JGRPD

ISSN : 3032-131X

https://doi.org/10.61796/jgrpd.v1i4.574

DEVELOPMENT OF A SYSTEM FOR REGULATING THE THERMAL PROFILE OF ROLLS AND STRIPS DURING HOT ROLLING IN THE FINISHING GROUP OF STANDS

Sanjarbek X. Rayimkulov
Department of Metal Forming, Faculty of Mechanics, Tashkent State Technical University, Tashkent, Uzbekistan
richsanches@mail.ru

Kamoliddin A. Khasanov
Department of Metal Forming, Faculty of Mechanics, Tashkent State Technical University, Tashkent, Uzbekistan
kamoliddinxasanov1995@gmail.com

Sadulla S. Fayzullayev
Department of Metal Forming, Faculty of Mechanics, Tashkent State Technical University, Tashkent, Uzbekistan

Received: Feb 22, 2024; Accepted: March 29, 2024; Published: Apr 18, 2024;

Abstract: Thermal regulation is based on the ability of metals to change their -geometric dimensions and volume when temperature changes. This type of regulation can be either external or internal and is carried out in relation to the working tool or the material being processed. The type of control under consideration is inertial and can be used for the ¬finishing group of the mill. The advantage of this method is the ability to influence ¬asymmetrical flatness defects during the rolling process.

The use of forced cooling systems for rolled strips, which include interstand cooling (ISC) in the finishing group of stands and accelerated cooling on the outgoing roller table, can increase the productivity of mills and improve the consumer properties of hot-rolled strips.

Keywords: Rolling, Hot Rolling, Rolling Temperature, Cooling Of Rolls, Interstand Cooling.

Introduction

Interstand cooling of the rolled strips significantly changes the temperature-speed and deformation conditions of rolling in the finishing group of stands, which leads to a serious change in the conditions for the formation of the metal microstructure in the interstand spaces and the mechanical properties of hot-rolled strips.

The temperature-speed cooling system on the outgoing roller table largely determines the mechanical properties of hot-rolled strips. Particularly acute is the problem of ensuring the specified winding temperature for thick strips, during the production of which correction of the current cooling mode is extremely difficult, and in some cases simply impossible due to the significant transport delay and the short length of the strips.

The ever-increasing complexity of the range of strips rolled at continuous strip hot rolling mill (CRM) makes the issues of developing mathematical models of hot rolling that take into account the following relevant:

- application of strip cooling systems and thermal processes of steel phase transformations;
- research into the possibilities of interstand cooling in the field of formation of the microstructure of hot-rolled strips;
- development and improvement of technological terms for the production of hot-rolled strips.

Strip and roll cooling system configuration

To develop a scheme for regulating the thermal profile of the working tool and deforming metal was selected the finishing group of the continuous hot rolling mill, consisting of five (5) quarto stands. Let's consider each system separately.

Interstand cooling system for rolls and strips

Interstand cooling system for the finishing group of stands should consist of rows of nozzles fixedly installed on the movable upper and fixed lower plates in the direction opposite to rolling at an angle to the rolling axis (Fig. 1). This system consists of two parts: cooling of the deformed metal and the rolls. The first two interstand spaces of the mill (K1-K2 and K2-K3) are equipped with a metal cooling system, due to the intensity of the rolled product cooling. Cooling of the rolls occurs in all interstand spaces. In this case, water enters through nozzles evenly spaced across the width of the roll.

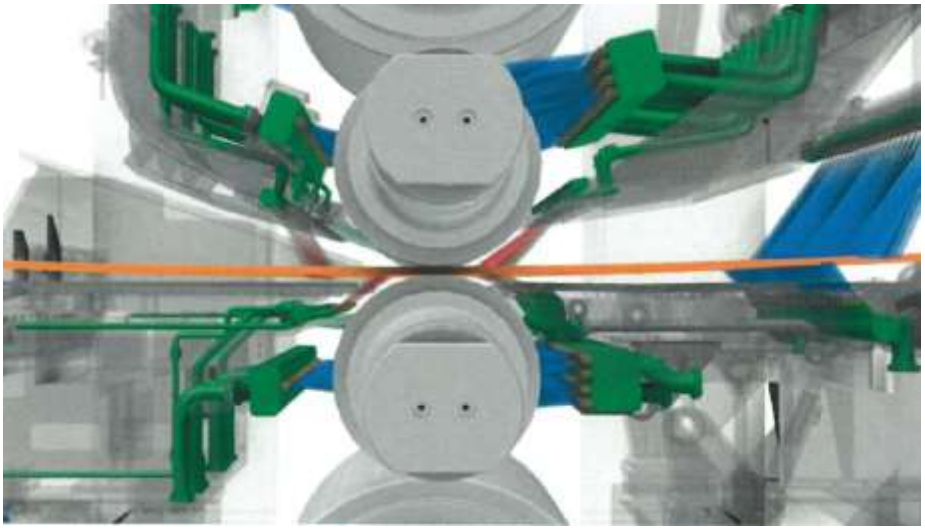

Figure 1 - Interstand cooling system for rolls and metal

When water hits the surface of a heated metal, intense vaporization occurs. As a result, the time of exposure of the coolant to the surface of the roll increases and, in addition, the efficiency of heat removal from the surface of the roll along its width increases. The temperature field of the roll surface is controlled by changing the geometric dimensions of the slot channels. The total area of the slotted channels of the lower wiring should be twice the total area of the slotted channels of the upper wiring. The condition must also be met under which the total area of the slotted channels of the wiring of each subsequent stand must be smaller according to the ratio:

$$S_{i-1} = (1{,}05 - 1{,}15)S_i,$$

where S_{i-1} - the total area of the slot channels in the previous stand;

S_i - area of slot channels of wiring in the subsequent stand.

As a result, the surface temperature of the work roll is maintained in the range of 40-80°C, which prevents the formation of surface defects on smooth rolls.

Figure 2 – Cooling of the strip during rolling

Process lubrication system

The process lubrication system is located on the inside of stands K1, K2 and K3 (Fig. 3).

The process lubrication system sprays an oil-water emulsion from a system of auxiliary manifolds and nozzles into the inter-roll gap of the working rolls of stands K1-K3 in order to reduce coefficient of friction, and consequently the specific pressure of the metal on the rolls and reducing wear of the rolls.

Anti-peeling system

Anti-peeling system should be installed on the inlet side of the stands from K1 to K3 (Fig. 3).

This system includes a collector that irrigates the strip with water to reduce the surface temperature. Reducing the temperature of the strip prevents peeling of the roll surface.

Cross spray system

Nozzles of the transverse water-flushing system must be installed between all stands in order to flush water from the surface of the strip and not allow it to flow in the longitudinal direction, which increases the efficiency of downstream systems (surface cooling and anti-peeling systems).

Dust removal system

The dust removal system consists of a collector installed on the output side of stands K4-K5 (Fig. 3), which sprays water as close as possible to the roll gap to avoid the formation of scale-containing dust and consequently reduce emissions of gases containing dusty scale.

To tension the strip, a looper holder (looper regulator) should also be added to the above configuration. The looper maintains constant strip tension between two successively located stands and controls the balance of interstand material flow, which compensating for changes in strip length and ensures high efficiency of strip width regulation. Dynamic performance is enhanced by the use of a hydraulic actuator directly connected to the looper arm without a reduction gear. Installed in all inter-stand spaces from K1 to K5.

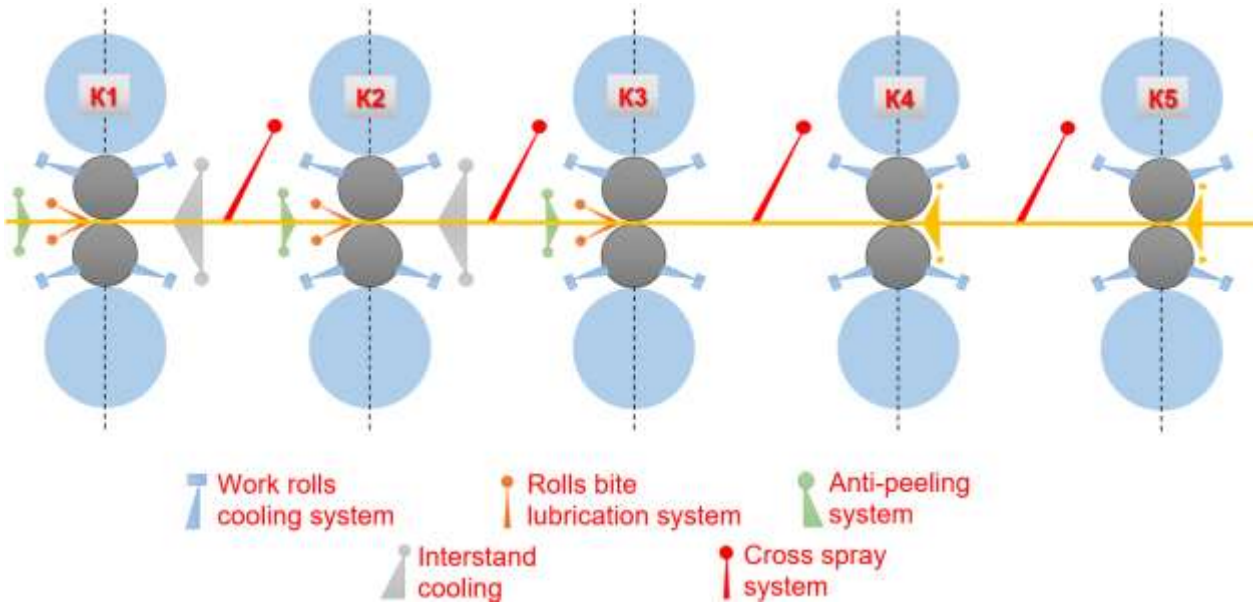

Figure 3 –Stand and strip cooling system configuration

The use of cooling systems, which include interstand cooling in the finishing group of stands and accelerated cooling on the outgoing roller table, can increase the productivity of the mills and improve the mechanical properties of hot-rolled strips, as well as increase the service life of the rolls.

Modern rolling mills are equipped with automated rolling process control systems (APCS) based on measuring sensors, microprocessor controllers and computers. The quality of rolling products will depend on the degree of equipment and methodological use of the automated process control system.

References

[1] .M. Saydumarov. Prokat ishlab chiqarish texnologiyalari. Darslik. Toshkent 2022. 302 b.

[2] Крискович С. М.; Скрипаленко, М. М.; Будников, А. С. Компьютерное моделирование технологических процессов ОМД. – МИСиС, 2019. – 146 с.

[3] Коновалов Ю.В. Справочник прокатчика, Книга 1. Производство горячекатаных листов и полос. – М.: «Теплотехник», 2008. – 640 с.

[4] Мухин Ю.А., Макаров Е.В. Влияние принудительного межклетевого охлаждения полосы в чистовой группе клетей НШСГП на структурообразование металла // Современная металлургия начала нового тысячелетия: сборник научных трудов. Ч.2. Липецк: Издательство ЛГТУ, 2011. 215 с.

[5] Improving of low-carbon hot-rolled strips production at the high acceleration rolling / J.A. Mukhin, V.N. Soloviev, E.V. Makarov// New technologies and achievements in metallurgy and materials engineering: a collective monograph. Czestochowa, 2012.: p. 423-427.

[6] Interstand Cooling – Design, Control and Experience / M. Raudensky1, J. Horsky, D. Hajduk, L. Cecho // Metallurgical and Mining Industry, 2010, Vol. 2, No. 3.: p. 193-202.