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The work roll bending control system of the hot plate rolling mill

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Abstract

This article describes the kinds of thickness deviation arising during hot plate rolling process. The ways to determine thickness deviation by measuring the thickness of the sheet at various points are shown. The reasons of rolls bending under the rolling pressure are found. Examples of using the different structures for the implementation of the roll bending system are shown. The results of the system were considered in the hot rolling plate mill conditions.

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Keywords: hot rolling, roll bending, sheet thickness, sheet flatness.

1. Introduction

The quality of the final rolled sheet greatly depends on its thickness deviation. This statement is applicable for thin and thick sheets, rolled on hot and cold rolling mills. Sheet thickness falls into two categories: longitudinal and cross (transverse) thickness. Both of these parameters define the final flatness of the sheet. The initial reduction of the slab, taking place on hot rolling, makes a significant influence on the geometric parameters of the metal. No matter the rolled plate is the final product or just the first step in getting a thin strip - the longitudinal and cross variation in thickness is laid in primary rolling passes.

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2. Determination of the thickness deviation

The most common schemes of hot plate rolling are "longitudinal", "cross" and "angular" [1-3]. In these schemes all types of thickness deviation occur mostly in the cross passes. Thus, the cross component of the sheet thickness should paid an attention. First of all, it is necessary to define what does "thickness deviation" mean?

The actual measurement of the sheet thickness n times at regular intervals of length and the mark their numbers $i = 1,2, \ldots, n$ gives a sheet thickness at every point h_i [4]. In this case the thickness difference means the deviation on the absolute value

$$\Delta_i = |h_i - h_{\text{cp}}|, \quad (1)$$

where $h_{\text{cp}} = \frac{1}{h}\sum_{i=1}^{n} h_i$ - the average thickness of the sheet.

Then, the average thickness variation of the sheet can be calculated by the next formula

$$\Delta = \frac{1}{n}\sum_{i=1}^{n} \Delta_i. \quad (2)$$

As shown on formulas (1,2) the accuracy of the thickness deviation value depends on the number of measurements. It is very difficult to make a large number of measurements under real conditions. Therefore, the sheet thickness measured at the three points: at the center and at the lateral edges (at some distance from the edge). The values obtained on the edges are averaged, and the difference between this two values is the desired value.

During the rolling process it's difficult to take into account all parameters impact on the cross thickness deviation of the rolled sheet. The same difficulties take place in developing of the automated rolling control system. More than 10 different factors may counted in the first approximation, including deformations as sheet metal, as rolling equipment. The temperature of the rolling play a central role, also the force and speed of rolling. In this situation it's better to avoid a complex aproach and separately calculate the influence of each component. The component combination and development of the control system are carried out after finishing all mathematical calculations and its approvement on the computer models.

3. The work roll bending

One of the most influential parameter on the hot plate geometry is the bending of the work rolls. The consideration that all rolls in the main rolling cage have an ideal geometric form of cylinder (in the case of rolling in "quarto" stand) allows to determine a "work roll bending" (figure 1, a). Another assumption is the constant roll-gap during work roll width. In such condutions, at the rolling moment, the rolls bend takes place under the metal impact, that has a negative influence on the sheet geometry (figure 1, b). A value of the bending can be identified by rolling force "P". A dependence between the bending value and the cross-section of the work roll is called "bending curve". The form of the "bending curve" is complex, vaguely resembling a parabolic.

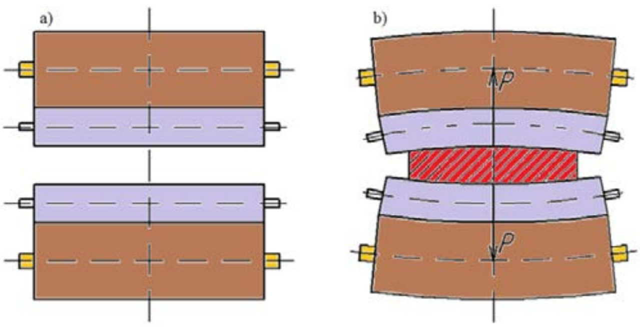

Fig. 1. Rolls of the "quarto" stand without the force (a) and under the rolling metal pressure (b).