REDUCTION OF ROLL CONSUMPTION IN HOT STRIP MILL AT ARCELORMITTAL TUBARAO*

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Abstract
Faced with an increasingly demanding and selective market, a thorough analysis of each step of the processes is required in order to achieve high levels of performance. In addition to a major factor of importance in the rolling process, due to its high price, the rolls represent one of the main items in the cost of hot coils production.
Using the 6 sigma methodology, there were opportunities for improvement in the grinding process, fatigue analysis, improvement in NDT in rolls, as well as means to guarantee operational stability, which allowed the reduction of roll's consumption and consequently the cost of production.
Keywords: Hot Strip Mill; Rolling Process; Roll Shop Process; Roll Grinding; 6Sigma.

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1 INTRODUCTION

ArcelorMittal Brasil, through its commitment of always improving the performance of the enterprise, of sharing with the society its vision of being the most admired steel producer of the world and also of continuing to assure progress in every aspect of sustainability, has returned, since 2017, with its investments in the technical capacitation field, aiming to achieve continuous improvement of the company (6sigma).

The market of steel is even more selective and strict nowadays, requiring a very meticulous analysis of each step in the production process with the main goal of reaching high levels of accomplishment and quality. Since 2009, the hot strip mill is upon a procedure of production increase, with the startup of the second reheating furnace and overall improvement of the production process, going from 2,5 Mt/year of production to the actual 4,1 Mt/year, with an expected production of 4,5 Mt/year in 2022.

In the hot coil production process, the processing of rolls represents one of the main items regarding the cost of operation due to its high price apart from being a factor of great importance in the quality, since the rolls are the tools in direct contact with the laminate. Therefore, the rolls manufacturers are in constant development, aiming to increase these tools wear resistance and dimensional metallurgical stability, factors combined with adequate mechanical resistance and fracture tenacity.

2 MATERIAL AND METHODS

In order to reduce the consumption of rolls, a global evaluation is necessary, being:

1) Increase of rolls campaign in HSM.
2) Reduction of rolls consumption in Roll shop.

To do this, it was important to study the types of consumption reduction in the WR, BUR and Edger.

After a statistical capacity analysis, a consumption reduction target was established, according to figure 1.

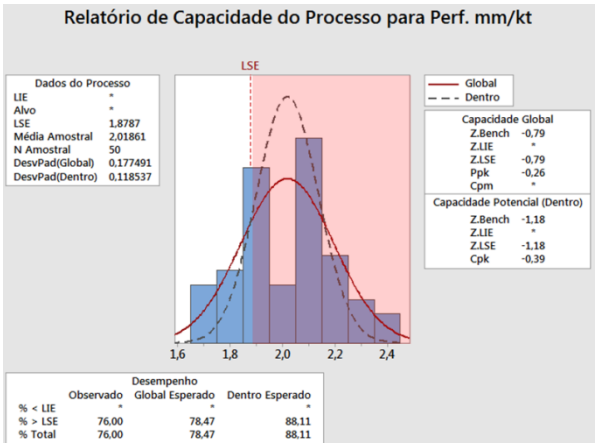

Figure 1. Capability analysis.

According to the capacity report, it was verified that 78% of the indexes were outside the control limit, requiring a reduction of 90%.

A study on the control chart was conducted. It was verified the lower and upper control limits, and also outliers' limits for a specific time, as follows in figure 2.

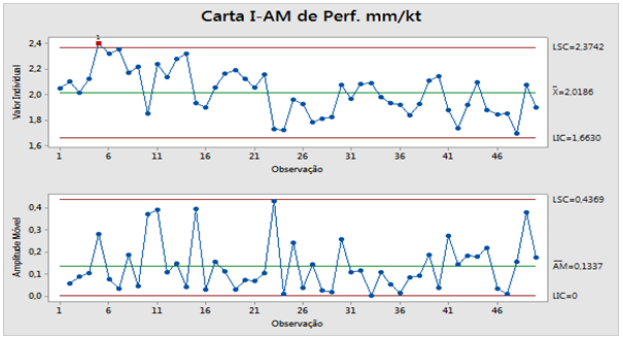

Figure 2. Control Chart.

To understand the evaluation process and to precise which definitions wear the rolls the most, a mental map and an Ishikawa diagram were elaborated, detailing each process of roll's consumption, either in the HSM or in the Roll Shop.

When performing a detailed analysis on the types of cylinders, a Pareto chart was used, according to figure 3, to identify the type of roll that has the highest consumption.

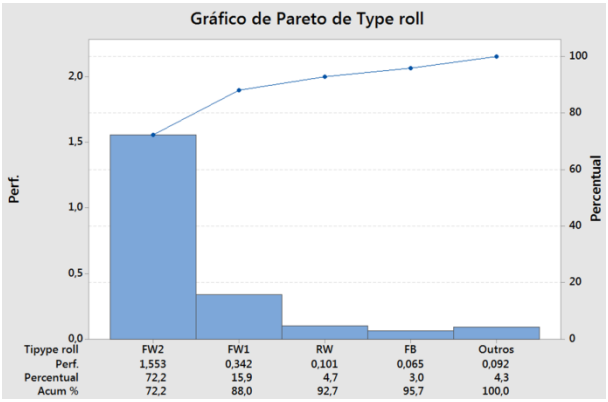

Figure 3. Pareto Graph.

When analyzing the consumption of rolls, it's observed a higher consumption in WR rolls of the FM, followed by WR Rougher and BUR. Therefore, a sequence of studies was determined.

After a team brainstorming, a fishbone diagram was prepared for exploring and identifying the potential root causes for the roll consumption. In order to quantify the priorities a "Cause x Effect" matrix was developed. Afterwards an "Effort x Impact" matrix was elaborated to define which causes would be pursued initially or which ones would not be prioritized in the project – see example of matrix "Effort x Impact" in Figure 4.

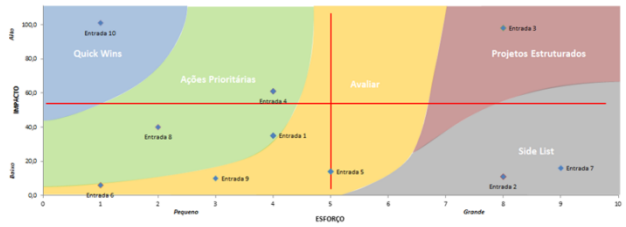

Figure 4. Effort x Impact Matrix

3 RESULTS AND DISCUSSION

By means of studies of material fatigue analysis of the rolls, methods were developed for increasing the roll campaign, initially focusing on the edger roll and BUR. According to figure 5, it's possible to see the surface wear of the roll, which is being analyzed.

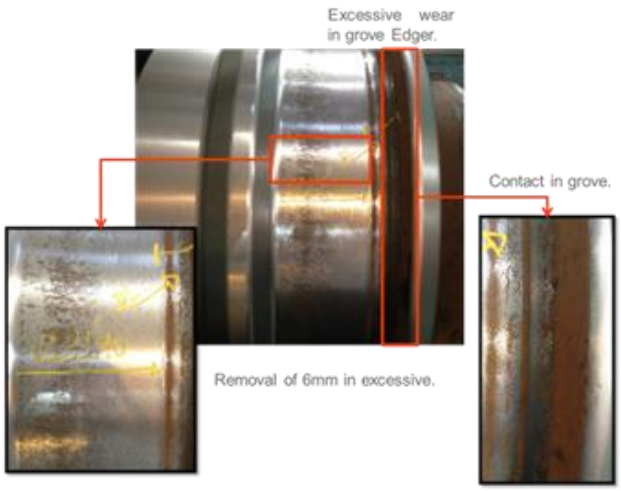

Figure 5. Surface wear in VE

When analyzing a surface feature, we observe a possibility of increasing the roll campaign as it's shown in Figure 6.

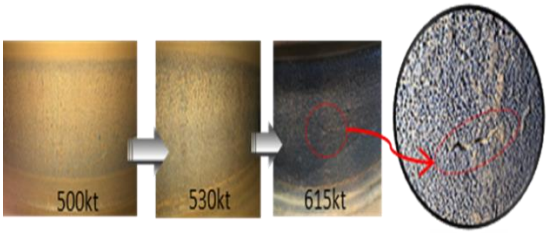

Figure 6. Surface wear in VE "micro"

After adopting these evaluations, there was a campaign increase of the vertical rolls, as it's visualized in the control chart, figure 7.

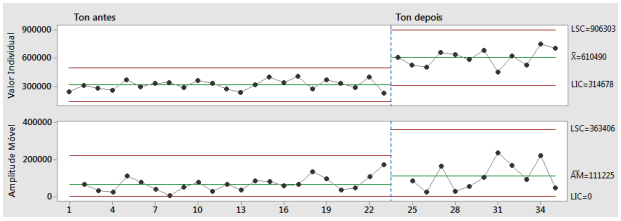

Figure 7. Increase of Edger campaign"

A study was also developed to evaluate the contact pressure between the BUR and WR RM roll, as it follows in figure 8.

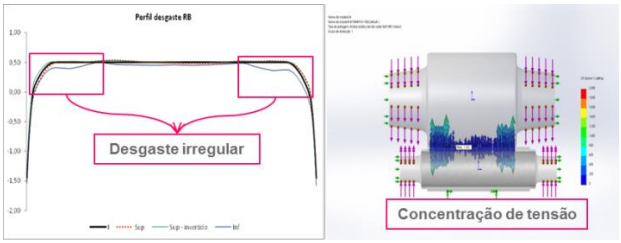

Figure 8. Profile of BUR

After several simulations in Computer Aided Engineering (CAE) software, it was established a new curve with new parameters at the edges, aiming to an optimized roll contact pressure (see figure 9), reducing the contact pressure between BUR and WR during operation in HSM.

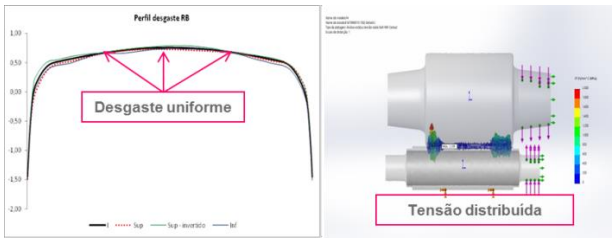

Figure 9. New profile of BUR

Another important point to be addressed, the contact fatigue at the edges of the rolls. A study to mitigate these occurrences was also performed (see figure 10). In all the rolls with a specific structural type, and in a given chair, suffered from contact fatigue cracks, as visualized in the figure below.

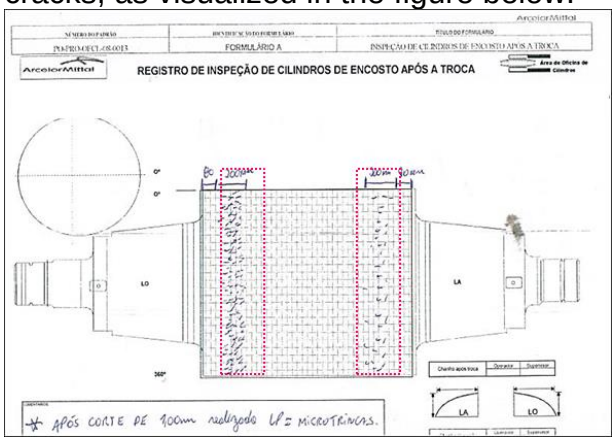

Figure 10. Analysis of contact in BUR

4 CONCLUSIONS

In a scenario of increased production and because of the fact that the wear of the rolls affects directly the coils production cost, some statistical analysis were conducted with the 6sigma methodology, pursuing to verify and evaluate the working conditions of the rollers in the hot mill of ArcelorMittal Tubarão. In 2018 it was initiated a work in the roll factory via blackbelt 6sigma, to study the tribology applied to the rolls wear, the operation conditions, the campaign and fatigue during its lifetime. This research has shown a great reduction in the rolls consumption (work rolls, backup or vertical edge), increase in the mill production, reduction into the capex of the rolls as well as in costs measured indirectly (energy, FTE, lubricants).

Another important factor was the financial feedback (ebitda) to the company. Around R$ 16 million less in capex of the rolls, 32 hours of increased production in function of the rolls campaign improvement, as well as an avoided cost of R$ 18 million that would be required, in order to afford a new grinding machine, which would be necessary to attend the conditions of the annual production.

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