A KOCKS RSB 3-ROLL BLOCK PERFORMS AS A COMPACT ROUGHING MILL *

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Abstract
While most of the Kocks 3-roll mills are installed as finishing blocks in the rolling mill, there is an increasing amount of producers that also trust in the 3-roll technology, when installed as pre-finishing or roughing mill. The very compact and modular design allows an implementation in a very tight space.

Especially in existing rolling mills space is very limited. Still being able to add additional reduction capacities grant some very crucial advantages. Bigger billet sizes can be used, or a different, more flexible distribution of the reduction in the stands is feasible.Which in consequence is a key factor in order to optimize the quality of the finished product.

As a result, the productivity of the plant can be increased, and the rolling process can be optimized. New, more difficult to roll material grades, can be added to the product portfolio. All of this without major changes of the layout of the rolling mill.

This paper describes the application and the unique advantages of the Kocks 3-roll technology, when used as a roughing block..

Keywords:3-roll block, SBQ Products, Rolling Mills.

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1 INTRODUCTION

Being able to produce more effectively, more cost efficiently, while at the same time increasing the product quality is a development, with which all the steel producers are confronted nowadays.
For the SBQ rolling mills this means that higher value added products need to be produced, which, without any exception, comply with the high market demands regarding mechanical properties, surface conditions and dimensional tolerance limitations. All of this with the additional goal to increase the overall production, while having constantly varying and smaller lot sizes in the process.

For existing rolling mills, these high requirements are big challenges, which are oftentimes not possible to be realized without major investments for the necessary modifications in the mill line.

The Kocks 3-roll mills have proven to be a technology with which all of the before mentioned requirements can be fulfilled. The modular and very compact design of the rolling blocks allow an implementation in very tight spaces, therefore bigger modifications in the rolling mill are not necessary.

Mostly known is the Kocks 3-roll technology in the SBQ market as a finishing block before the cooling bed or the Bar-in-Coil line.

Features, like the unique stand design with 3-roll passes, the fast stand change, the remote adjustment, the Size Control System (SCS®) have made this technology the market leader for SBQ finishing mills. The advantages in terms of product quality and mill productivity have been described and discussed in several publications.

The use of the Kocks 3-roll technology however is not limited to the application as a finishing mill. The installation of a Kocks 3-roll block as a roughing mill also has some very significant advantages.

2 Application as Roughing Mill

Improved Quality by Optimized Reduction Distribution in the Mill
One of the most important factors influencing the quality of the finished product is the reduction distribution in the rolling mill.
While producers of structural steel generally have a considerably high reduction in the rolling stands of up to 27 – 28%, special steel producers aim for an average reduction of 17,5 - 21,0%,. This value always depends on the customer's rolling philosophy and is a compromise between:

- Aiming for high reductions, in order to reduce or even eliminate the core segregation of the alloy elements and impurities of the casted product.
- Aiming for lower reductions, in order to perfectly control the rolling process in terms of temperature and spreading, which influence the size accuracy.

Some particular groups of special steels (ferritic stainless, ledeburitic tool steels, etc.) require soft reduction rates along the rolling process since these grades, because of the specific chemical composition, are very prone to high spread during deformation. In order to control and contain the spread, the reduction ratio has to be reduced accordingly.

In consequence, if an existing rolling mill want to improve the quality of their special steel grades, or want to roll new, critical, but very profitable material grades, new reduction capabilities to soften the overall reduction in the mill line have proven to be a successful approach.

A Kocks 3-roll bock is a suitable rougher in these situations and has some very unique advantages.

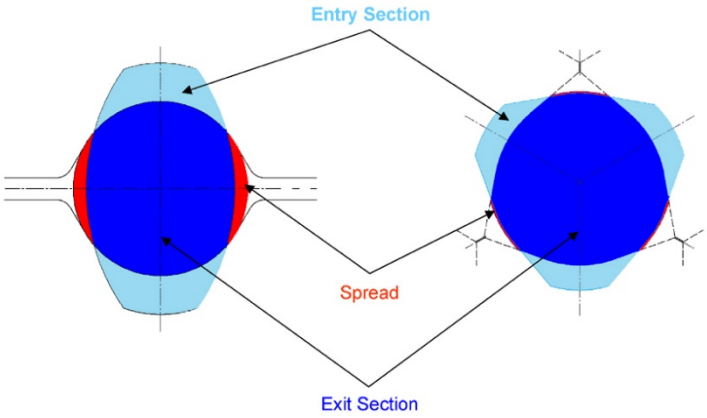
Kocks 3-roll passes

While the reducing block with stands with 3 rolls benefits from all of the advantages, which make the 3-roll finishing mill so popular in the SBQ industry, one advantage that should be pointed out in more detail is the unique deformation process.

A stand with three rolls arranged at an angle of 120° to each other uses a different calibration design, and consequently a different deformation process than the use of stands with two rolls. Figure 1 shows the comparison of a 2 high and a 3-roll pass with 20 % reduction.

When the rolled bar is compressed by the rolls, a deformation occurs into the direction of the least resistance. A longitudinal flow, called “elongation”, and also a lateral flow, called “spread”, are the result.

The superior “covering” of the circumference of the bar with the 3-roll passes lead to a drastically reduced spreading behavior.



(Fig. 1: Comparison of 2-high and 3-roll pass design)

Another point are different roll diameters for the two systems. 2 high systems usually use bigger rolls than the 3-roll systems. Bigger rolls mean bigger contact area between rolls and rolled material. The result is also more spreading in case of the 2 high rolling process.

The result of less spreading of the 3-roll systems is less energy is wasted for objectionable heating up of the material, which is important to avoid, when applying

for example thermo-mechanical rolling process or when rolling sophisticated material grades.

Additionally, as mentioned before, the reduced spreading and heating up of the material allow a much better control of the complete rolling process. The result is a much better size accuracy of the feeders for the downstream rolling stands, and consequently finished products with increased finished accuracies.

Footprint

With a stand spacing of less than 1 meter, a Kocks Reducing Block with 4 stand positions can be installed in an available space of less than 5 meters total. Depending on the rolling parameters like temperature, dimension and material grade, this means that within 5 meters a total reduction of up to nearly 60% can be achieved. It goes without saying that the amount of stands in the Reducing Block can be increased in order to achieve an even higher reduction.

The possibility to fit in into very tight spaces is obviously a tremendous advantage, if there is a need to add additional reduction capabilities into an existing rolling mill, in order to optimize the overall rolling performance.

For the installation of the Kocks 3-roll system this means that apart from the investment into the new reducing block, usually no big additional investments are required due to:

- The possibility to refrain from using a central oil lubrication system. Instead, an integrated lubrication is used for the drive system which saves:
  - Investment costs for central oil lubrication and tank system
  - Piping works and costly modifications on the existing piping system
  - Space for the oil and tank system and the piping
  - Mill shutdown time during the erection and commissioning of the block
- No need to re-arrange of the existing equipment. The removal of the roller table often times is enough in order to create enough space for the new block. This also saves:
  - Disassembly and Re-assembly time for the existing equipment which in fact is mill-shutdown time and therefore a loss of production time.
  - Foundations works for the existing equipment at the new location

Bigger Billets &Productivity

One of the most important factors, if not the most important one, when discussing and judging over an investment is the return on investment (ROI). Increased quality and producing value added products are of course big pros, but these factors are not always easy to quantify in terms of ROI. One easy to measure factor in this regard is the production of the rolling mill in tonnage, and the increase thereof.

By implementing a Kocks 3-roll Reducing Block and adding additional reducing capabilities, bigger starting billets can be used which directly influences the productivity.
For example, if a steel producer operates the rolling mill with round billets of dia. 120,0 mm for very sensitive material grades. And after the installation of the Kocks Reducing Block, this customer would be able to roll the exact same material grades

with achieving a higher quality. But also this customer will be able to increase the billet size to 140,0 mm or even 160,0 mm.

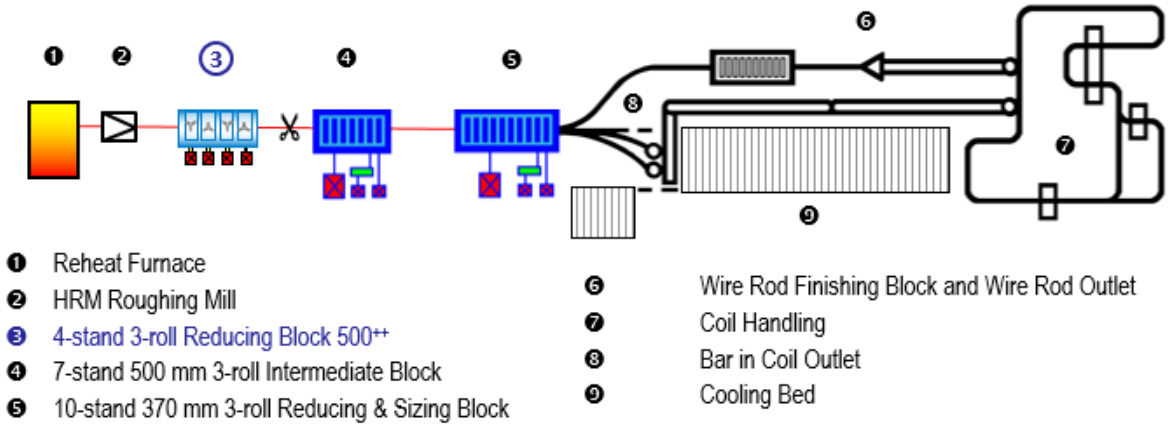
Assuming the customer uses billets of a length of 6,5 m and is rolling the finished size of dia. 20,0 mm with a rolling speed of 20 m/s. Then an increase of the billet diameter from 120,0 mm to 140,0 mm would mean an increase of (theoretical) productivity from initially 116 t/h to 125,3 t/h.
If the billet diameter is even increased to 160,0 mm, the productivity would be at 131,9 t/h. Compared to the small billet this is a production increase of 13,7%.

If the rolling mill has a total average of 6500 operating hours per year, the production would be increased in this case by 103.000 tons. Despite the fact, that in reality, due to yield effects, the produced tons would be below this number, it should be worth mentioning that due to bigger billets, also the overall yield rate would also be increased due to less front and tail cuts during the rolling process.

3 End User Experiences

The just mentioned calculation example is not randomly taken, but can be attributed to WalsinLihwa. WalsinLihwa is a leading manufacturer of specialty steel from Taiwan, and operates their wire rod and bar mill in Tainan, which specializes in the production of stainless steel.

The first deformation step of the billets in Walsin's rolling mill is the High Reduction Mill (HRM). The HRM is a planetary rolling mill, using a cross-rolling deformation process, which is unique, compared to the longitudinal deformation of regular 2-high stands.



(Fig. 2: Schematic Layout of WalsinLihwa after the modernization project)

The HRM produced round bars of the size of dia. 85 mm with ingoing round billets of the dimensions from dia. 120 mm up to dia. 180 mm, depending on the material grades. For critical material grades, like ferrtitic stainless steel grades (eg.430) or grades 308, 309 (welding grade), smaller billets were used to reduce the reduction in the roughing mill. The task to roll such material grades, with reliable flawless results,

is a challenging one. Walsin's way of using a planetary rolling mill instead of conventional 2-high stands does not make this task easier.

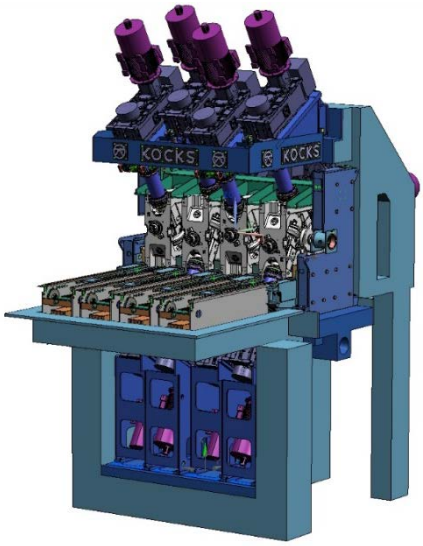
After the HRM two 3-roll blocks are installed as intermediate and as finishing mill, followed by combined wire rod and bar outlets.

After detailed studies fromWalsinLihwa and Kocks, Walsin decided in early 2017 to place an order for an additional 3-roll roughing mill which would be located between the HRM and the first 3-roll intermediate mill.

First Results

After a successful erection in the very limitedavailable area (less than 5 meters for the new block with 4 stand positions), the block was producing the first bars in mid-April 2018.
In total only little more than two weeks of mill shutdown time was required for the erection and commissioning period. And after 4 trial bars, the rolling mill started production with the new roughing mill in operation.

With the additional Kocks mill in operation, the reduction in the HRM could drastically be reduced. Instead of producing round diameters of 85 mm, now the HRM outgoing size is 130,0 mm. The remaining reduction from dia. 130.0 mm down to dia. 85,0 mm is made in the new Kocks 3-roll roughing mill.



(Fig. 3: 3-roll Roughing Block)

Due to the drastically reduced reduction in the HRM, the quality of the finished product increased already with the first bar rolled. Favorable mechanical properties, and increased surface qualities were identified - throughout the complete production schedule - for all sizes and material grades. Rolling the mentioned challenging material grades reliably with a superb product quality is one of the big benefits of this project.

WalsinLihwa also has the possibility to further decrease the minimum sizes rolled after the roughing train (HRM & new RB 500++) down to sizes of dia. 75,0 mm (feeder of 120,0 mm). This allows enables a modified, smoother reduction in the intermediate mill, consequently a different rolling setup. The existing intermediate mill has a lower load, and less maintenance is required. Depending on material grades and sizes, the alternate setup results in even more favorable product qualities.

A boost in production could also directly be noticed after the completion of the project. WalsinLihwa now produces with bigger billets, leading to an increased production of additionally 50 tons per day on average.

Another advantage that was noticeable after the revamp, is the reduced roll wear in the HRM due to the lower reductions, which increase the rolling time until a roll change is required. Due to the fact that the roll change time in the HRM is substantially higher than in the Kocks 3-roll mill, this also results in a higher mill availability.

In this regard it should be mentioned that the new setup of the rolling mill is only in operation since a few weeks. WalsinLihwa continues to study and try out bigger billets for the different material grades. The customer therefore expects significant further boosts in production in the upcoming future.

4 CONCLUSION

The Kocks 3-roll concept is a state-of-the-art technology for SBQ rolling mills. Not only as finishing block, but also as a roughing mill, unique advantages can be achieved.

In the past, this roughing mill concept was already installed several times in special steel rolling mills. And also the newest results from WalsinLihwa in Taiwan show that benefits are and will be obtained directly after the installation.

Especially in existing rolling mills with limited space for additional reduction capabilities, an installation of this very compact block allows much more flexibility. Bigger billets can be used, which increases the production output, and different reduction setups can be chosen to optimize the product quality.

Bibliography

Dr. W.J. Ammerling, S.A. Filippini, S. Schwarz: The new RSB Generation – Innovative Design and Process Features of the RSB SCS®; presented at SEAISI Conference 2015, Manila, 25. – 28.05.2015.

M. Kruse: Know-How for Tomorrow – Innovative Solutions for Future-oriented Long Product Mills, presented at XXIII Colloquium on Metal Forming, 2014.

S. Schwarz: Perfect SBQ Production with Optimized Machinery Design and Processes; presented at SAC, Shanghai, 21. – 23.10.2016.