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HOW TO INCREASE TIN PLATE PRODUCTION BY MORE THAN 25%?[1]

Case Study: Revamping of Tin Plate Tandem Mill of ArcelorMittal in Aviles by CMI

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Abstract

Commissioned in 1976, the 5-stand 4-Hi Tin Plate Tandem Mill n°2 in ArcelorMittal Aviles is currently producing 550.000 mt/y. In order to improve product quality, rolling capabilities and increase annual capacity to 700.000 mt/y, CMI put his experience at work to revamp the mill. To achieve this objective, the existing mill situation was completely analyzed and following cost effective solutions were proposed: achieving a maximum speed of 2.000 m/min through increasing power and installing new gear boxes, spindles and couplings; modifying existing direct application lubrication, strip cooling between all stands, work roll cooling and strip drying system at exit of stand 5; completing full automation and capacity increase of auxiliaries fluid systems for direct application, strip and roll cooling in the cellar; improving mill availability through implementation of a fully automatic quick work roll change system for all 5 stands, to achieve the sequence in less than 3 minutes; modifying fume exhaust system. Our presentation will be divided in 3 parts. First, our analysis, made for all 5 stands with data of 7.000 coils, will be presented. From this analysis, we will show how the new required powers and the most suitable drive arrangement were defined to reach targeted speeds. Second, quick roll change system and resulting equipment modifications will be explained. Finally, specific key process aspects of lubrication, cooling and drying will be exposed.

Key words: Revamping; Tin plate; Tandem mill; Productivity; Rolling capability.

COMO AUMENTAR A PRODUCÃO DA FOLHA DE FLANDRES EM MAIS DE 25%?

Estudo de Caso: a Reforma do Tin Plate Tandem Mill da ArcelorMittal, em Aviles - Espanha, pela CMI.

Resumo

Comissionado em 1976, o Laminador de Tiras a Frio nº 2, 5-cadeiras, 4-Hi, da ArcelorMittal Aviles está produzindo atualmente 550.000 t/ano. Para aumentar a qualidade da produção, a capacidade de laminação e a capacidade anual para 700.000 t/ano, a CMI aplicou a sua experiência na modernização do laminador. Para atingir esse objetivo, a situação do laminador existente foi completamente analisada e as seguintes soluções de custo otimizado foram propostas: atingir uma velocidade máxima de 2.000 m/mn através do aumento da potência e instalação de novas caixas de engrenagem, eixos e acoplamentos; modificar a lubrificação de aplicação direta existente, a refrigeração da tira entre todas as cadeiras, o resfriamento dos cilindros de trabalho e o sistema de secagem da tira na saída da cadeira 5; aperfeiçoar a automação e aumentar a capacidade dos sistemas auxiliares de fluidos de aplicação direta, a refrigeração das tiras e cilindros no porão; melhorar a disponibilidade do laminador através da implementação em todas as 5 cadeiras de um sistema de troca de cilindros de trabalho totalmente automático e rápido para atingir a sequência em menos de 3 minutos; e modificar o sistema de exaustão da fumaça. Nossa apresentação será dividida em três partes. Na primeira, serão apresentadas nossas análises, feitas para todos os 5 *stands* com os dados de 7.000 bobinas. A partir dessas análises, nós mostraremos como as novas potências exigidas e o arranjo mais adequado dos acionamentos foram definidos para atingir as velocidades. Na segunda parte, serão explicadas a rápida troca do sistema de cilindros e as modificações resultantes dos equipamentos. Finalmente, serão expostos os aspectos-chave específicos dos processos de lubrificação, resfriamento e secagem.

Palavras-chave: Modernização; Folha de flandres; Laminador de tiras; Produtividade; Capacidade de laminação.

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1 PURPOSE OF THE PROJECT

The purpose of this project was to increase the annual capacity of the Tin Plate Tandem Mill number 2 of Aviles, Spain, from 550.000 t/y to more than 700.000 t/y. In order to achieve such a production, it was necessary to focus on the following points:

- to roll all the products at maximum speed with the existing mill conditions;
- to reduce the downtimes due to the manual changing of work rolls;
- finally, to increase the rolling speed from 1.600 m/min to 2.000 m/min.

To achieve these objectives, the following modifications were proposed:

- modification of existing direct application lubrication, strip cooling arrangement for stands 3 and 4 as well as stand 5 work roll cooling and strip drying equipments;
- complete full automation and capacity increase of auxiliaries fluid systems for direct application, strip and roll cooling;
- Implementation of fully automatic quick work roll changes systems on all stands to achieve work roll change sequence in less than 3 minutes;
- determination of necessary power and supply of new gear boxes, spindles and couplings to enable Tandem Mill 2 to operate at a maximum speed of 2.000 m/min instead of 1.600 m/min;
- modification of fume exhaust system.

As the last point has no impact on the production increase, only the 4 first topics will be covered in this paper.

Given that the replacement of existing equipment will be performed begin of August, the recent results will be presented at the conference.

In addition, before implementation of the above modifications, a process team was constituted including customer operational team and CMI experts. The mission of this team was to fulfill the first objective consisting of rolling at maximum speed with the existing mill conditions.

2 MATERIALS AND METHODS

In order to define the new powers, torques and rolling speeds required in all stands, a model was developed by our experts team. This model provides the rolling schedule based on the following data:

- entry and exit thickness;
- strip width;
- maximum rolling forces;
- maximum motor powers and speeds;
- gear box ratios;
- maximum tensions;
- work roll diameters.

The results of the analysis of 120.000 tons of production are presented in section 3.3.

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3 RESULTS AND DISCUSSION

3.1 Cooling and Drying System

The basic of tin plate lubrication is to spray a rolling emulsion (direct application) onto the strip at the entry of each stand, just after the deflector and tensiometer rolls assembly. In order to cool the mill and the strip, water is sprayed at the exit of each stand directly onto work rolls as well as onto the strip, before the deflector and tensiometer rolls assembly. This configuration enables to avoid coolant and direct application emulsion mixing, which could deteriorate the lubrication. At the exit of stand 5, a strip drying system is used to prevent to have emulsion and coolant on the strip for the recoiling.

After technical analysis, it was pointed out that:

- maximum speed was not always reached with existing configuration;
- chatter occurrence has to be improved;
- too high strip temperature between the stands;
- strip pollution after stand 5 may occur when the speed will be increased up to 2.000 m/min.

CMI was asked to make all the necessary changes on the existing fluid system in order to reach the requested speed performances and to reduce drastically the chatter occurrence.

The first conclusions of the process team were:

- the strip lubrication has to be improved. The lubrication was not even distributed across the strip width;
- for some products the emulsion concentration has to be increased;
- the strip cooling between the stands has to be increased. But, it was not possible because water was going over the deflector/tensiometer rolls assembly. Therefore there was still water on the strip just before the direct application (DA) headers. The remaining water was breaking the DA applied on the strip, which leads to bad and uneven lubrication along the strip width;
- the deflector roll was too close to the stand and too far from the tensiometer roll.

Consequently, the strip was heating too much and there was chatter on nearly 10% of the production which limited the rolling speed.

The improvements made by CMI in order to reach the targets fixed by the client are summarized below.

3.1.1 Adaptation of direct application system

There are two circuits for direct application (DA): one high concentration circuit and one low concentration circuit. In order to achieve better performances and flexibility, CMI modified those circuits in order to be able to lubricate all the stands with one circuit in case of failure of the other circuit. New mixing tanks, dosing pumps and piping were provided, in order to have a recirculated DA flow inside the pipes 10 times bigger than the DA flow applied on the strip, in order to have constant operation condition at all the nozzles.

After analysis made by the process team, a third circuit was added.

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The chatter and lubrication troubles were also due to the existing headers: not enough nozzles, no double covering and some clogged nozzles. Consequently, the client was not able to run the mill at its maximal capacity.
The process team proposed new headers, with more nozzles and different orientation, in order to have a double covering (triple on last stands) and even distribution of DA along the strip width.
The direct result of this change was the drastic decrease of chatter problems (from 10% chatter to approximately 2%) and the capacity to run the mill at full speed, which was not the case before.

3.1.2 Adaptation of strip cooling system

When too big flow was applied on the strip, water was disturbing the DA sprayed on the strip, which led to bad lubrication.
The solution was to change the deflector rolls positions.
By moving the deflector roll closer to the tensiometer roll:

- The wrapping angle around the rolls was increased;
- The distance between work roll and deflector roll was increased.

Consequently, water was prevented to disturb the DA. Due to the bigger wrapping angle, the water wiping is much more efficient and prevents water to flow between the strip and the deflector roll. Due to the bigger length between the work roll and the deflector roll less water has to be wiped.

3.1.3 Sealing effect at stand 5

In order to improve strip cleanliness before recoiling, the strip drying system was completely modified after stand 5. A new drying system combined with the dynamic sealing effect prevents to have roll emulsion or coolant on the strip after rolling.
This system includes:

- a new frame to support the air nozzle beams and the new roll cooling beam for the top work roll;
- a new guiding and retracting mechanism for the new frame;
- a new stripper housing, attached to the top of the above mentioned frame;
- a new air nozzle beams of V-type design;
- a new bended air nozzle beam to blow the water between the top work roll and top back-up roll.

CMI technology center experts have designed all equipment related to emulsion cooling and drying of stand 5 in order to help significantly the drying performances at normal rolling speed. This new system avoids the need of a top work roll air knife system located just over the stripper, potentially reducing the cooling efficiency.
Depending upon speed and dimensions, a dynamic (fluid) seal is formed, avoiding coolant leakage through the work roll/stripper gap onto the strip.
This sealing effect is a function of several process and equipment parameters among which the gap between work roll and stripper, the coolant height, the stripper length in front of the work roll and the coolant viscosity.

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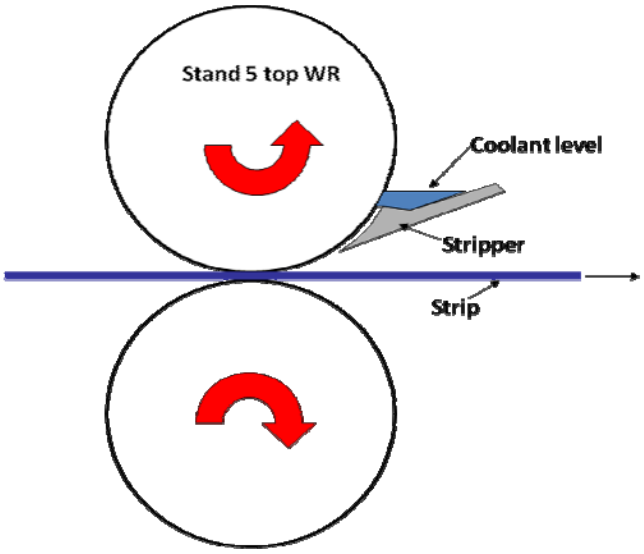

Figure 1. Sealing effect.

The most important factor is the gap between the stripper plate and the work roll. It is therefore very important to have an accurate position of the stripper for any work roll diameter. Therefore, CMI implemented a system with two wedges. The small wedge is moved up and down depending on the work roll diameter. When the small wedge is at the calculated position, the stripper plate is moved by hydraulic cylinder. The stripper plate is in place when the big wedge is in contact with the small wedge.

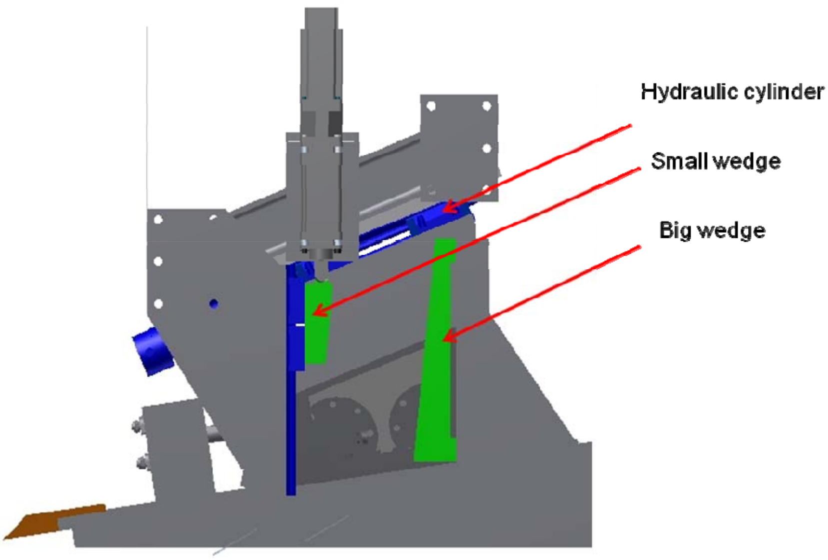

Figure 2. Mechanical arrangement of stripper plate at stand 5.

3.2 Work Roll Changing System

A full automatic quick change system for the work rolls in all 5 stands was implemented. It aims at achieving a change time of less than 3 minutes instead of more than 30 minutes with manual operation.

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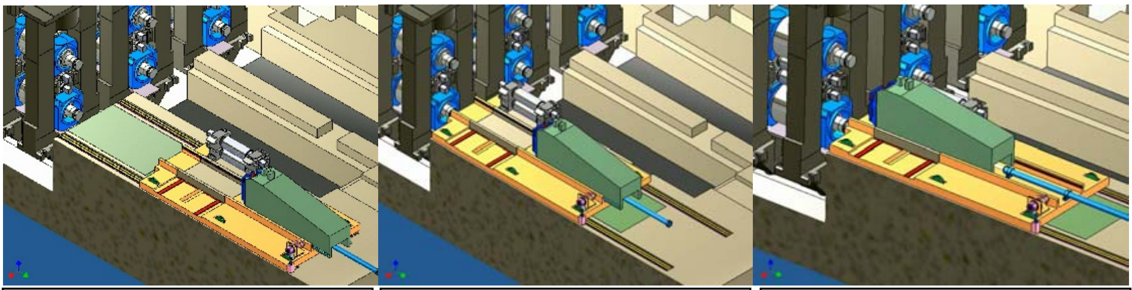
The sequence is presented below.

3.2.1 Rolling mill is still running



Initial situation.	When a work roll change is scheduled, the work roll changing platform travels to the stand.	Just before the mill gets stopped, the system is moved closer to the stand.

Figure 3. Sequence when rolling mill is still running.

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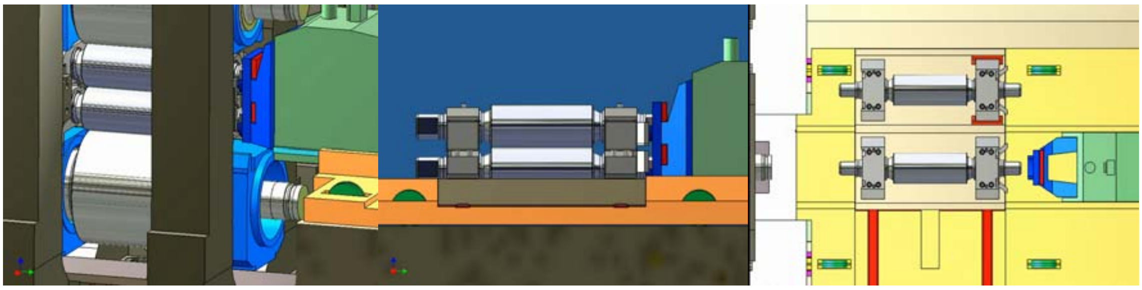
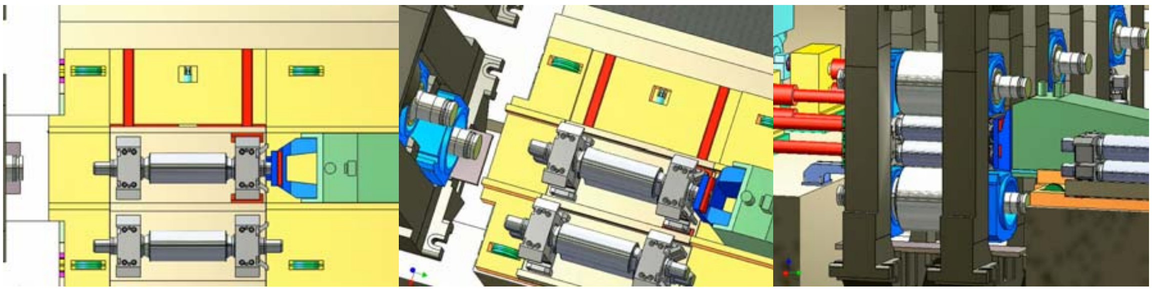
3.2.2 Rolling mill is stopped – extraction operation



After mill stop, work rolls are placed in the right position. The roll changing car clamps the work rolls.	The roll changing car travels out of the stand.	The roll set is laid down on the shifting platform.

Figure 4. Extraction operation sequence.

3.2.3 Rolling mill is stopped – loading operation



The platform is shifted and the roll changing car picks up new rolls.	The roll changing car travels new rolls to the stand.	New work rolls are in operating position in the stand.

Figure 5. Loading operation sequence.

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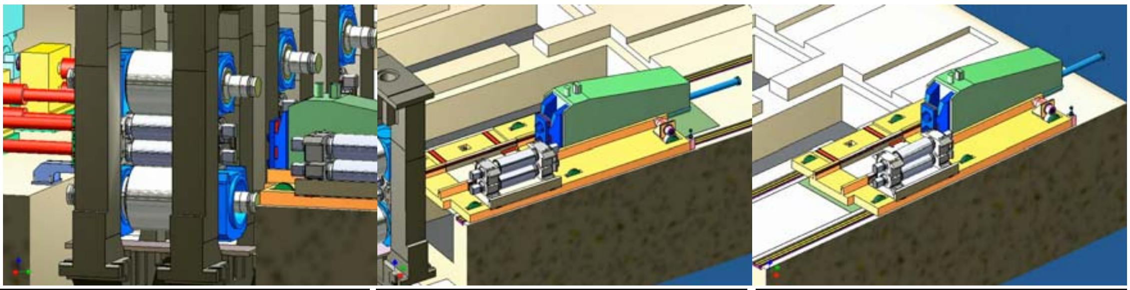
3.2.4 Rolling mill can start



The roll changing car moves back, spindle clamps are opened, rolls are set in rolling position, The mill can start.	The roll changing car travels back in parking position.	The work roll changing platform travels back in idle position.

Figure 6. Sequence of mill starting up.

3.3 Power Determination

The mission was to define the new powers required in all stands and the most suitable drive arrangement to reach 2.000 m/min and consequently to increase the production up to 700.000 t/y of products of similar grades as being rolled today.
An analysis has been made for all the five stands with the data of approximately 7.000 coils (120.000 tons). The motor powers were: 2.985 kW for stand 1, 3.730 kW for stands 2, 3 and 4 and 3.916 kW for stand 5.
Current torque/speed diagrams are presented in Figure 7 for stands 2 and 4.

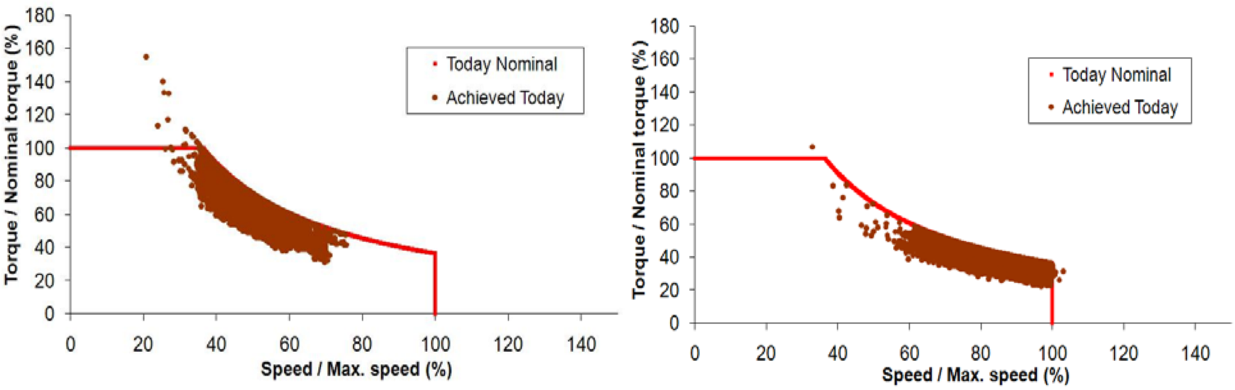


Figure 7. Torque/speed diagram for stand 2 (left) and for stand 4 (right).

In the initial configuration, there were some limitations:

- in power and sometimes in torque for the stand 2;
- in power and sometimes in speed for the stand 4.

In order to increase the power, CMI Rolling Mills has proposed the following cost effective solution, presented in Figure 2:

- one existing motor shifted from stand 3 to stand 2 to increase its power;
- new single drive 5.500 kW motors for stands 3, 4 and 5.

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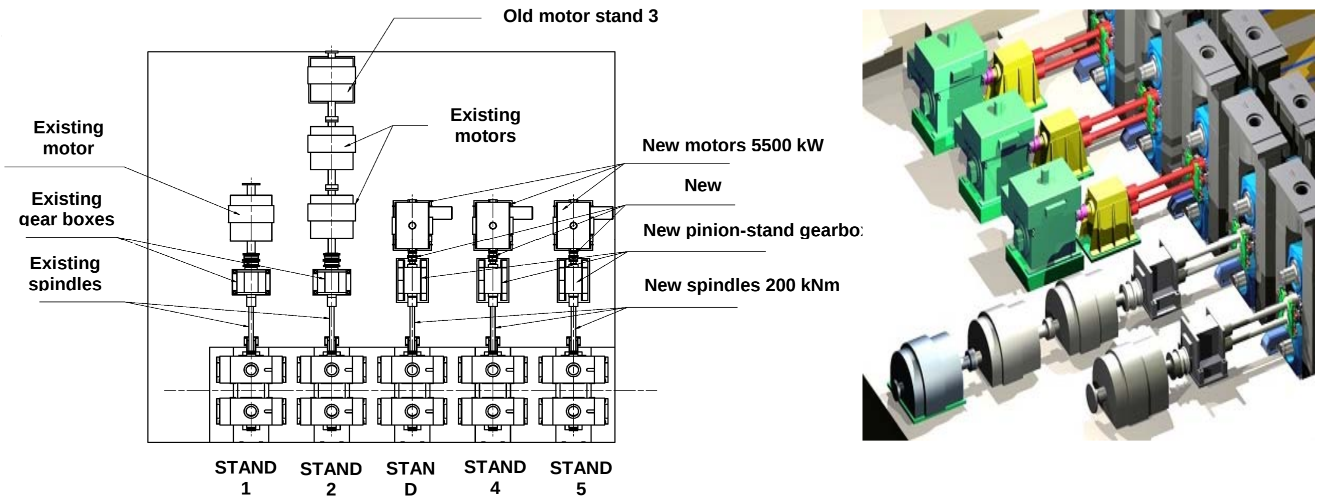

Figure 8. New motors configuration.

According to CMI calculations, the proposed configuration can offer a speed of 2.050 m/min or above in stand 5 over a work roll diameter range of 585 mm to 550 mm. This power of 5.500 kW was chosen on basis of the graph representing the time saving regarding the power (Figure 9).

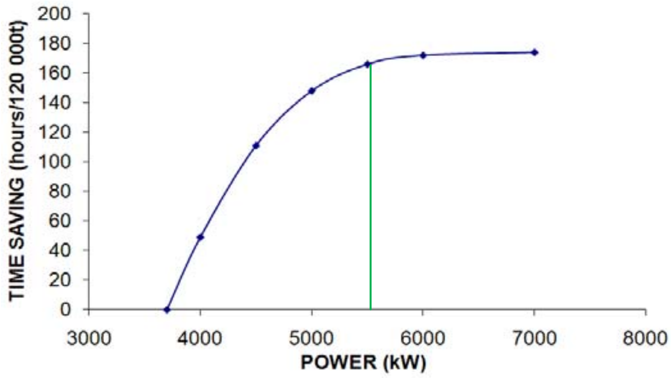

Figure 9. Sensitivity of time saving regarding power.

Results can be observed on torque/speed diagrams generated for the new configuration. Current and future torque/speed diagrams are presented and compared in Figures 10 and 11 for stands 2 and 4.

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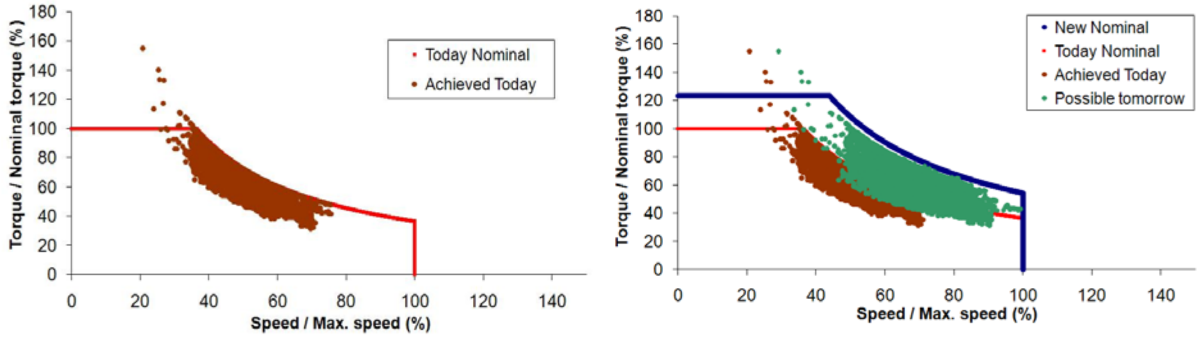

Figure 10. Torque/speed diagram for stand 2.

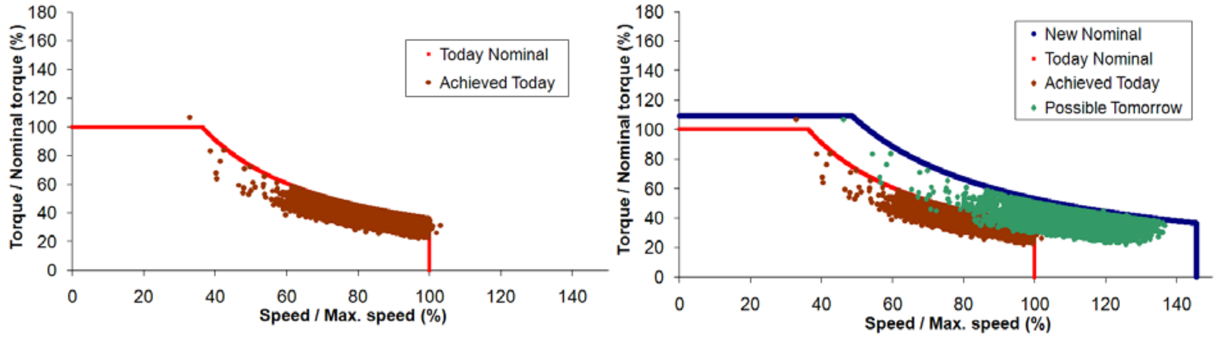

Figure 11. Torque/speed diagram for stand 4.

4 CONCLUSIONS

Thanks to CMI as a supplier of technology as well as technical assistance and thanks to a friendly cooperation with the customer teams, the following results have already been achieved:

- ability to roll at the maximum mill speed (2.000 m/min when all the motors will be installed) for most of the products. To reach this objective, the following modifications were performed:
  - new direct application headers in order to have a double covering (triple on last stands) and even distribution of oil along the strip width. This reduced drastically chatter (from more than 10% to approximately 2%) as well as strip heating;
  - new deflector/tensiometer arrangement to prevent water to disturb the DA lubrication and therefore improve lubrication conditions.
- improvement of the production time. A full automatic quick work roll change system was implemented, which enables to reduce the changing time by more than 90%;
- changing of the motorization of the mill in order to reach (when finished) a maximal speed of 2.000 m/min. New motors, gear boxes and spindles are already provided for stands 4 and 5 (and soon for stand 3).