ADAPTING OF EXISTING HOT STRIP MILLS TO PRESENT-DAY MARKET REQUIREMENTS[1]

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Abstracts
This is to present at three examples the scope of work, the targets and the results.
1. Revamp of the HSM Salzgitter/Germany. Scope:Slab Sizing Press, new 4-high roughing mill stand with attached edger, new loopers, shifting and bending systems at the finishing mill, complete L1 + L2. Target: Quality improvement, capability to roll new high demanding steel grades. 2. Revamp of the HSM Meishan/China in two steps Scope Step 1: Heat retention hoods, new descaler; AGC-cylinders F4-F6, shifting/bending F1-F6, new looper, new spindles, new runout roller tables with new laminar cooling, new downcoiler Target Step 1: Increase of produvrion from 1,2 to 1,75 Mio tpa Scope Step 2: new roughing mill with edger, two new descaler, new F0 infront of finishing train, installation of coilbox Target Step 2: Increase of production to 3 Mio tpa. 3. Revamp of the Steckel-Mill Outukumpo Stainless/Finland. Scope: 3 finishing mill stands behind the existing Steckel-mill stand, second downcoiler, L2. Target: Double of production to 1,65 Mio tpa; improve of quality
Key words: Revamp of HSM

ADAPTAÇÃO DE LAMINADORES DE TIRAS A QUENTE EXISTENTES ÀS EXIGÊNCIAS DO MERCADO ATUAL

Resumo
Este trabalho apresenta três exemplos de escopo, metas e resultados obtidos com a reforma em modernização de laminadores de tiras a quente na Salzgitter / Alemanha, Meishan / China e Outokumpo / Finlândia, objetivando o aumento da capacidade de produção, melhoria na qualidade de produtos ou a possibilidade de se laminar novos tipos de aço exigidos pelo mercado.
Palavra-chave: Modernização de laminadores de tiras a quente.

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Adapting existing hot strip mills to present-day market requirements

Given their size and high investment volume, hot strip mills have an extremely long life. Almost 40% of the 140 conventional-type hot strip mills currently in operation all over the world were set up between 1960 and 1970. At that time these mills were designed as fully continuous or three-quarter continuous mills, featuring 5 to 7 roughing stands and producing 3 to 4 million tons. The production of today's mills amounts to 3 to 5.5 million tons per year in semi-continuous operation, using 1 to 2 roughing stands. In addition mechanical equipment, drive systems and process automation systems have since been developed further. Latest-generation hot strip mills with their lower power requirement and higher productivity are able to produce at lower cost, with new technologies resulting in an even better product quality.

SMS Demag-developed flexible concepts allow the modernisation of older hot strip mills such that they meet today's market requirements in exactly the same way as latest-generation mills. This also applies to the rolling of many newly developed materials with the required dimensions.

Market requirements to be met by hot-rolled products

For a number of years the use of innovative material concepts in the automobile industry has risen constantly. IF (interstitial-free) steels, owing to their excellent cold-formability, are able to cope both with extreme deep-drawing as well as tensile stresses in the lower strength range. The strength of multi-phase steels (DR, TRIP, CP) is raised by incorporating soft phases in the microstructure in addition to hard phases. When used for the load-bearing members of motor vehicles, these materials always allow lighter structures. This will save fuel on the one hand while improving passive safety on the other hand.

High-strength materials (for example, S700M) are needed with thin final dimensions in the range of ≤ 2 mm. They are used in components for building-construction and mobile cranes (crane jibs).

The requirement for soft steel grades extends to the range of down to 1 mm and thinner, where they are to replace products which in the past have been cold rolled.

The geometric tolerances are in the range of ¼ to ½ of the relevant EM, ASTM or JIS standards.

Mainly for auto body parts and other body shells, tinplate and rim steels the demands for surface quality are very high.

All these aforementioned requirements are to be met by hot-strip suppliers under high cost pressure, while observing the shortest delivery periods.

Hot-strip mill requirements

For the rolling equipment the following requirements can be derived from the above:

- Raising productivity by increasing yield, availability and cutting down on maintenance
- Improving the product quality by using powerful final control elements, for example, by observing narrow thickness and profile tolerances
- More flexible rolling schedule composition to ensure short delivery periods and economical rolling of smaller lot sizes
- Optimal production conditions while adhering to the aforementioned framework conditions.

Analysis of customer enquiries

Older rolling mills which do not meet or do not fully meet these requirements can be brought to the level of modern mills only through modernisation measures.

Operators use different methods when determining the need for modernisation.

On the basis of relevant analyses, some operators determine which plant components should be replaced, renewed or improved. In such a case, inquiries to the plant builders contain concrete requests for a new roughing stand, a new cropping shear or for the reinforcement of the coiler with clearly specified performance data.

Other operators specify their goals, e.g. increase in production, observance of specified target profiles or the production of certain high-strength grades. They leave it to a plant builder to work out a suitable modernisation concept within the scope of a study.

In each case, it is the task of the plant builder to dimension the new facilities or those to be modernised and to draw up the individual revamping stages.

Studies

Studies for developing modernisation concepts or for analysing weak spots are tailor-made to meet special customer requirements. Together with the analysis of the product spectrum, they examine which plant sections are to be modified or renewed in order to manufacture certain products.

The production analysis provides information on bottlenecks in the mill which impede an increase in production. With the help of FEM analyses, the static and dynamic loading of plant components is examined. In conjunction with measuring data from the plant, dynamic simulations, for example, of drive trains, provide an insight into the behaviour under extreme load conditions and allow conclusions to be drawn about the cause of damage.

The result of such a study specifies which forces, torques and setting ranges are required to meet the targets defined by the customer. Proposals for modernisation measures to be carried out are derived from this.

Concepts

The implementation of modernisation projects requires a high degree of experience in this field and close cooperation with our customers. Consistent project management guarantees the quality of individual components and the observance of the planned deadlines. The structures are designed in such a way that the existing foundations remain unchanged as far as possible. This together with other suitable measures contributes to ensuring that the shutdown times for the installation of new facilities or the revamping of existing facilities are kept as short as possible.

Prior to installing the facilities in the production line, extensive tests are carried out. This ensures that the plant attains the planned production and quality level within the shortest period after revamping.

Mill shutdowns

The shutdown periods during revamping are of particular importance in modernisation projects. So as to avoid surprises during the shutdown periods, the risks are minimised. New facilities are fully assembled and piped in our workshop. All movements are initially powered mechanically and hydraulically. The automation is also frequently tested together with the mechanical equipment already in the workshop and the control parameters are optimised.

Further tests take place in the shadow mode after the components have been assembled parallel to the production line at the customer's works.

Preparatory work during normal maintenance downtimes and the installation of new or the revamping of existing facilities during longer shutdown periods (e.g. summer shutdown) are carried out according to detailed time schedules.

Using the example of some successfully implemented modernisation projects, we wish to point out how old hot strip mills that are 20 to 30 years old can be modified in such a way that they meet present-day market requirements.

Example 1: Meishan hot strip mill in China

The Meishan hot strip mill in China was in production for 21 years in Japan before being dismantled there and rebuilt and put into operation in 1994 in Meishan, which is an approximately five-hour drive north-west of Shanghai. In 2000, SMS Demag received the order to extensively modernise the finishing mill.

The target of increasing production from 1.2 to 1.8 million t had already been met a few months after the recommissioning of the plant. With a daily production of more than 7,000 t, the annual production is way above the two-million-ton limit.

The requested quality improvements were also successfully proved within the scope of the acceptance tests.

After completing the 1st extension phase, SMS Demag received an order in 2004 for revamping the roughing mill.

The aim is to increase production to 3 million t/year and a further increase in quality in terms of improved width tolerances and better rolling stability by avoiding cambering in the transfer bar.

Phase 1 of modernisation of Meishan hot strip mill

During a shutdown period of 37 days (40 days were planned originally), the finishing mill up to the coiler had been fully revamped:

Hydraulic adjustment systems in the last three stands and hydraulic loopers allow for stable strip flow and improved thickness tolerances. CVC^{plus} shifting systems and work roll bending systems in all stands offer sufficient setting range to obtain the specified hot strip profiles from the beginning to the end of each rolling campaign. Good strip flatness always has top priority.

The new laminar strip cooling system in conjunction with a corresponding process model ensures proper setting of the required material properties. With the aid of the two new fully hydraulic coilers with automatic step control, the strips are wound with defined strip tension and in a straight-edged manner.

Phase 2 of modernisation of Meishan hot strip mill

In the second extension phase, the roughing mill is almost fully renewed. The two main shutdown periods last 25 and 30 days respectively. The roughing stands R1 and R4 – R6 and the edgers E4 – E6 are replaced by a reversing rougher with an attached edger. A coil box is installed in place of the existing F0, and a new F0 stand is positioned upstream of the finishing mill.

The results of this measure will be available most probably in summer 2006.

Example 2: Steckel mill Outokumpu in Finland

An example of an extremely unconventional modernisation project is the extension of the Steckel mill Outokumpu in Finland. The customer's aim was to more than double the production of the Steckel mill from 0.8 million t to 1.7 million t.

Modernisation phases and project sequence

This drastic increase in production could only be attained by installing additional finishing stands directly after the exit-side Steckel furnace.

Furthermore, the coiler was replaced by a hydraulic coiler with step control and the laminar cooling section was renewed. In place of the new stands, a roller table bridge was first installed during a two-day shutdown. While production was in progress, the foundations below the roller table bridge were prepared. The stands were fully assembled on a foundation block next to the production line and then moved together with the foundation block into the mill line during a shutdown of 5 ½ days.

Instead of the rolls, the roller table bridges in the stands carried out the transport of the finished strip. During this shutdown, the new coiler was also put into operation and the old coiler removed. The Steckel mill with the new coiler attained the normal production level merely two days after the end of the shutdown period.

Around six months later, after the summer shutdown of 2 weeks, the finishing stands went into operation.

Results

During a transition phase, production took place alternately in Steckel mode and in combination/tandem mode (3/1 pass(es) on the Steckel stand, 1 pass each on the new finishing stands). As early as the second day following the summer shutdown, the entire Outokumpu product range was once again fully covered. Four weeks later was the successful premiere of rolling in combination mode. The portion of production in the Steckel mode decreased continuously by the end of the year.

The availability of the new facilities (mechanical and automation) of > 96% during the first 14 weeks and > 98% during the following 12 weeks which had been contractually agreed upon for the test operation did not fall below these specified values and attained values around 99% after the completion of the optimisation phase.

Today the mill produces almost exclusively in the combination mode. Thicker strips (> 5.5 – 7.5 mm depending on the width) are rolled in the tandem mode. The SMS Demag pass schedule model and the profile, contour and flatness model, which had specially been developed further for this particular configuration, help to calculate the set-up values for the roughing mill, the Steckel stand, the new finishing stands and the coiler. Deviations in thickness at the strip head end of < 120 µm testify to the quality of the Level 2 system.

Example 3: Hot strip mill of SZFG in Germany

The hot strip mill of Salzgitter Flachstahl GmbH in Germany which went into operation in 1963 has been continuously adapted to the increasing market requirements. The most recent modernisation began in 2001 with the installation of a new sizing press. This was followed in 2003 by a new roughing stand with attached edger and the installation of CVC^{plus} and work roll bending system in the finishing stands F2 – F5.

Installation of roughing stand and edger

The installation of the new roughing stand and the new edger constitutes the most exacting part of the modernisation project in terms of logistics. The old components were dismantled, the new ones installed and fully put into operation – all within a shutdown period of merely 18 days.

30 minutes after the end of the shutdown period, the mill started production from the 3rd strip onwards. One week later the mill had attained 80% of its normal production level, thereby surpassing the highly exacting goal.

The roughing stand and the edger were manufactured at the SMS Demag workshop in Germany and then assembled together with all the piping systems. The commissioning team then tested all the main movements of the stand and edger until some controls had been optimised.

After completing the workshop test, the facilities were dismantled, again installed next to the mill line in Salzgitter and once again tested with the final electrical and automation system.
By adapting the stand contour (in the design phase) of the new roughing stand, the foundations remained virtually unchanged after the old stand had been removed. The aligning of the bed plates takes at least 36 hours using the conventional process. Thanks to a special concept, aligning was possible within only 12 hours. The assembled new roughing stand with a weight of approx. 850t was moved on rails from the preassembly area to the final position. The edger reached the final position in the mill line with the help of a special lifting device and the bay cranes.

Commissioning and start of production

All the shutdown activities were timed down to the last minute. After the completion of installation and connection of all utilities and cables, the roughing stand and edger took up production in just about 18 days, seven hours before the contractually agreed deadline.

New automation system
Concurrently with the mechanical revamping of the hot strip mill, SMS Demag replaced the existing automation system. The new modular X-Pact system with its process models based on physical relationships and extremely quick technological control systems is specially tuned to the requirements of the rolling process.

Improved product tolerances

Innovative solutions for optimising the rolling process make a major contribution to the stable rolling of special materials with extreme dimensions. The thicknesses and width tolerances attained speak for themselves.

Improved product tolerances (profile and flatness) by using CVC^{plus} technology

The required strip profiles are kept constant within extremely narrow tolerances from the strip head end to the tail end and from the beginning of a rolling schedule to the end of a rolling schedule. Special strategies for the use of the CVC^{plus} shifting and work roll bending systems ensure that longer phases of a rolling schedule can also be rolled in the same width without any unwanted profile anomalies appearing in the edge area.

Example 4: Hot strip mill 1 Thyssen Krupp Stahl AG in Germany

The findings obtained during the modernisation of the hot strip mill of SZFG with regard to the rolling of camber-free transfer bars have been incorporated into the modernisation of the Hot Strip Mill 1 of Thyssen Krupp Stahl AG in Germany.

Extremely cambered transfer bars frequently result in unstable rolling of these bars in the finishing line. Together with the integrated SMS Demag automation system, the installation of new hydraulic lateral guide systems upstream and downstream of the roughing stand in combination with hydraulic adjustment systems in the roughing stand bring about an improvement which surpasses even optimistic expectations.

Measurement of slab camber

Cambers can form due to thickness wedges in the slab cross-section or asymmetric heating of the slabs. Nevertheless, a straight transfer bar is rolled through suitable interplay betweens lateral guides and hydraulic adjustment.

References

The projects described above are only some examples of a large number of new plants and modernisation projects which SMS Demag has handled in the past years.
In the last 15 years alone, our company can look back on the construction of more than 50 new plants and modernisation projects in more than 50 different hot rolling mills.

References

Since the end of the eighties, many of these projects have been implemented together with the Electrical and Automation Systems Division of our company. Since 1990, process models and basic automation systems for more than 40 hot mills have successfully been built and put into operation.
Our company SMS Demag is keen on maintaining longstanding contacts with its customers. This is effected through regular exchange of information on new developments and, if required, technological support. The setting up of a hotline with remote access to the customer plants is standard practice in conjunction with our automation systems.