on various generations of slab casters and from different original suppliers.

Typical objectives of a revamp are an increase in production, improvement of quality, increased flexibility and reduction of turnaround times. This can be achieved with the implementation of one or more of the following:
- Conversion from curved to straight mould for improved product quality at higher casting speed
- Cassette-type mould for reduced turnaround time
- Dynamic mould width adjustment for high flexibility in production
- Hydraulic mould oscillation for improved surface quality and caster reliability
- Segmented strand guidance for short maintenance outages
- Optimised roller geometry for improved internal quality
- Extension of metallurgical length for increased productivity
- Upgrade of cooling system for increased productivity and improved quality
- Dynamic soft reduction for highest product quality

Three slab caster modernisation projects are described that exemplify the benefits of the latest technological solutions.

USIMINAS CUBATÃO
Cosipa, a company within the Usiminas Group, in Cubatão, São Paulo, Brazil, is the largest flat steel
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producer in Latin America. The company produces a wide range of uncoated flat-steel products, including slabs, hot- and cold-rolled sheets and coils, and heavy plates for a wide variety of industrial applications. In order to improve caster performance, operational flexibility and personnel safety, the company assigned Siemens VAI in November 2005 to dismantle and replace the 1989 Concast-built slab caster No. 3.

With the replacement of the one-strand slab caster, Cosipa is now able to cast 1.2Mt/yr of both high-quality carbon and low-alloyed steel grades 210-260mm thick and 1,000-1,900mm wide. The replacement of the slab caster took place simultaneously with the ongoing operation of two adjacent slab casters.

LiquiRob For the first time in a South American steel mill, a LiquiRob robot (see Figure 2) has been installed on the casting platform to automatically perform steel sampling and temperature measurements in the tundish. The automation of these activities during caster operation reduces the presence of persons in the dangerous liquid steel area and thus is an important step towards considerably improving operator safety. Furthermore, LiquiRob ensures reliability, repeatability and the monitoring of operations which have a direct influence on product quality.

Thickness-on-demand The caster was equipped with thickness-on-demand capability to allow fast changes in slab thickness through rapid in-line narrow face exchange and remote adjustment of the roll gap in a very short time during restranding and without loss of production (see Figure 3). This is made possible by the combination of the Smart Mold, Smart Bender and Smart Segment technology packages.

Cosipa now is able to react faster to new orders – a valuable advantage. This new capability also allows the internal customer plate mill to optimise its pass schedule just in time through the selection of optimum casting thickness in order to reduce energy consumption and increase output, eg, through fewer passes.

Additionally, by combining Smart Mold and DynaWidth, the narrow sides can also be laterally shifted to change the strand width during casting. Furthermore, improved internal strand homogeneity for the production of highest quality slabs is made possible with DynaGap Soft Reduction technology in combination with Smart Segments. This is achieved by precisely adjusting the roller taper in the area of final strand solidification according to the Dynacs-calculated set points.

The benefits of the revamped system are:
- Highest operator safety
- Implementation of latest technology for highest flexibility in operation
- Maximum system and plant availability at low maintenance costs
- Assurance of optimised solutions for unique and specialised requirements
- Excellent and professional project management dedicated during the project life

ACRONI D.O.O.
The Slovenian steel producer Acroni d.o.o. specialises in the supply of structural and special steel grades, mainly for niche markets. In 2007, Acroni decided to modernise its
20-year-old Demag slab caster within the shortest possible caster downtime. With the modernised caster, higher product quality, higher capacity and wider slab widths had to be obtained. Maximum flexibility with respect to adjustment of all operational parameters, including the casting thickness, was a major design criteria.

Siemens VAI was selected as the partner for this project on the basis of its extensive experience in the upgrading of continuous casting machines. The responsibilities for this project included the design, manufacture, delivery, supervision of installation, start-up and commissioning of the caster, as well as personnel training. The project scope also involved civil and assembly work, integration of new and existing equipment, and the improvement of the caster workshop area with new maintenance stands. The project was completed in 38 days.

Following modernisation the slab caster is now capable of casting approximately 515,000t/yr of steel comprising medium- to high-carbon, peritectic, structural, micro-alloyed, stainless steel (series 300 and 400) and Si grades. Slabs can be cast 200-250mm thick and 800-2,120mm wide.

During this project, the machine head and strand guiding system were replaced and outfitted with the latest technological packages, systems and equipment to enable wider slabs to be cast, with a significant improvement in quality.

**Machine head** The previous curved mould was replaced with a curved Siemens VAI Smart Mold which, in combination with DynaWidth technology, allows the mould narrow sides to be hydraulically shifted for the flexible casting of strands of different widths. Furthermore, DynaFlex hydraulic oscillation enables not only the frequency but also the stroke to be changed during casting. In addition, the waveform is no longer limited to sinusoidal patterns as it was for the electro-mechanical oscillators – a major positive influencing factor for slab surface quality.

**Strand guide system** The strand guide system consists of nine Smart Segments (see Figure 4), which are installed in the bow, straightening and horizontal zones of the caster. The unique design allows the roller gap settings to be remotely adjusted for fast changes in slab thickness. The combination of Smart Segments with DynaGap Soft Reduction not only allows the soft reduction range to be corrected during casting conditions but provides the possibility of quickly changing the casting thickness by remote control. This precise calculation of the solidification process is of the utmost importance in achieving the best results. The use of a top-feeding dummy bar system also minimises caster downtime. Even in the case of thickness changes, the limiting factor for the restart of the caster is the exchange time for the mould and vertical rack.

**Secondary cooling** With the fully automatic and dynamic Level 2 Dynacs secondary cooling model, the strand temperature profile and the required secondary cooling water quantities can be calculated at any position along the strand as the basis for defining the optimum secondary cooling set points and final point of strand solidification. Part of the project has been the supply and installation of electrics, Level 1 and Level 2 automation systems and working media, hydraulic and lubrication systems.

The benefits achieved were:
- Increase of production capacity by 15%
- Slab width increased by 73%
- Higher flexibility and increased product quality due to technological packages
- Fast plant start-up ramp thanks to ‘connect and cast’ solutions
- Flexible, cost-effective casting of a wide range of products
- Fast project completion and operational availability

**BLUSCOPE STEEL LIMITED**

BlueScope Steel Ltd, in Wollongong, Australia, is an international flat-steel solutions company with a manufacturing and marketing footprint spanning Australia, New Zealand, Asia and North America. The company is a global leader in the provision of high-quality metallic coated and painted steel products for the building and construction sector, and also in the general manufacturing, mining and automotive sectors. In May 2005, BlueScope awarded Siemens VAI a contract for the caster system replacement, called the Kyeema Project. It is integrated with existing upstream (BOS, production scheduling) and downstream (slab yard operation control)
systems. In May 2007, Siemens VAI additionally received the order to install the LevCon package on the three slab casting machines after the package proved successful on an on-site test installation.

The project comprised three slab caster automation systems, one two-strand caster and two one-strand twin casters. The prime objectives of the Kyeema Project were to reduce operational risk caused by the legacy system and to increase production efficiencies.

These objectives were achieved by replacing the existing caster system running on a VAX with a modern standard solution providing the same functions plus additional capabilities to handle increased volumes of data, quality measurements and customer quality requirements.

VAIQ quality control system BlueScope Steel applies numerous and advanced business rules to control the quality of the slabs. This set of rules was implemented on the basis of the Siemens VA IQ software components which determine the production practice per heat, track process parameters and events influencing the resulting quality, and decide about pass or fail of a slab compared to its quality requirements. The requirements were downloaded from a central repository (Specification Management System) and the results were compared to these specifications.

Plant status An online visual representation of what process is currently being performed to a heat, including current status and estimated completion time. This assists in pacing the plant if upstream or downstream delays are experienced. The plant status overview displays dynamic icons and heat information data for each processing station in the steelmaking process.

Intermix calculation This cyclically determines the volume concentration of the heat mixture in the tundish and in the strands and tracks it along the strands together with the related heat numbers. An Intermix model considers whether the tundish was changed or whether a separator plate was inserted.

The chemistry determination module calculates the chemical analysis along the intermix area of the strands. It needs the relevant chemical analysis of the two mixing heats as an input and uses the volume concentration of the mixing heats as determined by the Intermix model.

Tundish tracking The tundish tracking system is an equipment maintenance application responsible for tracking tundish components (zones, cassettes, etc) and usage (cycles). Its main function is to keep track of the events applied to a tundish before, during and after the casting process, and then determine when tundishes and components are due for preventative maintenance. Algorithms are included which support time-based business rules that predict the cooling time for a tundish before work can commence.

LevCon The LevCon package combines state-of-the-art mould level control with additional features that reduce clogging effects, SEN wear and mould level fluctuations that stem from bulging effects.

The benefits achieved were:
- From a self-made solution to a standardised automation solution, which may be easily extended or upgraded
- The same Level 2 software is running on the three different casters, which leads to dramatically reduced maintenance costs
- Comprehensive operator guidance, alarming and process information
- Minimum production downtime for automation upgrade (2–5 days per caster)
- Full automation functionality from the first heat
- Service contract and remote support for additional changes after start-up

CONCLUSIONS Siemens VAI recognised the increasing market potential for revamping projects and, as a consequence, redesigned the principal structure of a casting machine. With the design of technological packages for individual machine areas, it has become possible to develop tailor-made revamping concepts for each client. In addition, exact planning of the revamps ensures shortest outages of the machines and fast ramp-ups after upgrades. Siemens VAI has proved its competence in numerous projects worldwide for all types of slab casters, which has been acknowledged by satisfied customers.

Gerald Hrazdera is Product Manager, Reinhold Leitner is Product Lifecycle Manager, Oliver Schulz is Head of Sales and Peter Juza is Head of Sales, all at Siemens VAI, Linz, Austria.

CONTACT: rainer.schulze@siemens.com