RX roller guide technology for long product rolling mills

Balancing stock levels, product delivery times, mill productivity and cost control is not easy, especially in speciality steel long product mills. Morgårdshammar has developed a new rolling concept and the RX roller guide as a 'production system' to optimise these mills by providing greater flexibility, efficiency, quality and safety through a new approach to mill scheduling and the use of an online, remotely controlled roller guide.

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Customer demands for shorter lead times and smaller order quantities leave many hot rolling mills struggling to find an economic balance between making for stock and producing solely to order. Speciality steel long product (bar and rod) rolling mills tend to work best when rolling large tonnages of the same grade and size, meaning mill settings are not changed too regularly. However, while keeping a stock of rolled products decreases customer lead times, it can adversely affect profitability, as binding a lot of capital in stock affects the return on capital employed (ROCE).

One way to increase ROCE is to employ less capital for the same turnover by rolling the same production volume, but with lower stock levels throughout the whole process route. This can be done by rolling smaller batches more frequently. This practice can reduce lead times, but on the negative side, mill set-up time and the scrap rate per tonne produced will increase. This is due to the time needed to accurately set up the mill between size changes.

To respond to this conundrum, Morgårdshammar has developed a new rolling concept and the patented RX roller guide as a 'production system' to optimise long product rolling mills by providing greater flexibility and efficiency.

MILL PLANNING

Planning philosophy, especially in speciality steel rolling mills, is usually determined either by temperature or product dimensions. Although there are a few mills that organise their campaigns by rolling temperature (even with extremely long temperature set-up times), traditionally, dimension is the major determining factor and which prevails when reheat temperature set-up times are significantly longer than dimension set-up times.

A traditional mill rolling sequence is shown in *Figure 1* where, in this example, all 15mm bars are rolled, then the 15.5mm bars and so on. If there is a mix of grades (and hence reheat temperatures) the furnace is progressively altered as illustrated. Reheating temperature differences between products/grades in some speciality mills can be as much as 150°C and it can take up to 40 minutes to ▷

Fig 1 **Traditional rolling schedule**

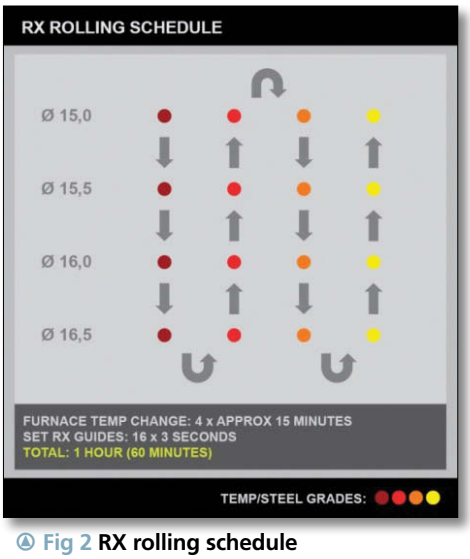

Fig 2 **RX rolling schedule**

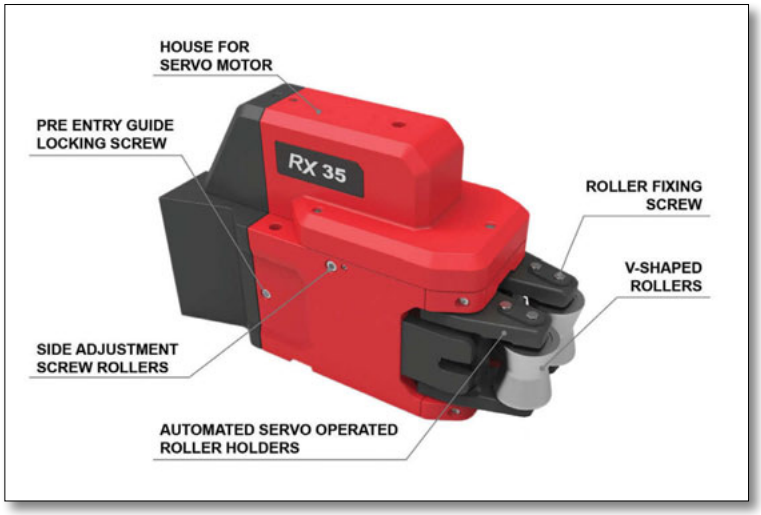

Fig 3 **RX roller guide**

Availability	Performance	Quality
Planned downtime	Minor stops	Production rejects
Breakdowns	Speed loss	Rejects on start-up

Table1 **The six big mill losses**

change furnace temperature. Smaller batch sizes (aiming to minimise stock inventory) mean increased set-up time and lower overall equipment efficiency (OEE). Mill speed loss often also occurs when changing settings, as the normal routine is that a test piece is used to set the dimension in the mill and after measuring the mill needs adjustment.

MORGÅRDSHAMMAR ROLLING CONCEPT

An approach to reducing set-up time in the furnace (assuming pit or other individual furnaces are not used) would be to group products with similar reheating temperature that finish in the same rolling stand. This is illustrated in *Figure 2* where a range of sizes is rolled from a constant temperature, followed by a temperature change and a further range of sizes rolled and so on. Analysis of customer order intake normally reveals that certain customers order specific steel grades in a number of different dimensions, so one way of loading the mill would be to group and organise the rolling schedule according to steel grades instead of dimensions, meaning fewer temperature changes and a 50-80% cut in temperature set-up time.

Furthermore, when rolling/sorting is done by grades, there may be further advantages in the rolled product annealing operations when such grades have common annealing temperatures. Thus, batch annealing furnaces can be charged with a number of different dimensions from the same steel grade, but not the other way around. Dispatch scheduling may also be improved.

Thus, in order to benefit from this approach Morgårdshammar has developed a new roller guide that is moved and adjusted automatically and facilitates rapid product dimension changes and which will reduce the total changeover time (dimension and temperature setup) by up to 30-40%. This applies specifically to speciality steel mills.

GUIDE DEVELOPMENT APPROACH

During the development of the RX guide, an OEE approach was used during the initial analysis phase and ideas were gathered to reduce as many of the six big losses as possible, as identified in *Table 1*.

Other aspects considered when developing the new RX guide series were consistency (operator independence), safety (operator not needing to approach the rolling line with hot material running) and the possibility of building a database with diversified product settings depending both on dimension and steel grade.

THE RX ROLLER GUIDE

The key features of the guide (see *Figure 3*) are that it is an online and automatic roller guide remotely controlled from an HMI located on the mill floor or in the main mill control pulpit. The system consists of quick and robust sensors and motorised roller arms in the guide. The complete control system with drives, PLC and associated database is controlled from the HMI panel. With a traditional roller guide groove change and roller guide, setting changes takes 4 to 5 minutes, whereas the RX guide has roller arm positions that are servo-assisted and dimension set-up change can be done in a matter of seconds. All set-up data are saved in a database and by one simple mouse click all guides can be changed simultaneously.

Stock in a rolling mill varies up to 5% in cross-section area due to temperature wedge and variable tension along the bar. This causes stresses in a normal guide that is position controlled, ie, the roller arms are placed in a fixed position. The RX concept has patented force control of the roller arms whereby the position of the arm follows the shape of the bar, eliminating fatigue stress and excessive wear. Measurements have revealed that shock loads on the roller holder arm forces can be reduced by 60-80%.

The RX guide also gives feedback regarding dimension variations that could come from excessive bar tension in the mill, vibrations due to marks in rollers or rolls out of round. It is also able to give feedback on the actual position of the arms when the stock is engaged and provide a dimension measurement. Finally, it detects and gives a warning if the size of the incoming stock is wrong such as from excessive roll wear in the previous stand.

For a rest-bar mounted roller guide, the rest-bar can also be automatically positioned by means of another servo. Where the guide is mounted on a pedestal and the stand is shiftable, the same principal applies, but here the stand is shifted instead.

By using this principal, the overall guide dimensions have been reduced compared to previous guide series and fit almost any mill. The RX series has been developed to fit roughing, intermediate and finishing stands of continuous mills and can be used as one guide per stand or in multiples for slitting processes. The product range and applications are shown in *Table 2*.

RESULTS

The new roller guide has been test run with positive results in two mills, one rolling ball bearing steel grades and one rolling high-speed steels.

Quality By saving the mill set-up data from the operator panel (see *Figure 4*) in a database, the setting of the first billet in the mill can be as optimal as possible for every start-up, leading to a reduction of up to 60% in start-up rejects. This is particularly beneficial for older mill control systems (>10 years) which often do not have enough data storage space for a large number of different recipes, so placing too much emphasis on operators having to remember too many settings. By using both long-time and short-time adaption routines when setting up the rolling mill, quality can be vastly improved. Further fine-tuning of the Morgårdshammar Wicon software that is used for mill set-up calculations can be made by identifying mill-specific spread coefficients with an integrated logic in the RX control system. Further descriptions of this is available via the Morgårdshammar website in Wicon **[1]**.

Safety With the new RX concept, mill settings are altered from the HMI, which can be moved to a safe location away from the stock. This is of great benefit in terms of safety as the operator does not need to enter the rolling mill during rolling and the gaps on the roller guides can be monitored on a screen instead.

CONCLUSIONS

- Morgårdshammar has developed the intelligent RX series of roller guides for long product rolling mills.
- Product size changes can be achieved in seconds at the click of a mouse rather than minutes with traditional guides. This improves mill productivity and reduces rejects.
- Such a significant reduction in set-up time enables speciality product mills (which have a significant reheating temperature range) to roll according to temperature, rather than the traditional dimension approach. This can significantly improve OEE and hence reduce stocks and also improve delivery performance and ROCE.
- Dependence on unique operator skills is minimised and plant flexibility is maximised.
- The system is adaptable to all long product rolling mills, but will be especially useful for those that have small campaigns and relatively many set-ups.
- Safety for operators is vastly improved as they do not need to enter the mill area to adjust roller guides. MS

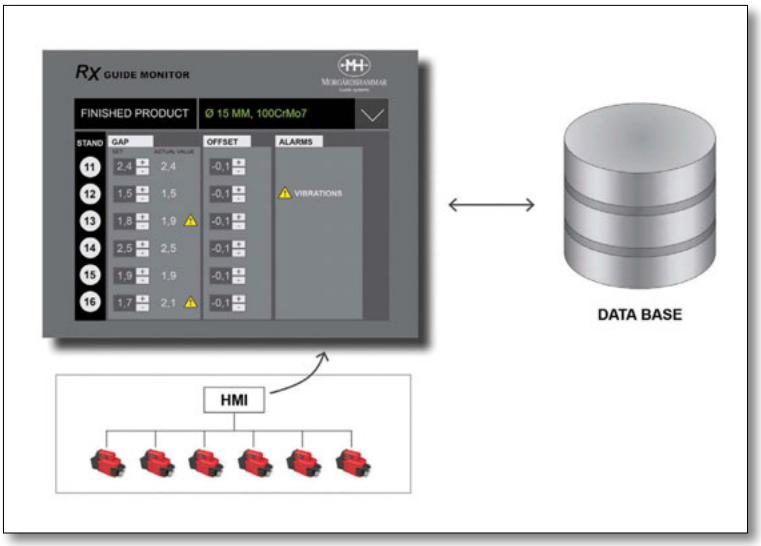

Fig 4 **Example operator panel linked to database**

Guide	For finishing rounds min/ max diameter [mm]	Roller height [mm]	Roller diameter min/ max [mm]
RX 185	120/200	250	150/230
RX 125	85/140	200	120/180
RX 85	55/90	150	80/130
RX 60	35/65	110	60/100
RX 35	25/40	65	50/70
RX 25	8/30	45	45/65
RX 15	6/20	30	40/55

Table 2 **RX product range**

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REFERENCES

[1] www.wicon.se