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Finite volume method for temperature distribution of steel strip in run out table

Subhamita Chakraborty[1], **Shubhabrata Datta**[2] and **Partha Protim Chattopadhyay**[1]
[1]Indian Institute of Engineering Science and Technology, India
[2]Bankura Unnayani Institute of Engineering, India

Under controlled cooling condition, low temperature transformed product of austenite draws much attention in manufacturing high strength steel in hot strip mill. In almost all hot strip rolling mills, controlled cooling after finish rolling of the steel strip takes place on cooling section. Emerging from last finish stand mill, the hot strip is subjected to spraying water by a number of headers placed at regular intervals along the length of the run out table (ROT). During the cooling process, the heat of strip surface is quickly transferred to spraying water/air and the heat of inner strip is conducted to the surface. Then, strip temperature is gradually decreased to the target coiling temperature. The reliable prediction of temperature profile is essential in order to accesses the evolution of microstructure at different location of steel strip. Therefore, it is necessary to improve the agreement between the calculated and the experimentally determined temperature profile. Finite Volume Method (FVM) is used to predict temperature distribution of the steel strip in Run–Out-Table (ROT) of the hot strip mill. FVM enforces conservation of mass, momentum and energy using the control volume concept leading to enhanced accuracy of the prediction. The cooling behaviour of the strip in ROT is studied using the two-dimensional heat distribution equation (1).

$$\rho c \frac{\partial}{\partial t}(T) = \frac{\partial}{\partial x}(k \frac{\partial T}{\partial x}) + \frac{\partial}{\partial y}(k \frac{\partial T}{\partial y})$$

where T is temperature, k is thermal conductivity, ρ is density, cp is specific heat, t is time, x is the coordinate along the length and y is the coordinate along the strip thickness. For modelling purpose, the total length of ROT is divided into three different zones including inlet region, water jet cooling region and outlet region. At inlet and outlet region, the strip is cooled in air, while at jet cooling region strip is cooled by water jet. Heat transfer equation (1) is solved using finite volume method in cell centered approach. The temperature distribution of the small portion of the strip in ROT is simulated. The predicted temperature distribution profile of the strip in ROT is compared with experimentally determined temperature profile of the strip. Excellent agreement has been observed between predicted and experimental temperature profile.

subhamita.2006@gmail.com

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