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APPLICATION OF ELECTRIC DRIVE EXCITATION FOR INCREASING THE PRODUCTIVITY OF PROCESSING GROUPS IN A HOT ROLLING MILL

Metal rolling production is a sophisticated technological process that seamlessly integrates the physical and chemical principles of metal deformation with the operation of advanced mill machinery and the precision of cutting-edge electrical drive systems. Modern industrial standards require stability of thickness, mechanical properties and structure of rolled metal, which is possible only with high precision control of technological processes. Variations in temperature, structural changes in the metal, and instability of strip tension between stands adversely impact the final product's quality. This necessitates enhancing control systems to boost the competitiveness of rolling production [1].

The rolling process represents the final stage of the production cycle in ferrous metallurgy, playing a crucial role in shaping the ultimate characteristics of the finished products. A hot rolling mill is a highly interconnected electromechanical system comprising diverse electrical and electromechanical equipment with significant installed capacity. Coordination of the operation of all its units requires high-precision control and automation systems that ensure process stability, reduce energy costs and minimize process deviations. The facility operates a continuous wide-strip hot rolling mill 1700, consisting of five roughing stands, seven finishing stands, multiple cutting units, and a spar strip unit.

A key aspect of the hot rolling mill's power supply system topology is the requirement for an even distribution of electrical loads between the transformers in the two-transformer main step-down substation. Consequently, the DC electric drives operating in the finishing group of the rolling mill are linked to different transformers. This design characteristic of the mill’s power supply grid results in electromagnetic interaction between the electric drives of the roughing and finishing groups. In [2], it is shown that shock loads of the synchronous electric drive of the roughing group cause an uneven distribution of supply voltages in the finishing group of the mill, and this kind of interaction through the elements of the power supply system is proposed to be classified as elasticity of the third kind.

To investigate the operation modes of the finishing group of the hot rolling mill, a mathematical model of the regulated DC electric drives of the stands of the finishing group connected with each other through the strip of rolled metal has been developed [3]. On the developed model the influence of supply voltage sags on the state of metal in the inter-stand gap was investigated.

In order to reduce the effect of voltage sags, it is proposed to reduce the excitation of the DC motor when the supply voltage is reduced.

Based on the results of processing the results of mathematical modelling, regression models of the dependences of the current difference of the drive motors and the lengthening of the rolled strip on the relative decrease in the magnetic flux were constructed in the form of linear regression equations.

Mathematical modeling of the system-including the effects of second- and third-order elastic couplings-demonstrated that a reduction in magnetic flux during a voltage drop helps equalize the current loads among interconnected electric drives and maintain consistent metal strip tension during voltage fluctuations, ultimately improving the quality of rolled products.

This control method is recommended for implementation on rolling mills equipped with DC electric drives operating under unstable power supply conditions, as it will enhance production efficiency and product quality.

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