Proceedings of the 10th World Congress on Mechanical, Chemical, and Material Engineering (MCM'24)
Barcelona, Spain - August 22-24, 2024
Paper No. ICMIE 134
DOI: 10.11159/icmie24.134

Accelerated Cooling Control Technology for TMCP Plates of Longitudinal Uniform Material Properties

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Extended Abstract

The production of high-strength TMCP (Thermo-Mechanical Control Process) steel plates poses a significant challenge in ensuring a uniform distribution of material properties in the longitudinal direction. High-strength TMCP steel is usually produced using an accelerated cooling[1] device. In this case, it is required to ensure that the temperature of all parts of the steel plate is above Ar3, the temperature at which austenite begins to transform to ferrite during cooling, before entering the accelerated cooling device. When the steel plate undergoes accelerated cooling, it starts water cooling from the leading edge as it passes through the accelerated cooling device, and the trailing edge enters the device last. If the trailing edge stays in the air for too long, it can initiate a phase transformation in the air, resulting in the formation of an air-cooled ferrite structure. As the amount of air-cooled ferrite increases, a significant decrease in strength occurs. In the case of thin plates, it is common to design them with shorter lengths to avoid this phenomenon, although it comes at the expense of productivity.

To address this issue, two methods were developed. Firstly, a speed-up logic was implemented by operating the roller table at maximum speed to minimize the time spent in the air. Secondly, a lengthwise cooling temperature control technology was developed to adjust the FCT(Finish Cooling Temperature) of the tail section. This control method involves 1) increasing or decreasing the cooling water quantity during cooling (Flow Control) 2) controlling the acceleration and deceleration of the roller table to adjust the plate's transfer speed (Speed Control). While the speed-up logic increases SCT (Start Cooling Temperature) equally from head to tail, the lengthwise cooling temperature control allows gradual increase/decrease of FCT in longitudinal direction. The Flow Control gradually increases or decreases the cooling water quantity at intervals of 2~4 seconds. This leads to gradual decrease or increase of FCT in longitudinal direction. The Speed Control adjusts the FCT of tail section by changing the roller table's acceleration. The FCT of the tail section increases if we increase the transfer speed, and vice versa. By employing these methods, it is possible to control the temperature and micro structure of the tail sections of the plate.

These methods were applied to structural steel (60kg grade) for building construction and line pipe(API-X70 grade) steel of thin plates (< 20mmt). After deriving the target temperature that minimizes the difference in material properties between the head and tail sections, the lengthwise cooling temperature control was applied to meet the new FCT of tail section. It was possible to secure similar material properties in head and tail sections. Additionally, the ability to secure the temperature in the tail section, which was previously difficult, allowed for packing three products per one mother plate instead of two, resulting in improved productivity.

In summary, the speed-up and temperature control which adjusts the amount of cooling water and roller table transfer speed, enable the achievement of both productivity enhancement and material assurance by securing uniform material properties in the head and tail sections of high-strength and thin TMCP plates.

References

[1] Lee, J., S. Samanta, and M. Steeper., "Review of accelerated cooling of steel plate," *Ironmaking & Steelmaking*, vol. 42, no. 4, pp. 268-273, 2015.