BIGGEST 5.0 REDUCING & SIZING BLOCK (RSB®) IN EUROPE

BY

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While numerous RSB®'s have been installed in recent years in countries with a strong automotive industry such as Japan and the US, the newest KOCKS 3-roll block in 5.0 design is the first of its kind in Europe.

Customers are worldwide forced to continuously meet changing requirements in the SBQ market, while keeping the production costs low and productivity high.

An excellent example of dealing with the a.m. challenges is one of the leading SBQ producers in Europe, Sidenor Basauri / Spain. They substantially modernized its straight bar SBQ mill in order to strengthen competitiveness in the market, to carry out a substantial project. The goal is to develop new high added-value products based on a commitment to the highest standards concerning tolerances and surface quality.

This paper describes this revamping project in Spain and the results with focus on the KOCKS 3-roll Reducing and Sizing Block (RSB®) of the latest generation. With most modern automation systems like the Size Control System (SCS®), fully automated adjustments of setup parameters are possible in the RSB®, assuring consistently good product tolerances. The product size range of the bar mill was substantially increased as well as the overall production capacity. At the same time the flexibility of the rolling mill line improved while the rolling process itself was simplified significantly.

Keywords: 3-roll block, SBQ Products, Long Product Rolling Mills, RSB®, Modernization

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1. Introduction

Sidenor Aceros Especiales S.L. (Sidenor) is the biggest special steel producer in Spain and one of the largest in Europe.

In 2017 Sidenor started a major modernization of their Special Bar Quality (SBQ) Mill in the Basauri Plant which was divided in two phases. First phase was the replacement of the existing reheating furnace (RHF) in combination of replacing the 3-high / trio reversing mill by a continuous H/V rolling mill. The second phase was a new 3-roll Kocks Reducing and Sizing Block (RSB®) followed by a new cooling bed, abrasive shears and a completely new finishing area.

The installed RSB® is the 5th generation (RSB® 5.0) of Reducing and/or Sizing Blocks, incorporating over 75 years of experience and developments in the field of 3-roll technology. With the RSB® size 435 it is also the biggest and first of its kind in Europe.

This paper describes the modernization project of Sidenor with a focus on the RSB® 5.0. Features of the RSB® are explained and the results and benefits are portrayed. This includes the Size Control System (SCS®), Free-Size-Rolling and 1-Pass-Family design.

The results are an increase of the product size range of the bar mill as well as the overall production capacity. By substantially simplifying the rolling process, the flexibility of the rolling mill line was improved significantly. Consequently also the operation process in the reheating furnace could be optimized to reduce energy (and CO_2) consumption and go a further step towards carbon neutrality.

2. The Modernization of the Sidenor Basauri SBQ Mill

Sidenor has approximately 1.800 employees and eight production plants throughout Spain, in the Basque Country, Cantabria and Catalonia. The steel production capacity is around one million tons per year, destined mainly for the manufacture of components for the automotive, machinery and capital equipment, shipbuilding, defense, energy, mining and petrochemical sectors.

The SBQ Rolling Mill is located in the Basauri plant same as the General Offices, which is located near Bilbao / Spain in the Basque Country.

The rolling mill was commissioned in 1972 and underwent several modernizations throughout the years. The latest major modernization project started in 2017. The main targets were to improve the product and process quality as well as to increase the product size range.

2.1 Before the Modernization

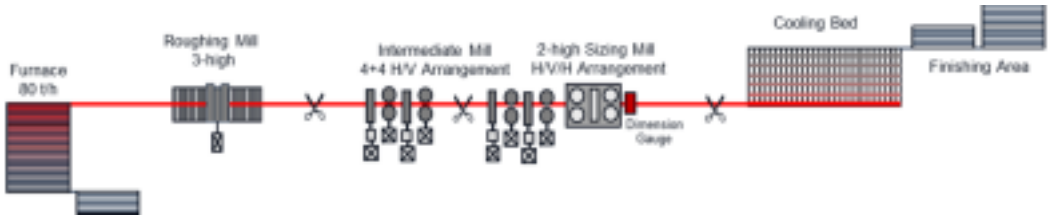


Fig. 1: Schematic Layout of Sidenor Basauri before the Modernization Project

Before the modernization project, the bar mill was operated with a walking hearth reheating furnace capacity of 80 tons per hour (tph), followed by a 3-high reversing mill. The intermediate mill consisted of 8 H/V stands followed by a 2-high sizing mill with three stand positions (VRM).

2.2 Phase 1 of the Modernization

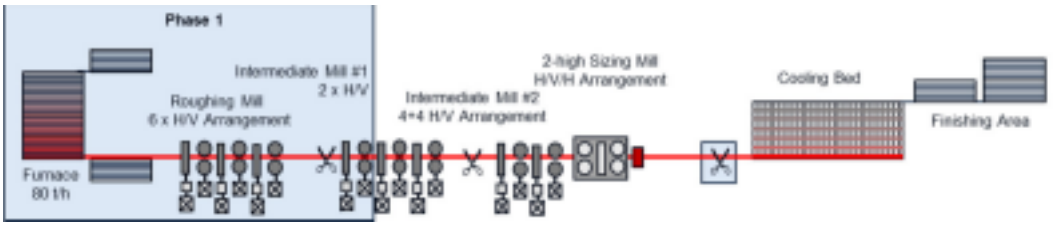


Fig. 2: Schematic Layout of Sidenor Basauri after Phase 1 of the Modernization

In the first phase of the modernization project, which started in 2017, the existing walking hearth furnace was replaced by a new walking beam furnace with identical capacity but was already considered to be increased in capacity in the future.

The 3-high reversing mill was replaced by a 6-stand continuous roughing mill with compact stands (CS stands) in H/V arrangement. Two additional compact H/V stands were added after the roughing mill as well as two new shears. One is placed after stand #6 and the other shear was the cooling bed shear which will be able to cut the cross sections with higher speeds as well as the larger cross sections.

2.3 Phase 2 of the modernization

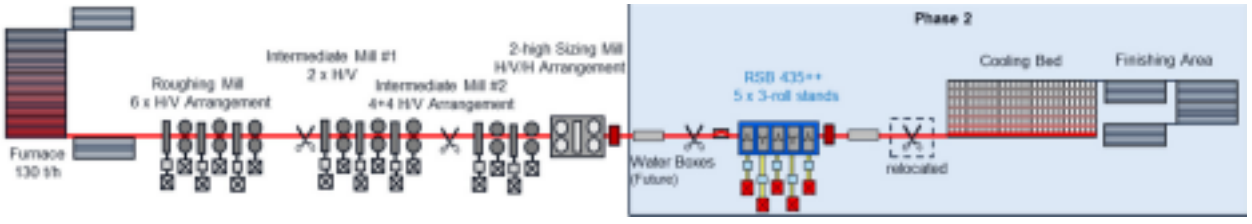


Fig. 3: Current Layout of Sidenor Basauri (after Phase 2)

Already during the second phase of the modernization, the furnace capacity was extended to 130 tons per hour.

Furthermore, all equipment downstream the existing 2-high sizing mill was replaced and modernized. This included a Kocks Reducing & Sizing Block (RSB®), which was installed downstream of the current 2-high sizing system, a new cooling bed, two new abrasive saws and major overhauling of the existing abrasive saw and finally a completely new finishing area. Furthermore a new storage area and new heat treatment furnaces were installed. This all came along with an upgrade of the existing Level 2 system.

3. Design Features of the Kocks RSB®

One of the highlights of this modernization project was the implementation of the RSB® 435++ with 5 stand positions as new finishing sizing mill.

Fig. 4: RSB® 435++/5 in Sidenor Basauri

With its first installation in 1954, the Kocks 3-roll technology went through a steady evolution, always following the market requirements. Up to 2022 in total over 125 RSB®s have been installed worldwide with currently the 5th Generation prevailing for SBQ production. After installations in Japan and USA the RSB® 435++ installed at Sidenor is the largest one in the 5.0 portfolio in Europe being able to produce all finished sizes from Ø 20 – 120 (130) mm.

The new generation of Kocks 3-roll Reducing & Sizing Blocks is furthermore characterized by the following design features.

3.1 3-roll Stands

The trademark of Kocks rolling mill blocks are the 3-roll stands. Since the first developments in the 1950's, Kocks has steadily improved them and until today has manufactured over 8000 3-roll stands for customers worldwide. All of which were, and will be manufactured in Germany.

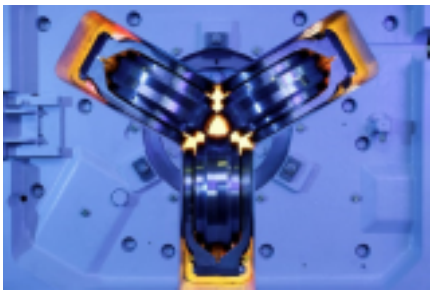


Fig. 5: RSB® 3-roll stand

The 3-roll stands consist of a solid one-piece single casted housing to withstand the highest possible roll separating forces, while keeping stand size

and roll ring as small as possible. Together with the mechanical adjustment included in every stand, this allows for the best tolerances and also flexibility in the rolling mill (as described below in Chapter 4).

3.2 Modular Drive Concept

The drive concept of the RSB® 5.0 is designed with the goal to have the smallest possible footprint, while still being able to transmit the highest possible rolling torques and forces. Each stand position has an individual drive train, allowing fully flexible adjustments in terms of reduction and motor speed respectively rpm (i.e. tension).

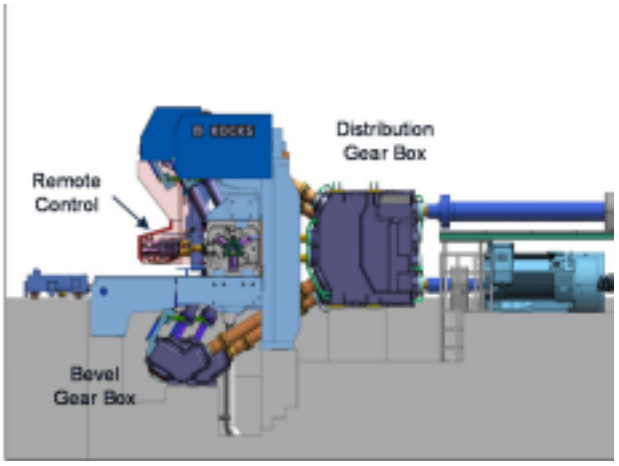


Fig. 6: Drive train RSB® 5.0

This modular drive concept together with the stands, which are available in several RSB® Block sizes, allow a tailor made solution for every rolling mill setup. For Sidenor this means to have five (5) stand positions with a maximum reduction in cross section of over 60% within 6 meters of longitudinal distance.

3.3 Remote Control & SCS®

The remote control allows individual adjustments for every stand and roller guide by means of servo-motors, which are situated inside of the safety cover of the RSB® (see Fig. 6). The coupling of the remote control drives occurs automatically when the safety cover is closed.

Adjustments can be done either from the pulpit (automatically) within a billet gap of five seconds, or even manually in the mill line. The remote control is ensuring immediate wear compensation if necessary assuring flawless tolerances of each bar.

Additionally the Size Control System (SCS®) was also implemented in the Sidenor SBQ mill. This closed loop system adjusts fully automatically and in real-time the setup parameters of the RSB®.

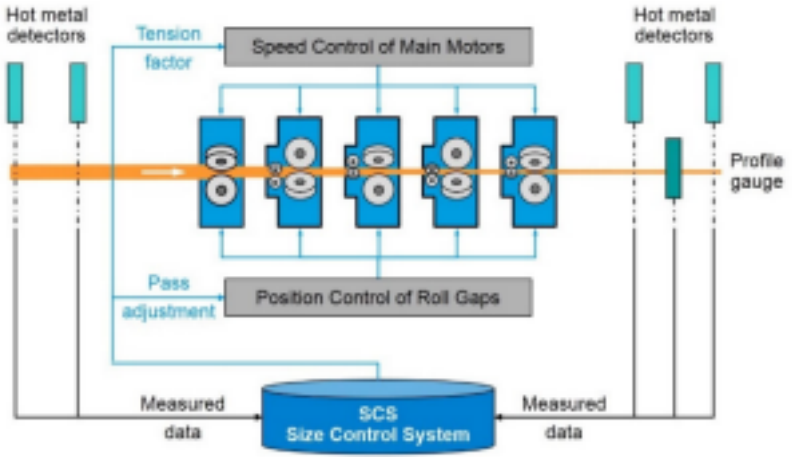


Fig. 7: Overview of SCS®

Based on the measured profile deviations of the finished round, SCS® creates a correction which can influence the speed control of the main motors or the position control of the roll gaps in the 3-roll stands.

The speed control automatically adjusts the main motor RPM, influencing the tension factor between the stands.
The position control adjusts the pass sizes in the billet gap by means of the fast remote control. Both control systems assure an immediate reaction to differences in cross section dimensions.

The optimized operating parameters both for the speed control as well as for the position control are saved and can be analyzed and re-used, ensuring a long-term improvement of the rolling process and product quality.

The SCS® ensures an immediate compensation of roll wear and an optimal tolerance level at all times. Additionally these optimized setup values are saved and can be analyzed and re-used, ensuring a long-term improvement of the product quality.

4. Benefits and User Experience

4.1 3-roll Passes

In comparison with their previous 2-high sizing mill, Sidenor is now operating their special bar mill with a 3-roll Kocks RSB®. One main advantage of the 3-roll technology is the different deformation process and consequently its influence on the spreading behavior.

Figure 8 shows a schematic comparison of spread depending on reduction in 2-high versus

3-roll passes. As can be seen, the deformation efficiency in the 3-roll pass is much higher than in the 2-high pass. Thus with the 3-roll passes the deformation capacity will be converted more into elongation rather than spread by means of roll forces acting from three sides concentric onto the bar. As less spread occurs during rolling, less energy will be wasted for undesirable deformation and converted into heat that could affect the material. This is particularly critical in temperature controlled rolling processes.

The more the spread behavior of a material is controlled, the better the results will be with

Fig. 8: Comparison of spread depending on reduction ratio for 2-high and 3-roll passes

regards to the tolerances that can be achieved. The spread behavior is different for each material and it also depends on:

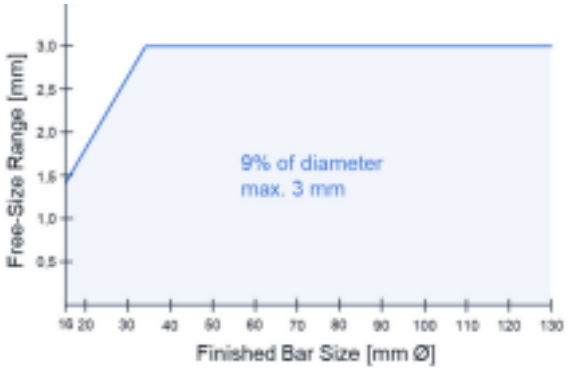
- the rolling temperature (temperature distribution of the bar head-to-tail and/or bar-to-bar)
- tension between stands

- cross sectional variations (heavy ends) entering the stands.

The Kocks 3-roll technology assures a significantly reduced influence of the spread and is, therefore, able to minimize also the influences of all of the above mentioned effects leading to an excellent, more consistent and repeatable product tolerance. In addition, thanks to the homogeneous deformation of the 3-roll pass across the section of the product, very homogeneous structural properties with regard to grain sizes will be achieved.

4.2 Free-Size-Rolling

Another significant advantage of the Kocks 3-roll stands is the capability of using a wide "free-size" range as opposed to the 2-high stands. By using a certain 3-roll pass geometry, an unlimited number of finishing diameters can be produced within the free size range of 9% of the finished diameter or maximum 3mm out of the same entry section just by adjusting the roll gap. The “free-size” ranges depending on the finished bar diameter range are shown in Fig. 3.



This possibility of using a large “free-size” range enables Sidenor to re-arrange and optimize their production schedule based on maximum flexibility.

Before the revamp, the production

schedule was sorted by finished diameter (see Fig. 10). For each production cycle first the smallest diameters were rolled followed by steadily larger sizes. As special steel producer with relatively small production lots with many different material grades, many of them requiring different furnace temperatures (between 1100°C and 1280°C), this led to a big amount of empty strokes in the reheating furnace.

With the possibility to finish sizes up to 3 mm within one "free-see" range without needing to change physically anything in the upstream rolling mill (except for the setup parameters such as speeds), customers are now sorting the production according to the respective heating group of the material grade.

Fig. 9: "Free-size" ranges of a RSB® 435++

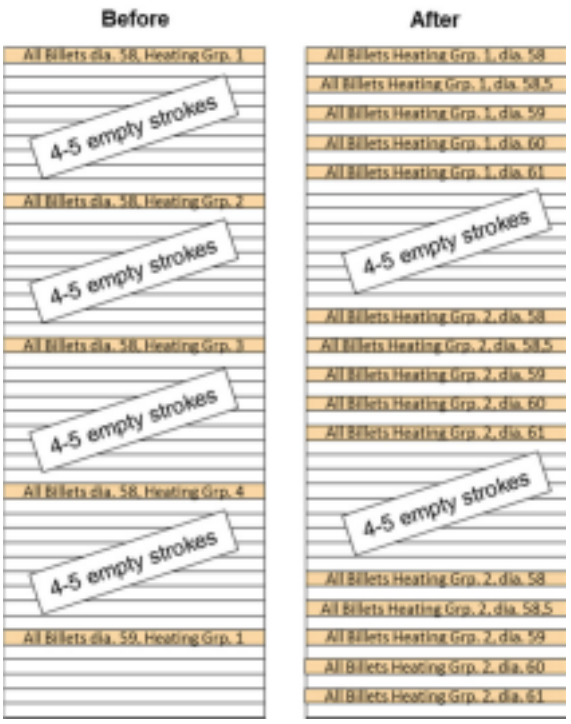


Fig. 10: Schematic furnace occupation for one free-size range (58 – 61 mm) before the revamp and after

This means for each "free-size" range, the billets in the reheating furnace are sorted according to their soaking temperature.

The result is a much more efficient furnace operation. Energy consumption is minimized while the productivity is maximized, due to a significantly higher billet allocation in the reheating furnace.

Additionally the furnace operation is more stable with less temperature variation, which is especially important for critical grades, like stainless steel. Consequently, after the revamp Sidenor could reduce the amount of trial billets by more than 50%.

4.3 One-Pass-Family

The introduction of "free-size"-rolling combined with the fast stand changing system of the Kocks RSB®, which can be performed within max. 3 minutes, the pass schedule of the bar mill could be simplified and optimized tremendously.

For Sidenor this meant one- (single) pass family, meaning all H/V stands in the roughing and intermediate mill have only one single pass/groove geometry. Changes in the passes, either by changing the stands or adjusting the roll gap, are not required

anymore. Instead all the required changes are made by the highly flexible RSB®.

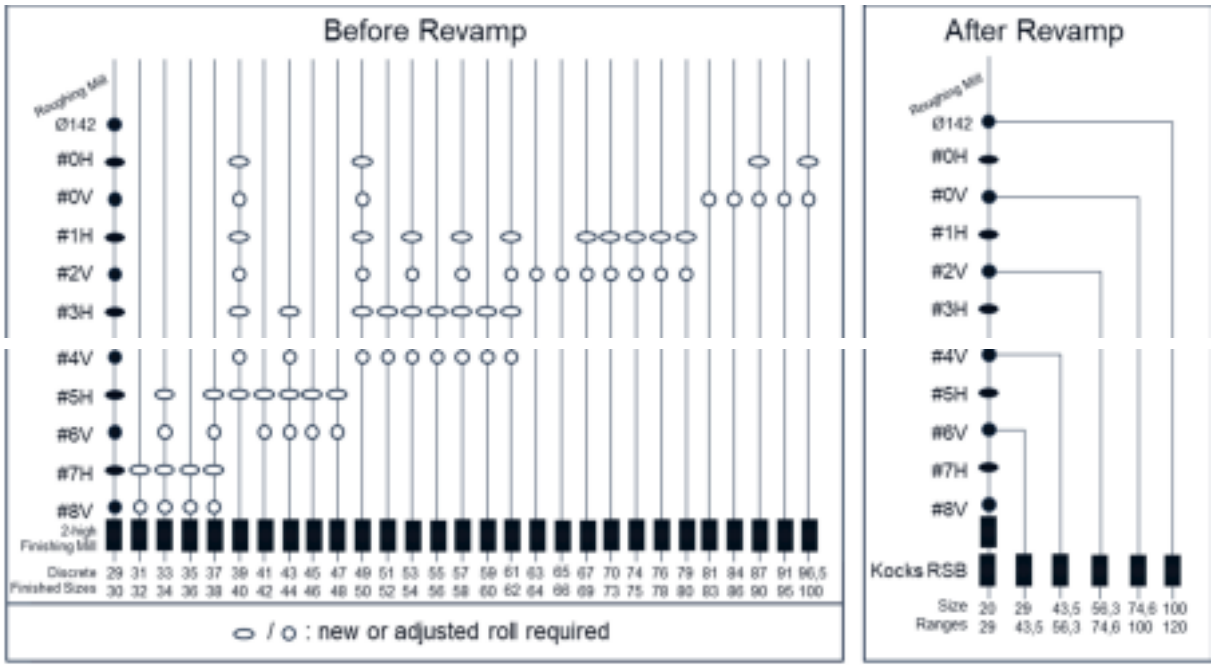


Fig. 11: Schematic Pass Schedules for the intermediate mill before and after the revamp

Whereas in the original mill concept 29 individual pass setups were required, with the RSB only six setups for the upstream mill are required. Four setups in comparison to the 29 setups before plus two setups for the finished pass extension for finished sizes smaller than round 29mm and larger than 100mm round.

The result is as follows:

- <u>Maximization of mill availability</u>
  No need any more to change or adjust passes (and guides) for different finished sizes, which takes between 10 and 45 minutes.
- <u>Minimization of operating costs</u>
  The simplified pass schedule also leads to a noteworthy reduction in inventory. Rolls and guides, both for the intermediate mill as well as for the 2-high finishing mill could be reduced.
- <u>Increase of operation safety</u>
  The setup in the roughing and intermediate mill always remains the same, minimizing the work in the pass line and consequently minimizing the danger of human errors.

In addition to the benefits resulting from the one pass family, the complete size range was extended. With a new size range of Ø 20 mm up to Ø 120 mm, both, the small size range as well as the big size range could be extended – from previously Ø 29 – 100 mm.
At the same time, the rolling speed was increased for the complete size range, with a maximum speed of 10 m/s from previously 4,4 m/s.

4.4 Tolerances

Figure 12 shows the achieved tolerances of the finished products of Sidenor with the RSB® 435++. The data show the tolerance accuracy of over 20.000 bars which correspond to a production of approximately two months.

For the complete size range from Ø 20 mm to Ø 120 mm Sidenor is now able to produce bars with tolerances of 1/6 DIN EN 10060 or better. This is also a significant improvement as compared to the 2-high sizing system which was able to produce tolerances of 1/3 DIN EN 10060 or better.

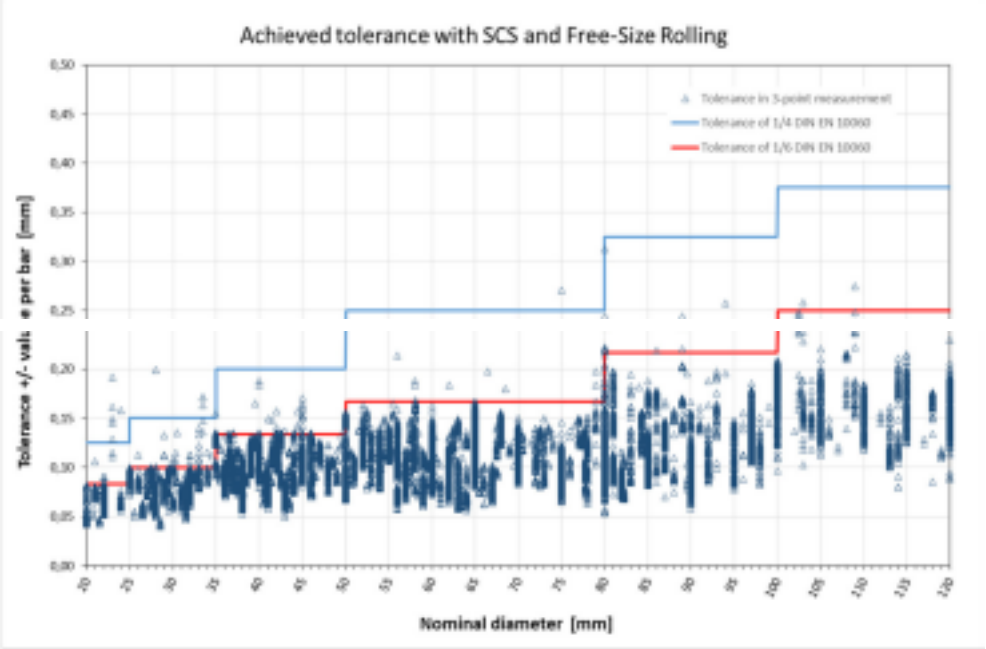


Fig. 12: Achieved tolerance data for products from Ø 20 mm to Ø 120 mm

5. Summary

With the commissioning of the new 3-roll Kocks RSB® 435++ as new Reducing & Sizing Block together with the new cooling bed and finishing area, Sidenor Bausari successfully completed a substantial modernization project.

The productivity could be increased by up to 50% by taking advantage of a higher furnace capacity, an extended size range, faster rolling speeds and an optimized rolling setup. The relative operation costs were lowered by optimizing the mill availability, the furnace occupancy and by reducing the required stand-by equipment in the rolling mill.

The RSB®, which is by design a highly flexible machine, is the key part of this project success. But it not only provided and supported the process optimization and flexibility of the rolling mill - also in terms of product quality significant improvements could be achieved. As Sidenor stated “The RSB produces the best tolerances in the

market at maximum flexibility”.

And it goes without saying that in any single RSB® application customers benefit from the Kocks 3-roll technology. Maximum reduction can be realized on shortest rolling mill length while simultaneously simplifying the operation process and improving the product quality.