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HEAT TRANSFER IN SPRAY QUENCHING

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ABSTRACT:

The focus of this experiment is to investigate the spray quenching characteristics and heat transfer rate of H-40 steel plate under a atmospheric conditions. Cooling of tool steel surfaces with flat nozzles was studied experimentally. The importance of coolant temperature on coefficient of heat transfer was investigated. Experiment test were performed with H-40 steel plate using two different method direct water deeping and air-water spray cooling(water and ethylene glycol). Experiments were conducted on an heated flat rotary steel plate of dimension 200 mm x 6 mm. The cooling rates were calculated from the time dependent temperature profiles were recorded during the experiment conducted.

KEYWORD: Forced convection, Heat transfer, spray cooling, rotary plate

INTRODUCTION:

The compounding problem of high-flux heat transfer from electronic and power devices has created an urgent need for effective cooling. Spray cooling performance depend on a number of parameters including nozzle, orifice-to-surface distance, heated surface size, spray orientation relative to surface. This article is based on an experimental study, which was conducted to calculate the rate heat transfer of a H-40 steel plate which will generally used in industries to sheet metal work.

One of the more important yet illusive parameters in spray cooling is subcooling. Most data upon which CHF correlations are based are for fluids that are intended for cooling of electronic devices. In this test we calculate the best method to transfer heat from steel plate and also the property of material will remains constant or any change in material property. In this test we give some rotation to the heated H-40 steel plate to get better cooling on the plate. Plate will be heated on the boilers Furness the temperature up to 1000 ^{0}c. The temperature will be measured using the Infrared gun has temperature ranges from 50-550^{0}cThis simple powerful criterion consists of setting the orifice-to-surface distance such that the spray impact area just inscribe the square heated surface.

Many articles about cooling in metallurgical industry and factors which have the biggest importance on heat transfer. Only a small number of them deal with the importance of coolant temperature. The electronic systems of today are embedded with large amount of minute circuits which makes it more compact and faster in processing speed. Thus it required a large amount of Power. Otherwise the heat thus generated will harm and affect the performance of the system. The reason behind to keep an eye on this investigation is that it is the next generation of heat transfer fluid. A number of experimental and theoretical studies have been conducted to understand the physics of the heat transfer due to impinging jets over a flat plate. Impact of air or water jet cooling techniques is very useful for many other applications like drying of papers and films, cooling of gas turbine and electronic elements.

EXPERIMENTAL SETUP:

The experimental setup consists of three systems:

1) The liquid delivery system
2) The spraying system
3) The plate rotating system.

The schematic of the entire experimental arrangement is demonstrated in Fig. 1.

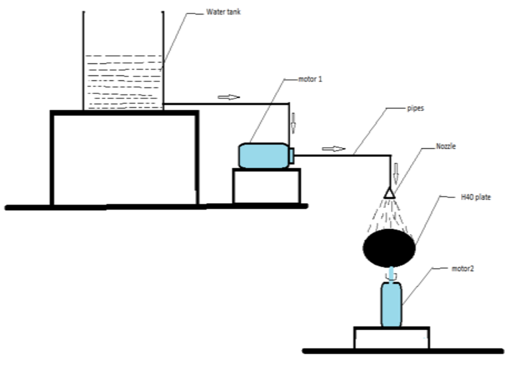

Fig.2 Consructional dig. of spray quenching

Several equipment are used in the setup of the liquid delivery system. A stainless-steel water tank supply the pressurized water with the help of 0.5HP motor has 2800 rpm and discharge of water by nozzle is 850lit/hr. And the motor used to rotate the heated steel plate is having 1400 rpm at the normal condition and with the heated plate rpm will be changed due to the weight of plate and it will be 230rpm. The liquid flow in the system has velocity of 2.87m/s. the extra outlet will be provided to the system to maintain the extra developed pressure of the system. A shut-off valve is used to switch on/off the main line flow, and an in-line filter to filtrate the impurities in water. also the change in temperature will be measured using the infrared temperature gun.

EXPERIMENTAL PROCEDURE:

The steel plate is heated to a temperature higher than the test temperature because some amount of heat is lost from the heated test plate during the transfer from heater to the setup. Then hot steel plate is taken out of Furness on the test bed (underneath the air atomizing nozzles). While the temperature of the steel plate dropped the required temperature, the spray was turned on and impinged on the hot plate surface.

Firstly the heated plate will be removed from the Furness and when the required test temperature will be maintained then the plate will be directly deepen into the water and the change temperature will be measured by 5 seconds difference up to the plate maintain the room temperature. After that the second plate will be removed from the Furness and kept on the bed to give the rotation the motor will be started and the water spray will be started and the temperature measurement will be taken out with the help of infrared temperature gun by the difference of 5 seconds. this same procedure will repeated to the next method in wich the ethylene glycol mixed in water by the ratio of 3:1.

RESULT AND DISCUSSION:

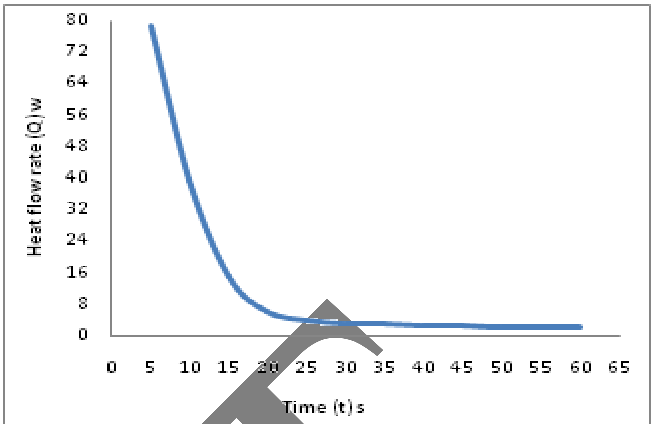

Fig. 2 Ethylene Glycol Spray Quenching

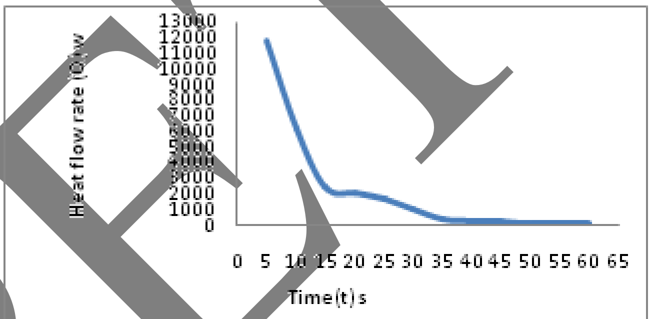

Fig.2 Water Spray Quenching

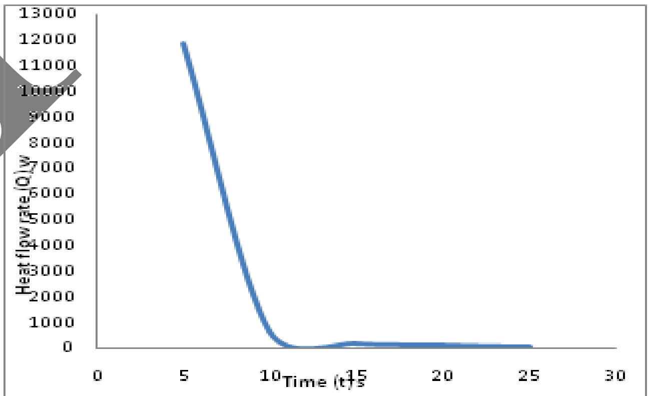

Fig.3 Water Deeping

Above are some graphical representation of our experiment results. Graphs are Heat flow rate (Q)in watts vs Time (t)in second this will clearly show you that the flow rate will be initially at high rate but after few seconds it will drop instantly and then goes normal cooling. The Heat transfer coefficient for water quenching is 916.56 W/(m2K) and for ethylene glycol it is 6.67 W/(m2K) that is the heat transfer coefficient is high for water quenching.

Comparing above three different graphs we getting that the time required for ethylene glycol is less as compare to water quenching. Subcooling has no appreciable effect on evaporation efficiency. Efficiency is greater for low volumetric fluxes and nozzles that produce smaller droplets.

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