Abstract

The cooling rate of steel strips on a Run-out Table (ROT) in a hot strip mill affects both the metallurgical microstructure and mechanical properties. In comparison to conventional laminar cooling methodology, cooling rates are obtained in the ultrafast regime (where the product of heat transfer rate in *°C/s* and plate thickness in *mm* is greater than 800) in case of forced jet cooling. Hence, jet impingement cooling is employed to achieve higher cooling rate, especially in high heat flux applications due to high values of local heat transfer coefficients. However, low thermal conductivity was found to be a major constraint in developing energy efficient heat transfer fluids during the cooling process. Nanofluids, prepared by the suspension of nanoparticles in water, have been found to enhance the thermo-physical properties of the base fluid and increase the active nucleation site density, thereby improving the cooling rate of the steel surface. Furthermore, the presence of additives affects the surface active nature of the resultant nanofluid, thereby enhancing the boiling heat transfer and critical heat flux (CHF) value. Metal oxide/hydroxide nanofluids in the presence of surfactants were found to give cooling rates in the ultrafast regime due to improved thermal properties.

Therefore, the primary objective of the current research is to contribute to the enhancement of cooling rate of a hot steel plate using different additive based nanofluid coolants. The heat transfer studies during jet impingement have been carried out in the case of a steel plate (100 *mm* x 100 *mm* x 6 *mm*) from an initial temperature of around 900*°C* at the surface. In order to measure the transient temperature during cooling, three sub-surface K-type thermocouples are inserted in parallel to the plate at different longitudinal directions. A data acquisition system is used to measure the thermocouple input signals at a sampling frequency of 10 *Hz* during cooling. The sub-surface temperature data collected through the thermocouples is used for inverse heat conduction calculation in order to estimate the temperature histories and heat flux at the surface using INTEMP solver. The base fluid used for the study is pure water, into which different nanoparticles and surfactants are added to prepare the final coolant. A maximum cooling rate of 154 *°C/s* was achieved in the case of Cu-Al LDH/Tween 20 nanofluid, which was 71 % higher than that achieved using pure water coolant.

Keywords: CHF; Jet impingement; Heat transfer enhancement; Nanofluid; Surfactants; Ultrafast cooling.