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Setting Automated Roll Axial Shifting Control System of Plate Mill

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Abstract

The paper provides the CVC[plus] system designed for control of cross-section and sheet flatness of the 5,000 mm plate mill stand at OJSC Magnitogorsk Iron and Steel Works. It considers principles of roll axial shifting and spindle horizontal balancing. It describes designs of correlated systems of automated roll and spindle position control. The authors offer oscyllograph records reflecting system settings. Their coordinated functioning is proven to provide a constant gap between the roll and spindle under conditions of rolling and setting between passes. The oscyllograph records provided confirm efficiency of the spindle position control system with automated switching to force control in the hydraulic cylinder.

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Keywords: Plate mill; mill stand; horizontal rolls; axial shifting system; spindle horizontal balancing; servo-system; design; setting; experimental studies.

1. Introduction

Today, rolling mills are equipped with systems enabling roll horizontal shifting relative to each other [1,2]. Thus, the mill stand of the 5,000 mm plate mill at OJSC Magnitogorsk Iron and Steel Works (hereafter referred to as the 5,000 mm mill) is equipped with the axial WRS (Work Roll Shifting) system being a part of the CVC[plus] (Continuously Variable Crown) unit for sheet shape and flatness control [3,4].

The CVC principle has been developed by Schloemann-Siemag in cooperation with Krupp [5]. It is based on rolls with an unsymmetrical crown. Axial shifting these rolls enables continuous variation of the required roll crowning directly during mill operation. Axial shifting both rolls in the same direction results in the same variation of the roll gap profile at both negative and positive roll crown (dependent on the shifting direction).

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The improved CVC^{plus} system differs from the known CVC one mainly in the following [6]:

- CVC^{plus}-shape – work roll crown with a control range significantly increased;
- CVC^{plus}-shape – crown of a support roll reducing load imposed on it;
- form-optimized shifting approaches for reduced shape deviations and increased sheet lots.

The WRS system is used for pre-setting the roll bite shape between passes without metal in the stand. It automatically provides correction of work roll wear and, thus, increases their durability. The control range of transverse gage interference and strip flatness is increased. The system functions also include elimination of edge thinning, monitoring and control of strip cross-section shape.

The mill is also furnished with the spindle horizontal balancing system along with the axial shifting one. It is designed for spindle shifting in the same direction as for the roll CVC-displacement. Thus, the specified gap between the roll and spindle head is controlled. The system also limits axial forces between them in dynamic modes.

Many authors studied the system of axial shifting theoretically and experimentally with the outcome published, in particular, in [7–11]. This paper considers issues of practical setting controllers of these systems and outcome of study of their coordinated operation.

2. Problem statement

2.1. CVC^{plus} work roll shifting control

The design of the CVC^{plus} system of the 5,000 mm mill is shown in Fig. 1,a. Its main function is axial shifting work rolls in the horizontal direction along the rolling axis. Corresponding grinding work rolls enables crown variation and consequent roll bite outline by shifting the top and bottom rolls oppositely. A special roll design with a gap up to 320 mm has been implemented for a rolling stand of the plate mill.

A definite shape of a finishing sheet is achievable due to the roll crown corresponding to the rolling force and sheet width. The CVC versions of the top and bottom work rolls have a S-cross-section shown in Fig. 1,b [12, 13]. The diameter difference across the crown of a roll is 0.2–0.4 mm [14-17]. The crowns of both rolls are identical but turned by 180° relative to each other. As a result, rolls complement each other and form a parallel outline of the opening between them. With a mutually antithetical axial shifting, the roll bite changes towards a negative or positive crowing dependent on the shifting direction. The shifting value can infinitely vary, thus providing a constantly variable roll crowing. The term "crowing" means the difference of the values of roll bite from the sheet center to its edge [15]. If roll convex areas approach each other at axial shifting, strip draft will be greater in the middle portion than at edges. If convex crown portions move apart at axial shifting work rolls, draft is reduced in the middle portion and increased at edges.

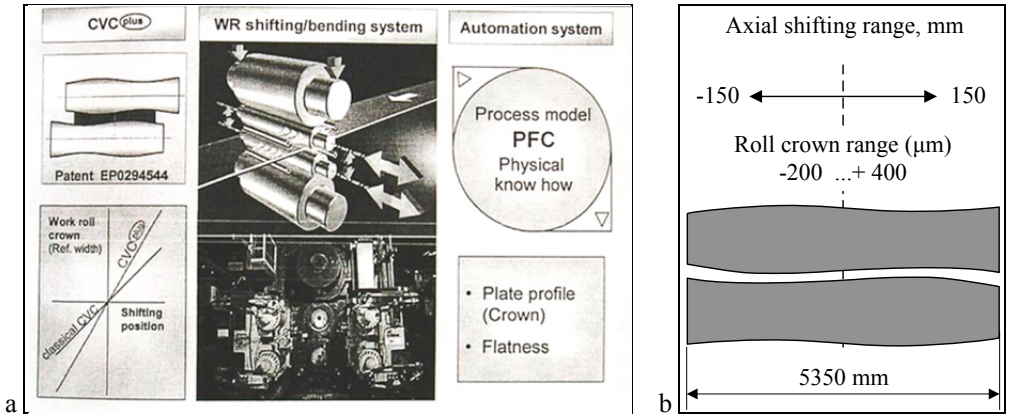

Fig. 1. (a) Typical design of plate mill's CVC^{plus} system; (b) Example of axial shifting CVC work rolls.