

Abstract

High heat flux removal from hot moving surfaces is important in case of several industrial processes like heat extraction from hot steel plates on the run-out table (ROT) of a hot strip mill. The rate of heat extraction determines the metallurgical and mechanical properties of the steel. Therefore, the present investigation focuses on achieving ultrafast cooling (UFC) of a moving steel plate by applying different cooling techniques like jet and air atomized spray impingements. The major limitation with the conventional cooling technique is the Leidenfrost phenomenon at high initial temperature of the plate. This problem can be minimized by using air atomized spray cooling.

An indigenously designed and fabricated moving bed experimental setup has been used for conducting the experiments. During the cooling experiments, the subsurface temperature of the plate has been recorded with the help of three thermocouples inserted in the plate. The surface temperature and surface heat flux have been calculated by applying inverse heat conduction method.

The effects of variation of experimental parameters on the cooling rate during jet and air atomized spray cooling with pure water have been studied. The findings are summarized for the unique combination of parameters for which ultrafast cooling rate is achieved in both the cooling techniques. The combination of these parameters has been further used in experiments for different types of coolants (surfactant added water, nanofluids etc.). The result shows that the surfactant added water is not beneficial for the cooling of a moving plate; whereas, the cooling rate enhances with the use of nanofluids. The maximum cooling rate achieved with air atomized spray impingement by using the alumina nanofluid as a coolant is 230°C/s , which is 61% higher than that achieved with water cooling.

Keywords: Atomized spray; Cooling rate; Nanofluids; Nucleate boiling; Response surface methodology; Surfactant; Water jet