Improvement of steel hot-rolling by the use of lubrication and hss rolls

Fact Sheet

Project Information

Grant agreement ID: BRPR950133

Project closed

Start date
1 April 1996

End date
31 December 2000

Funded under
Specific research and technological development programme in the field of industrial and materials technologies, 1994-1998

Total cost
No data

EU contribution
No data

Coordinated by
Cockerill Sambre SA
Belgium

Objective

1. A Metallurgical Rolling Model has been developed and validated on the HSM, this model is used for the on-line calculation of the friction coefficient in each stand of the mill;
2. The oil application system has been upgraded (static tube mixer) in order to put under control the conditions of oil distribution in each stand, being able to apply different emulsions in the front and rear stands, and controlling the emulsion flow for

top and bottom work rolls according to the rolling speed;
3. In order to improve the plate out of oil, a new type of wiper, equipped with pneumatic cylinders was successfully tested;
4. An automatic inspection system combining Eddy currents and Ultrasonic waves has been implanted on the grinding machine dedicated for the rear stands in order to minimise the risk of spalling due to the internal crack propagation induced by mill incidents;
5. Two on-line inspection systems (viewing units) have been installed in the stands 2 and 3 of the HSM in order to study and follow the degradation of the work rolls during the rolling campaigns. The system has demonstrated its reliability in supplying high quality images of the roll surface. The analysis of the images has allowed understanding the degradation mechanisms of the work rolls related to the processing conditions, the roll nature and the lubrication efficiency;
6. A roll shop control procedure and data management system have been installed in order to acquire all parameters characterising the different work rolls after grinding and coming off the mill. In order to analyse the rolls and lubrication performances, a new software (Quickind) has been developed, allowing a very quick and detailed study of the parameters influencing the rolling behaviour and strip surface quality.

For the development of efficient lubricants or emulsions, aiming at the decrease of the friction coefficient in the roll gap when HSS rolls are mounted in the stands, different lubricant concepts were tested:
1. Lubricant application systems were upgraded, installed in stands F2 through F6, and short-term tests showed that the equipment functions perfectly. Rolling load reductions up till over 30% were observed with the new lubricants;
2. The oil consumption rate in terms of kg's oil consumed per month is very low compared with the oil consumption in the pre-project phase;
3. Significant roll force reductions were observed with new lubricants on all roll types: High Chromium rolls, ICDP rolls and HSS work rolls;
4. In a short term test in rear stands F5 and F6 the new lubricant based on solids was tested and roll force reductions, as observed in lab mill tests, were confirmed. The concept of a suspension of solids in oil remains therefore still an interesting option for lubricating the hot mill.

With respect to their specific problems, users jointly with roll makers have defined three lines of development for HSS quality:
1. The improvement of the roll's surface aspect in order to cut down on defects generated on the product and its impact on the length of the campaigns;
2. The improvement of wear features on the roll in order to increase the lengths of the campaigns, among other things;
3. The development of a roll capable of withstanding mill incidents or severe rolling conditions better or equally to high chromium iron without any lost of performance.

Different new concepts have been tested:

HSS with Co additions:
The objective was to evaluate the performances of the Co-added HSS for the front stands. The rolls were used in stand F3 during 20 rolling campaigns and it is confirmed that the friction level could be effectively reduced. Unfortunately, this good result is not significant enough to compensate for the higher price resulting from the Cobalt addition.

HSS rolls with carbide shape modifiers:
The aim of was to go further in the development of HSS grades by casting rolls with optimised carbides morphologies and increased amount of MC carbides for the front stands.
The developments were done at a laboratory scale with V, Nb and Ta. The results currently obtained, are so very restricted and have to confirmed by more trials. The only result available at this time concerns the roll wear performance. It confirms the good results of the new grade.
HSS rolls for the rear stands.
If the results in rear stands are quite limited regarding the number of trials, they confirm the difficulty to introduce HSS rolls in those stands where the frequency of rolling incidents is still more important.
HSS rolls with crack arrest:
HSS roll grades with "crack arrest" properties were programmed for the rear stands as an alternative for higher safety in order to examine how a modification of the shell structure of new HSS grades may counteract this possible crack formation in case of incidents and to see if it is possible to maintain all the other advantages of HSS grades for the rear stands.
These trials were limited to laboratory castings with sulfur and manganese additions, which showed in fact a higher amount of MnS Sulfides, having crack arrest properties.
BE95-1179 Improvement of Steel Hot-Rolling by the Use of Lubrication and HSS Rolls

Steel Companies are operating Hot Strip Mills (HSM) to produce flat products on a base of 1.0 to 4.0 millions tons/year per mill. The cost of rolls for hot rolling is a substantial part of the steel processing cost not only due to the direct roll consumption by wear during hot rolling or grinding for surface repairing but also due to more or less long hot strip mill shut down for roll changing after each rolling campaign.

The main objective of the project is to promote the development of new compositions for rolls based on high speed steel tool (HSS) grades with special additions of W. Mo, V... instead of High Chromium (HC) or Indefinite Chill Double Poured (ICDP) rolls actually used respectively in the front and the rear stands of the HSM. It is anticipated that , to meet the local constrains prevailing in each stand of the mill, two HSS grades have to be developed for use in front and last stands. The roll properties

are adjusted by optimizing chemical composition in terms of cr. V contents and/or thermal post-treatments as well, in order to modify the microstructure, hardness and the oxidation resistance. It is also intended to examine which are the possibilities of co addition, of carbide shape modifier additions or of microcrack-arrest microstructure.. The spin-casting technology initially developed in Europe is particularly well suited to produce such compound rolls with a HSS composition in the external shell and a cheapest cast iron in the core. It must be also reported that the spin casting technology is in a very good position to compete with the Japanese roll making based on the CPC (Continuous Pouring Cladding) technology which is faced with a serious problem of investment and production cost.

Based on preliminary trials, it appears also that such a development is asking for a very efficient lubrication of the rolls in order to solve problems of their surface deterioration of due to too high friction. No need to mention that lubrication will help to reduce energy consumption.

An additional beneficial effect of lubrication is to be found in terms of quality improvement for the steel strip.: reducing friction induced shear strain at or just below the free surface by the use of lubrication especially in the final stands of the mill may improve the texture of the strip which in turn increases the deep drawability of the end product.

To assess the performances of both new rolls and rolling oils, it is necessary to perform industrial trials at scale 1/1 on an actual hot strip mill: more important, this mill has to be carefully monitored in order to produce quantitative data of rolling parameters Taking in consideration that any mill is processing many different steel grades, what means different rolling conditions in terms of deformation resistance, tribology,...a Metallurgical Rolling Force Model (MRF Model) must be implemented on the mill in order to compute in real time the contribution of both metal resistance and friction to rolling forces for each coil processed in the HSM.

The consortium in charge of this project comprises two roll manufacturers GP and FORCAST with an international and complementary experience in the spin-casting production of rolls, an oil supplier QUAKER CHEMICAL fully involved in the development of special rolling oils and a large steel maker COCKERILL SAMBRE hot rolling 4 million tons/year on two hot strip mills. Finally CRM, the Research Center in Metallurgy will cover the different metallurgical aspects involved in this project.

The main benefits of the project will be in the cost reduction of steel rolling what is of prime importance in the today's intermaterial competition and in the improved position of European roll manufacturers faced to the Japanese competition. In addition, new large markets may be expected as far as the chemical industry is concerned.

Fields of science (EuroSciVoc)

engineering and technology > mechanical engineering > tribology > **lubrication**

natural sciences > chemical sciences > inorganic chemistry > **inorganic compounds**

natural sciences > chemical sciences > electrochemistry > **electrolysis**

natural sciences > chemical sciences > inorganic chemistry > **transition metals**

engineering and technology > materials engineering > **metallurgy**

Programme(s)

FP4-BRITE/EURAM 3 - Specific research and technological development programme in the field of industrial and materials technologies, 1994-1998

Topic(s)

0101 - Incorporation of new technologies into production systems

Call for proposal

Data not available

Funding Scheme

CSC - Cost-sharing contracts

Coordinator

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EU contribution

No data

Total cost

No data

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No data

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Total cost

No data

Last update: 4 October 2002

Permalink: https://cordis.europa.eu/project/id/BRPR950133