THE RESEARCH OF NEW TECHNOLOGY OF PLATE ROLLING BY MEANS OF COMPUTER SIMULATION

ИССЛЕДОВАНИЕ НОВОЙ ТЕХНОЛОГИИ ТОЛСТОЛИСТОВОЙ ПРОКАТКИ СРЕДСТВАМИ КОМПЬЮТЕРНОГО МОДЕЛИРОВАНИЯ

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Abstract:
The development of new and modernization of existing methods of plate-rolling in order to obtain high-quality and competitive products is a promising task. This paper presents the results of a comparative analysis of the classical plate rolling technology and new technology, including rolling in relief rolls and workpiece alignment on a smooth barrel followed by rolling to the desired size. Comparison of these technologies was carried out with the help of computer simulation methods in finite element software package SIMUFACT FORMING together with a database of materials properties MATILDA. The analysis was conducted by parameters such as: the degree of elaboration of the workpiece, deformation scheme, the evolution of the microstructure. For comparison, the values of the stresses and deformations of the workpieces to be processed on existing and proposed technologies, studied the stress-strain state using the coefficient Lode-Nadai. Analysis results obtained in the course of the simulation allows to predict better quality plate production with the use of the proposed technology plate rolling.
KEY WORDS: *PLATE ROLLING; COMPUTER SIMULATION; ALTERNATING DEFORMATION.*

1. Introduction
High quality and competitive products is the main objective of any production, including plate rolling. However, the characteristic feature for the modern technology of plate rolling are monotonic deformation of compression, which poorly penetrates into the middle layers of the metal, which leads to anisotropy of mechanical properties in volume of the workpiece and reduce the quality of the finished product. A promising direction for improving the quality of hot-rolled sheet, and accordingly further cold-rolled, is the development of new schemes of the deformation in the rolling process, allowing to improve the strength characteristics together with good ductility through grain refinement of the source metal during the implementation of the deformation diagram realizing the intense alternating deformation in the whole volume of deformable metal.

2. Problem discussion
It is known that one of the main ways of achievement of sign-variable deformation in case of various processing of metals pressure is increase shift components of deformation (macroshift). Therefore an important condition of increase in production efficiency of plate hire is use of the local deformations providing creation in peals great importance of the cumulative deformation having sign-variable nature, and also its not monotony [1].To implement these conditions (impossible in classical longitudinal rolling) in practice is required to change the form of rolls or blanks. So one of the main ways of forming is the application of alternating projections and depressions on the surface of the wide faces of the rolls or to the workpiece [2]. Such a change in the form of rolls (or blank) will allow you to create additional streams of metal flow not only in longitudinal but also transverse direction (to the axis of rolling), which consequently will lead to the intensification of shear deformation in the whole volume of deformable metal, as well as the decrease of the anisotropy of the mechanical properties of the metal. However, most often, in practice, this method is associated with a significant change in the original dimensions of the workpiece, which is undesirable and even negative, since in some cases a significant change in the cross-sectional size (usually decrease) leads to a drastic reduction of the possible range obtainable from a given workpiece. Also a significant change in the original dimensions of the workpiece leads to higher energy consumption, which is not desirable.
In this regard, the development of new or improvement of existing technologies with the aim of creating the most favorable conditions for obtaining high-quality thick plate metal without appreciably changing the original dimensions of the workpiece is an urgent task. To solve this problem a new rolling technology has been developed, which allows to achieve increase of the quality of the metal plate with small changes in the initial cross-sectional dimensions of the workpiece [3]. Offered plate rolling technology includes rolling mill rolls with relief, executed in the form of trapezoidal protrusions and depressions along the entire length of the roll barrel [3], and the alignment of rolling billets at a smooth barrel to the desired size. This development will allow to intensify the shear deformation, which will ensure the emergence of additional streams of metal flow and, consequently, a better elaboration of the workpiece over the entire volume.
The aim of this work is to conduct a comparative analysis to identify characteristic differences, advantages and disadvantages between the proposed and the existing technology of plate rolling.

3. Objective and research methodologies
To achieve this goal with the help of software package Simufact forming, together with a database of materials properties MATILDA two models of plate rolling were created. Model existing plate rolling technology includes 6 stands with a smooth barrel in series (Figure 1.A). The proposed technique involves the cage with embossed rollers as annular grooves over the entire length and the roll stands 5 mounted in series with smooth barrels (Figure 1.B).

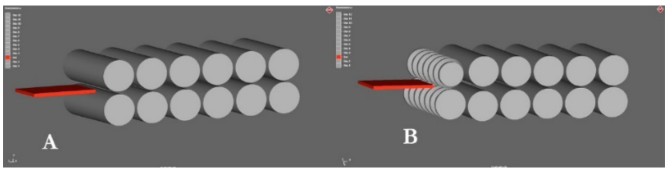

Figure 1 *- The appearance of the constructed models*
A - existing technology; B - the proposed technology

To compare the effectiveness of the models, it was decided to analyze the results on the rolling key stages, namely, after the first, the third and the last stand.
To determine the degree of elaboration of the workpiece at each stage of rolling in each model analyzed the effective plastic strain. The results obtained in the analysis of the results showed that even at the first stand in the rolling degree of elaboration and workpiece quantity of accumulated strain in the preform rolled on the proposed technology (preparation B) is greater than in the existing rolling (preparation A). The difference value reaches 0,087. This

phenomenon can be explained by the fact that the blank B occurs extra metal flow flows in the direction of least resistance.
After the third passage of the effective strain in the workpiece B starts to get uniformity across the section. After rolling in the sixth stand two blanks have a uniform distribution pattern of the accumulated strain. The difference values of the effective plastic strain between the proposed and existing technology reaches 0.45. This difference indicates a more effective elaboration billet rolled on the proposed technology, including rolling in the relief rolls.
In order to evaluate the stresses and strains in the values of the workpiece, as well as the discovery of a common type of deformation at a particular point of rolling a study of stress-strain state using the coefficient Lode-Nadai [4]. To calculate the maximum values have been taken, average and minimum principal stress in points 70 throughout the length of the cross section of the preform. The values of the coefficient Lode-Nadai are in the range from 1 to -1. The values of the coefficient, tending to 1 indicate the nature of the compressive deformation, to 0 to shift the character to -1 on the tensile nature. For a visual representation of the results of the analysis of the Lode-Nadai coefficient are presented in graphs (Figure 2).

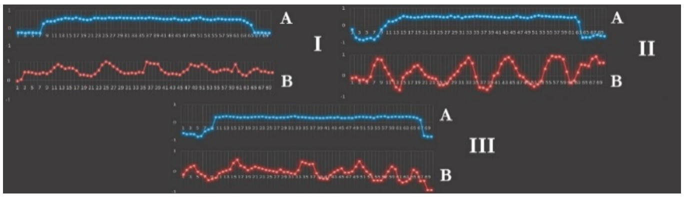

Figure 2 *- The results of the analysis of the Lode-Nadai coefficient A - existing technology; B - the proposed technology; I - first pass; II - the third passage, III- sixth pass.*

Deformation during rolling under the existing technology at all stages of rolling is monotone compressing character except the marginal portions where tensile stresses arise due to band broadening and a front tension band arising due to the difference of rolling speeds. Unlike existing technologies deformation has an alternating character with a large amplitude, dominated by shear deformation when rolling on the proposed technology that is beneficial to the grinding fraction harvesting grain throughout.
From the results of the analysis of the microstructure (Figure 3) that after the first and the third stand more even distribution of the blank has a structure A, but after the third stand in the blank B is equalized grain fractions in the cross section. After rolling the blank in the sixth stand B structure has a uniform distribution of grain size in the range 15 ÷ 20 microns. A grain fraction in the workpiece A in the range 20 ÷ 25 mm, the microstructure is non-uniform structure, which leads to anisotropy properties.

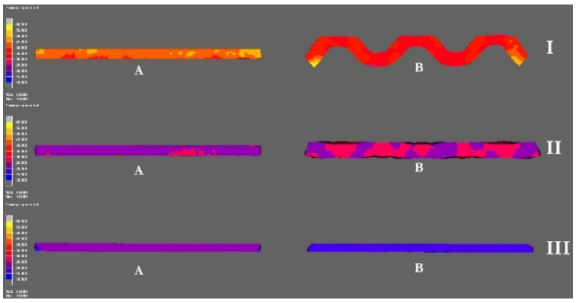

Figure 3 *- Results of the analysis of the microstructure A - existing technology; B - the proposed technology; I - first pass; II - the third passage, III- sixth pass.*

4. Conclusions

A comparative analysis of the proposed and existing technology plate rolling. Compared subjected to parameters such as: the effective plastic strain ratio Lode-Nadai, calculated according to the values of the principal stresses, as well as the evolution of the microstructure. Results of the analysis can be predictive of better quality plate production with the use of the proposed technology.

5. Literature

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