Alert Rolling of Long Products (May 2017)

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Metallurgical and Materials Transactions A, May 2017
Effect of microalloy precipitates on the microstructure and texture of hot-deformed modified 9Cr-1Mo steel. A. Chatterjee, A. Dutta, M. Basiruddin Sk, R. Mitra, A. Bhaduri, D. Chakrabarti
Microalloying elements like Nb and V are added to modified 9Cr-1Mo steel to ensure excellent creep resistance by the formation of fine MX precipitates during tempering treatment. The effect of those elements on the evolution of microstructure (and texture) in hot-deformed steel has hardly been studied. Industrial processing of modified 9Cr-1Mo steel often develops deformed and elongated prior-austenite grain structure, which can be detrimental from property point of view. The present study shows that the formation of such structure can primarily be attributed to the pinning effect from strain-induced Nb(C,N) precipitation, which can effectively retard the static recrystallization of deformed-c at high-deformation temperature and short inter-pass times (~10 seconds). Based on the results, the application of either heavy deformation pass at high-temperature or multiple-lighter passes maintaining sufficient inter-pass interval (30 to 50 seconds) is recommended to achieve fine and equiaxed c-grain structure by dynamic recrystallization and static recrystallization, respectively.

Iron & Steel Technology, May 2017
Pre-finishing mill modernization on the Sterling Steel Rod Mill. K. Reins, N. Gow, W. Krejdovsky
The most recent modernization phase of the wire rod mill at Sterling Steel involved the installation of a pre-finishing mill, using a Morgan Vee Mini-Block, a new water box and shear with utility systems and automation. The new mill configuration adds more stands to the mill for better drafting and is designed to improve finished product quality by providing a more uniform entry temperature and better control of the feed section into the No-Twist® Mill. The new shear improves cut length accuracy and decreases the amount of trimming to reduce yield loss. This paper explains the changes made in the mill and the features of the new equipment and automation system.

Materials at High Temperatures, April 2017
Metadynamic recrystallization of 300M steel after isothermal compression. Y. Liu, J. Liu, M. Li
Isothermal compression tests of 300M steel were performed on a Gleeble-1500 thermomechanical simulator at deformation temperatures ranging from 1173 to 1373 K, strain rates ranging from 0.1 to 5.0 s⁻¹, and a strain of 0.69. Metadynamic recrystallization and grain growth after complete metadynamic recrystallization were investigated by isothermal compression with different inter-pass times. It was found that the inter-pass time, deformation temperature and strain rate markedly affected the austenite grains size of metadynamic recrystallization. The austenite grain size model and grain growth model of metadynamic recrystallization were determined based on the results of quantitative grain size. A good agreement between the predicted and measured austenite grain size and grain growth of metadynamic recrystallization was obtained, and the present models were effective to predict the austenite grain size and grain growth of metadynamic recrystallization in the isothermal compression of 300M steel.

La Metallurgia Italiana, March 2017
Thermo-mechanical processing of steel: effect on microstructure, crystallographic texture and Charpy impact transition behavior. A. Ghosh, A. Chatterjee, D. Chakrabarti
The severity of fissure formation during Charpy impact testing of low-carbon steel increased with the decrease in finish rolling temperature (820°C - 650°C). Fissure crack develops on the main fracture plane due to the strain incompatibility between cube
(ND || ) and gamma (ND || ) texture bands, which resulted from intercritical rolling. Clustering of ferrite grains having cube texture promotes the subsequent crack propagation along the transverse ‘fissure plane’.

DLPP - Quality management software tool for rolling and heat treatment optimization. C. Fabbro, M.Durisotti

The increasing demand of as-rolled products’ quality (wire rods, smooth and ribbed bars, bars in coil, spoolers) is challenging the SBQ producers to implement new technologies by combining high plant productivity and efficiency of superior quality finished products thanks to the introduction of in-line heat treatment. For this purpose, Danieli and ITA have developed a specific quality management software tool, DLPP® (Danieli Long Products Predictor), which allows the prediction of metallurgical and final mechanical properties of hot rolled wire rods and bars. Metallurgical module MetaCool® implemented in DLPP® is used for quick and efficient computer simulation of In-Line-Rolling heat treating processes as well as for Off-Line conventional heat treatment. This paper will focus on the following three real processes where the use of DLPP® significantly helped optimize the heat treatment technology:

- the best layout definition for a SBQ wire rod line;
- the definition of controlled rolling conditions for a spooler line (hot-rolled rebar in coil);
- the definition of the correct process parameters for an Induction Hardening line.

Archives of Metallurgy and Materials, December 2016
Heat flux identification at the charge surface during heating in chamber furnace. A. Gołdasz, Z.Malinowski

In this study, a method of determining the heat flux, which reaches the surface of a charge, has been presented with the use of an inverse analysis. The research on the heating process of a square 15HM steel charge was conducted in a natural gasfired laboratory furnace. The inverse solution was based on the search of the minimum standard error between the measured and the calculated temperatures. The temperature of the charge has been calculated by the finite element method, solving the heat conduction equation for a square charge heated on all the surfaces. As a result, the mean value of the heat flux on each of the heated surfaces of the charge was estimated.

53rd Rolling Seminar- ABM Week 2016
Pre-finishing mill modernization on the Sterling Steel rod mil. Kermit Reins, Neil S. Gow, Wade P. Krej dovsky

The most recent modernization phase of the wire rod mill at Sterling Steel involved installation of a pre-finishing mill, using a Morgan Vee Mini-Block, a new water box and shear with utility systems and automation. The new mill configuration adds more stands to the mill for better drafting and is designed to improve finished product quality by providing a more uniform entry temperature, better control of the feed section into the No-Twist® mill as well as enhanced surface quality. The new shear improves cut length accuracy as well as decreases the amount of trimming to reduce yield loss. This paper explains the changes made in the mill and the features of the new equipment and automation.

Mechanical and microstructural characterization of wire rods and wire drawn steel 10806 with different boron contents. Taciana Rezende Pereira, Miguel Justino Ribeiro Barboza, Helio Fidencio Linhares, Giuliane Meireles Casali Goncalves (in Portuguese)

The steel 10806 is used in the production of wire rods for cold drawing. Due to the production in electric arc furnaces, the nitrogen content of this steel is high, which can cause strain aging, resulting in increase of the strength and decrease of the ductility. Reduce the free nitrogen content is one way to minimize this effect, which is made by
adding boron. This study aimed to carry out a mechanical and microstructural characterization of materials with boron contents ranging from 55 to 112 ppm's. Mechanical properties obtained in the wire rods showed a reduction in tensile strength with increasing boron content, indicating its effect on minimizing aging. In the metallographic analysis the microstructures showed to be similar for all tests. The images of the reagent Le Pera identified three phases, retained austenite and / or martensite, ferrite and pearlite. The presence of martensite was not expected in this steel. What may caused their formation is the presence of free boron, which can increase hardenability. In the next steps of this work further analysis will be done to confirm this result, such as microhardness, SEM-EDS and detailing the production of wire rod case.

Quality improvement of the dimensions of round bars hot rolled in LCP in Votorantim siderurgia. Izabelle Lannes Salgueiro Ferreira, Taciana Rezende Pereira, Edson Vasconcelos, Bruner Cândido Siqueira, Renato de Carvalho Vieira, Leandro Carlos Pinto De Almeida (in Portuguese)
This study aimed to ensure stability in the hot rolling process of round bars with the purpose to reduce the generation of products with defects and the number of customer complaints by out-of-roundness round bars. The hot rolled round bars are used in drawing industries, mechanical metal, agro-industry and other industrial components. The methodology used was DMAIC (define, measure, analyze, improve and control). This tool is used to improve processes. By the use of this tool was possible to identify the most influential parameters in the generation of out-of-roundness round bars, which enabled the development of an action plan directed to the root causes. After the end of the action plan, there was a reduction of 36% in the generation of defective products and no customer complaint was received until March of 2016, in addition to a greater stability during the hot rolling process of this product.

Stein furnace efficiency project through automation. Wesley Alves Quintão, Pedro Henrique Prudente (in Portuguese)
This project has been created and presented to meet the company's needs concerning energy saving targets and adaptation to the current market. For this purpose, it was studied a way to generate gas saving through the shutdown of ignition pilots and also to eliminate mechanical delays in the firing process, purging and leak-tightness of the Stein reheating furnace through the use of automation resources, eliminating electromechanical devices and ensuring speed information, proven gas savings and higher system reliability in the process monitorinc.

Improvement of the quality management system. Izabelle Lannes Salgueiro Ferreira, Raphael Barbosa De Souza, José Carlos Da Silva (in Portuguese)
This work aims to show how expert systems improve quality management and processes when working with large data sets, which are generated continuously by the production processes of hot rolling.

Increasing the number of bar rolled for bar lost of Demag GLQ-VSBM rolling mill. Izabelle Lannes Salgueiro Ferreira, Jose Carlos da Silva, Leandro Carlos Pinto de Almeida, Leonardo Henrique de Oliveira Mathias, Bruno Lovatini (in Portuguese)
This work was intended to increase the metal yield index in the hot rolling process of long steel in mill Demag, to reduce metal losses with major impacts in the process, with focus on the iron bar rolled / iron bar lost. Upon the current scenario of the Brazilian economy, the index of the metal yield in the rolling process is one of the largest impact on the cost of processing the final product. Based on this analysis, the proposed work is divided into two stages, applying Six Sigma, which consists to act in orderly fashion problems based on matrix stress X impact. Six sigma is a mechanism used in processes in general improvements, as strong feature identifies the most relevant and influential parameters in the generation of metal losses in the lamination process, which has
guided us to prepare an orderly plan of action solid that is, actions with lower effort and greater impact on the process with a focus on fundamental causes. With implementation of the action plan, there was an increase of 0.72% in the metal yield index for a 178kt production in 2015 with growing improvement in performance of iron bar rolled of mill Demag products.

**Metallic income increase in wire rod and rebar rolling process.** Rafael Lopes, Daniel Mesquita Duarte, Rogério Ferreira Ribeiro, Elias Ferreira da Silva Junior, Leandro Luís da Silva, Isabel Cristina Silvestre Baião Tavares Pimentel (in Portuguese)
The metal income is one of the long rolling process indicators, since it has direct influence on the reduction of cash cost is critical in the Brazilian steel industry’s current economic scenario. In function, it is necessary to identify the main causes of metal losses to increase the rate of this indicator using the DMAIC methodology. As a result there was an increase of 1.22% achieved by optimizing the heat treatment process parameters, reduction of the head and tail crop cut length in the shear and improved automation of valves quenching and self-tempering system.

**Steel rolling process development for production CA50 rebar 32mm.** Marcio De Fatima Rosa, Ademir De Oliveira Junior, Aline Da Costa Miranda Lima (in Portuguese)
CA50 32mm rebars bars via Cooling Bed CSN Long Steel began production in 2015 and for the production on an industrial scale needed to prepare an experiment for the steel definition to be used and the process parameters for achieving the properties mechanics to reach the NBR 7480. These products undergo heat treatment cooling water or not depending on the chemical composition of the steel. By performing the 4 kinds of steel lamination tests it became possible to reduce the heterogeneity of mechanical properties and set the process parameters.

**47th Steelmaking Seminar – ABM Week 2016, August 2016**
**Development of Shapes A572 to Serve Transmission Towers Market Request.** Izabelle Lannes Salgueiro Ferreira, Rafael Do Nascimento Santos, Denise Freire Duarte, Lívia Lopes De Oliveira Goulart, Taciana Rezende Pereira (in Portuguese)
This study aimed to suit the surface and mechanical properties of ASTM A572 G60 profiles to meet a specific request of manufacturing transmission towers industries. The request consists of a test of the “flattening”, which gives the product a tensioning and deformation at an angle of approximately 150°. The methodology used was DMAIC (define, measure, analyze, improve and control). This tool is used to improve processes. Through this tool it was possible to identify the main Steelmaking and Rolling Mill process variables, which allowed the determination of an action plan aimed at root causes. With the implementation of the plan it was gave significant improvements in material quality such as reduction in inclusion level of 3 to 4.

**12th Stainless Steel Symposium – ABM Week 2016, October 2016**
**Analysis of interpass time on microstructural evolution of high nitrogen austenitic stainless steels, with and without niobium.** Mariana Beatriz dos Reis Silva, Juno Gallego, José Maria Cabrera Marrero, Oscar Balancín, Alberto Moreira Jorge Júnior (in Portuguese)
The influence of interpass times on the microstructural evolution of two austenitic steels, F138 (without Nb) and ISO 5832-9 (with niobium), was investigated through torsion tests in industrial conditions. Analyses were performed by optical and transmission electron microscopy, EBSD and microhardness. Shorter interpass times produced smaller grain and precipitate sizes. More refined microstructures led to largest microhardness values. The ISO 5832-9 displayed greater strength than the F138. Precipitations of TiNbN, after soaking, and of NbCrN and NbN (5%), during processing, were observed in the ISO 5832-9. Both materials undergo dynamic recrystallization. Coarse particles (> 200 nm)
acted as matrix reinforcement, and smaller precipitates (< 50 nm) pinned grain boundaries and dislocations in the ISO.

**SEAISI Quarterly Journal, September 2016**

**4D-Eagle: The New Measuring Gauge of Kocks for Long Products.** Christoph Klebba, Stefan Schwarz, Jurgen Ammerling, Franz Strobl

The latest gauge developments are based on the “light section” method. This method is more suitable to provide real time measurement parameters of the rolled bar. Placed close to the last rolling stand, the “light section” gauge is capable of measuring around the complete diameter circle with a clear definition of the bar stage in relation to the axes of the rolls. It is also capable of making these measurements using a very high measurement frequency. Following the latest tendencies in the marketplace, which require highest gauge measuring frequencies in order to display the bar in the most accurate way, even at the highest rolling speeds, the “4D Eagle” gauge was developed. The “4D Eagle” gauge operates with light sectioning by laser triangulation with the highest available measuring frequency and without mechanical movement of the sensors. This paper describes all the process features and parameters of this impressive and unique newly developed gauge.

**Using Fine Grained Niobium Micro-Alloyed Rebar in Concrete Bridge Application.** Michael Wright

Concrete is strong in compression, but weak in tension. Reinforcing bar, or “rebar”, compensates for the lack of tensile strength in the concrete. The strengths of concrete used in these bridges has been increasing, however rebar has not experienced the same improvements. This mismatch in concrete development vs. reinforcing bar is being addressed to create a composite structural member with optimum mechanical properties. Although there are several routes available to produce higher strength rebar, certain approaches are more favourable in developing key microstructural characteristics that impart optimum mechanical property performance. The use of niobium micro-alloying to develop a finer grained microstructure during rolling will give higher strengths and improved ductility. Discussion is extended to the process metallurgy, the role of niobium in conditioning the austenite and subsequent microstructural transformation. This paper will explore the benefits of a fine grained niobium microalloyed rebar in reinforced concrete for bridges, including: Design improvements reducing the weight of the bridge - Improved ductility at higher strength - Reduced concrete congestion - Improved weathering properties