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Force limiting at roll axial shifting of plate mill

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Abstract

The paper considers operation of the CVC^{plus} roll axial shifting and Work Roll Bending (WRB) systems of plate mill horizontal stand. It provides arrangement of hydraulic equipment providing operation of these systems. It considers the functional diagram of the backup bending force control system. The authors mention shortages of the design algorithm for backup bending setting. They propose the improved system algorithm. They provide results of experiments with forces in the CVC and WRB hydraulic cylinders under conditions of roll axial shifting during implementation of these algorithms. Technical efficiency of the proposed solution is verified: roll durability is improved due to reduced friction forces at axial shifts.

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Keywords: plate mill; rolling stand; horizontal rolls; Continuously Variable Crown System; Work Roll Shifting System; design; algorithm; improvement; setting; experiments.

1. Introduction

The most important quality indexes of flat rolled products are geometry and its length and width deviations. The sheet shape and flatness control systems provide specified properties of hot-rolled sheet at plate mills [1]. Thus, the axial WRS (Work Roll Shifting) system based on the CVC^{plus} (Continuously Variable Crown) technology is operated at the 5,000 mm mill under study [2]. Together with the WRB (Work Roll Bending) system, it ensures dimension accuracy of flat rolled products [3,4]. The flowchart explaining force impacts on rolls during operation of these systems is shown in Fig. 1 [5].

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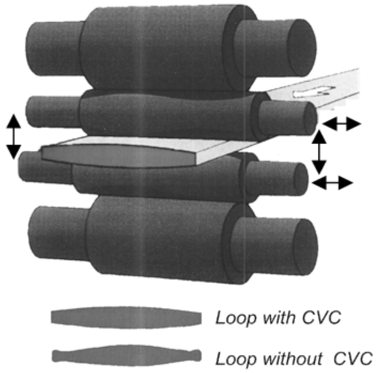

Fig. 1. Force impacts at sheet shape control.

The CVC^{plus} (hereinafter referred to as CVC) principle is based on the use of work and support rolls with an unsymmetrical crown (S-shape rolls) [6,7]. Shapes of top and bottom are similar, but they are mutually turned by 180°. Axial shifting these rolls shown in Fig. 1 with horizontal arrays enables change of the required crown and roll gap across the rolling width. Unlike mills producing a light gauge strip, plate mill provide axial shifting between passes and roll bending directly during rolling. Thus, the specified shape of the rolling cross-section shown in Fig. 1 as contour lines is ensured. A higher profile accuracy is maintained by control of transverse gage interference. Furthermore, this control type provide wear diffusion along the length of the roll crowing. The system also prevents edge thinning.

Work roll bending compensates their deflection caused by roll pressure and holds work rolls against support ones. Compensation is introduced at deviation of gap parameters from specifications by additional bending top and bottom rolls in opposite directions shown in Fig. 1 with vertical arrays. Forced roll bending is the most operative control method based on body elastic flexibility to the bending moment and transverse force action. Roll bending is also used for a rapid profile compensation if rolling force deviates from the design one. Thus, the WRB system corrects profile deviations not eliminated at CVC-shifting. This may be explained by the fact that CVC profile is set between passes and calculated based on the expected rolling force.

The bending force is maintained at the specified balancing level equal to about 2,000 kN at axial roll shifting without metal. The maximum rolling force is 3,800–4,000 kN. Balancing force is required to provide holding work roll against the support ones. In such a way, slippage between work and support roll at CVC-shifting is prevented.

Operation of the roll bending system is provided by hydraulic cylinders (HC) installed under work roll carriages (Fig. 2). This Figure also illustrates fastening hydraulic cylinders performing roll axial shifting in the positive (to the drive side) or negative direction (to the operator side).

Many authors investigate operation of the roll axial shifting system, e.g. [8-11] describe control principles implemented in the bending systems. Some results of study of the CVC system installed at the 5,000 mill are considered in papers of these authors [12–24]. At the same time, simultaneous operation of the roll axial shifting and bending is understudied. Results of experiments related to mutual influence of the CVC and roll bending automated control systems (ACS) of the 5,000 mm mill are provided below. At that, analysis is concentrated on the WRB system.

2. Main part

2.1. Specification of 5,000 mm mill WRB mill

As previously noted, the WRB system eliminates lack of flatness and transverse gage interference of flat products by mechanical impact on work rolls using slave hydraulic cylinders installed between bearings of top and bottom work roll necks. Each work roll is supplied with four hydraulic cylinders. The ACS flowchart for control of roll gap profile and bending is shown in Fig. 3.