World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:9, No:01, 2015

The Effect of Discontinued Water Spray Cooling on the Heat Transfer Coefficient

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Abstract : Water spray cooling is a technique typically used in heat treatment and other metallurgical processes where controlled temperature regimes are required. Water spray cooling is used in static (without movement) or dynamic (with movement of the steel plate) regimes. The static regime is notable for the fixed position of the hot steel plate and fixed spray nozzle. This regime is typical for quenching systems focused on heat treatment of the steel plate. The second application of spray cooling is the dynamic regime. The dynamic regime is notable for its static section cooling system and moving steel plate. This regime is used in rolling and finishing mills. The fixed position of cooling sections with nozzles and the movement of the steel plate produce nonhomogeneous water distribution on the steel plate. The length of cooling sections and placement of water nozzles in combination with the nonhomogeneity of water distribution leads to discontinued or interrupted cooling conditions. The impact of static and dynamic regimes on cooling intensity and the heat transfer coefficient during the cooling process of steel plates is an important issue. Heat treatment of steel is accompanied by oxide scale growth. The oxide scale layers can significantly modify the cooling properties and intensity during the cooling. The combination of the static and dynamic (section) regimes with the variable thickness of the oxide scale layer on the steel surface impact the final cooling intensity. The study of the influence of the oxide scale layers with different cooling regimes was carried out using experimental measurements and numerical analysis. The experimental measurements compared both types of cooling regimes and the cooling of scale-free surfaces and oxidized surfaces. A numerical analysis was prepared to simulate the cooling process with different conditions of the section and samples with different oxide scale layers.

Keywords : heat transfer coefficient, numerical analysis, oxide layer, spray cooling
Conference Title : ICMME 2015 : International Conference on Metallurgical and Materials Engineering
Conference Location : London, United Kingdom
Conference Dates : January 19-20, 2015