"EXPERIMENTAL INVESTIGATION OF DIFFERENT OPERATING PARAMETERS ON HEAT TRANSFER CHARACTERISTIC USING IMPINGEMENT SPRAY COOLING IN PRESENCE OF SURFACTANT"

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ABSTRACT:

In the present industrial globalization, thermal control or heat removal process from the hot surface (where cooling is essential) is very important issue, because the quality and reliability of the parts and components is dependable on the operating temperature. Now days we are using other methods such as cooling fans, direct water flow over the surfaces in some processes in some industries which are not the effective techniques.

Spray cooling processes are known to yield high heat transfer coefficients due to high heat rates associated with latent heat at absorption during liquid vapor phase transition of the spray cooling methods which are employed in current electronics cooling applications. Heat transfer enhancement is one the major parameters required to improve the performance of the thermal system in any industries such as Electronics, Aerospace, Automotive and steel manufacturing. Jet impingement cooling and spray impingement cooling are two of the most effective ways to improve the rate of heat transfer from the hot metal surface spray. Impingement cooling helps to achieve desired cooling rates from the surface by appropriate parametric control during the cooling process. Hence this process finds its use in many cooling application in particular to metal processing industry.

Different Industrial applications required high heat removal rate in order to provide efficient cooling for reliable working and its operational life. There are different ways to achieve uniform cooling .1.Microchanel Cooling, 2. Jet impingement cooling, 3. Spray impingement cooling. Out of these three methods Spray cooling have some advantages like low fluid inventory, Compact in size, light weight with few moving components, uniformity of cooling and isothermally. Due to the above mentioned advantages spray finds their use for cooling in number of industrial applications for example: HVAC, Laser guided weapons, Supersonic Flights, Agriculture, Cooling of super computers and many others. In the spray cooling properties under consideration are the different nozzle operating pressure, effect of mass flux, effect of surface enhancement, cooling effect, optimisation of various enhance surface with respect to nozzle diameter fluid properties under consideration and experimental investigations are thermal conductivity of liquid, surface tension of liquid, specific heat of liquid, latent heat of vaporization and lastly Calorimeter design properties are: super heat of heater, surface wet ability surface size, thermal diffusivity of subtract. It can be concluded that parameter which are the most significant parameter and sub significant parameters further used to these parameters to optimize and the considered parameters on heat transfer coefficient (HTC) using impingement spray cooling.

To achieve more cooling effect it is very necessary that penetration of working fluid should be high. So to increase the penetration we mix a little amount of surfactant in fluid by which surface tensial property of fluid decreade and good penetration can be obtained.

OBJECTIVE OF PRESENT WORK:

The main Objective of the work: To do comparative study of heat transfer characteristics by using surfactant (sodium lauryl sulphate) and distilled water by below mentioned parameters:

1. At different Nozzle operating pressures
2. Surface enhancement (rectangular, triangular) on heat transfer coefficient.
3. At standoff distance between nozzle and heated surface.

EXPERIMENTAL SET UP:

The major component of the experimental set up as shown in figure1. In which these components are heater target assembly, accumulator, intensifier, calorimeter, water tank, and compressor. A reciprocating plunger pump supplied high pressure water from the nozzle to the target surface .This high pressure water is further accelerated by mixing it with compressed air .The mixture of air & water is targeted over the test surface supplied to the nozzle via accumulator. A water filter is employed on the pump suction to maintain a clean water supply to the nozzle. On the delivery side, a pressure relief valve, pressure gauge, a flow control valve, nozzle and a pneumatic pulsation damper are place in order.
To maintain the water supply to the nozzle. The pressure relief valve was adjusted to the required pressure. The water flow rate has been varied by the inlet pressure the top surface (i.e. heating surface) of the block was kept horizontal to ensure that water drives equally in all horizontal surface and the uniform film is formed on the surface.

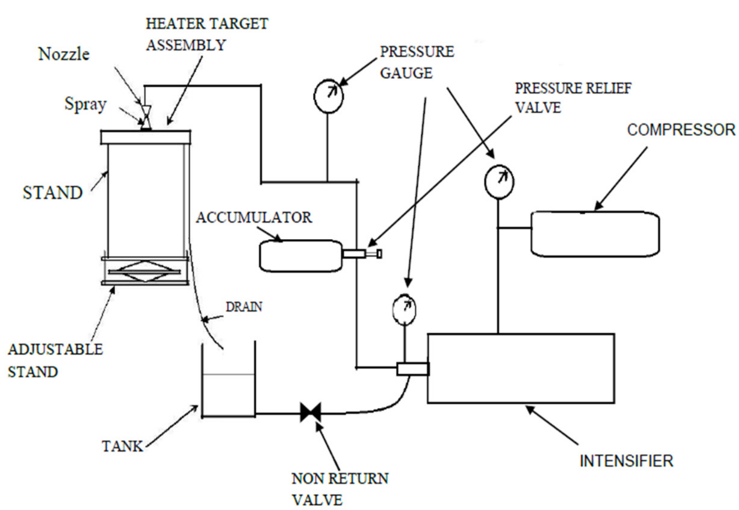

Figure.1:- Experimental Setup

THE EFFECT OF WATER AND SURFACTANT AS MEDIUM TAKING DISTANCE BETWEEN HEATED SURFACE AND NOZZLE AS PARAMETER:

1.1 FOR TRINGULAR ENHANCED SURFACE:
At 2 bar pressure, the graph indicates that the value of the heat transfer and heat transfer coefficient varies according to the height of the distance for 5 cm height the result were obtained maximum while for 10 cm distance the result obtained were minimum.
At 4 bar pressure, it is observed that due to the increment in the mass flux the values for 6.5 cm and 10 cm. For 5 cm height still the results were maximum.

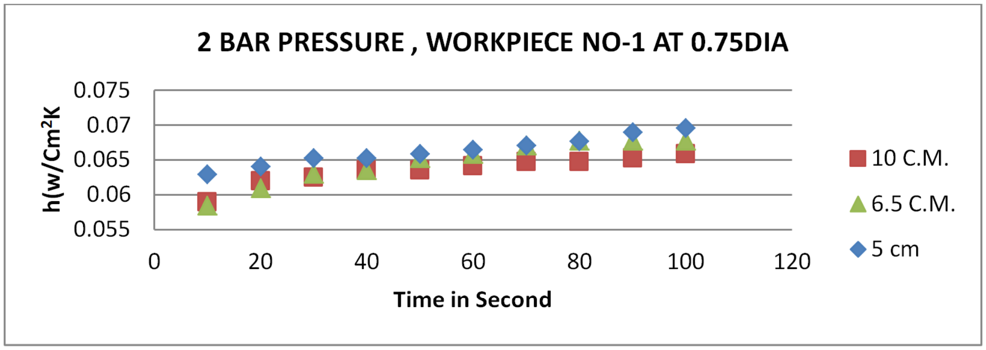

Fig.2.Variation of h, For 2 Bar, Triangular enhanced surface for surfactant for different standoff distance.

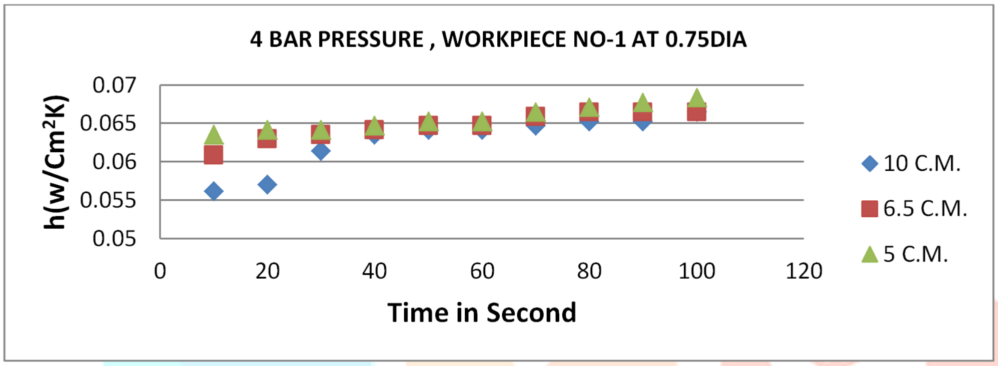

Fig.3.Variation of h, For 4 Bar, Triangular enhanced surface for surfactant for different standoff distance

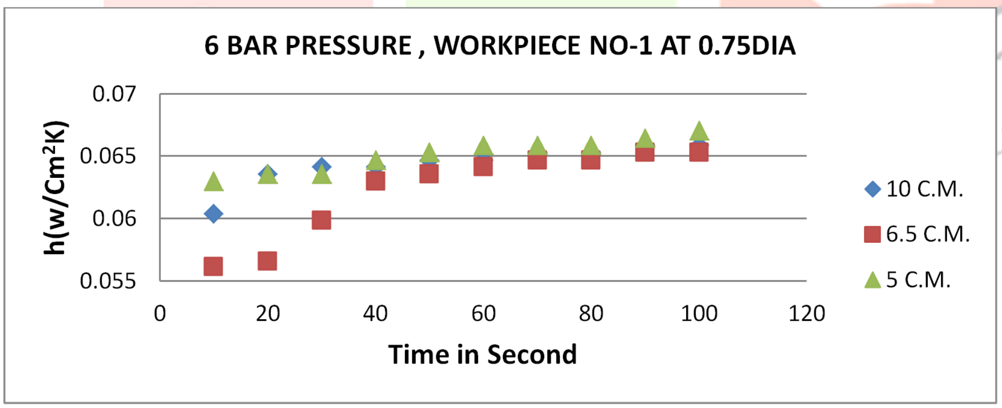

Fig.4.Variation of h, For 6 Bar, Triangular enhanced surface for surfactant for different standoff distance

At 6 bar, For the 5 cm distance the heat transfer rate and the heat transfer coefficient obtained was maximum. The difference which was observed between the previous graphs was that the result for 10 cm height was better than the 6.5 cm height.

1.2 FOR RECTANGULAR ENHANCED SURFACE

The maximum rate of the heat transfer and resultant heat transfer coefficient was observed during this experiment. It was found that at 5 cm height for water using rectangular enhanced surface was proved best option among all. Graph followed that as height increased the value of the heat transfer decreases.

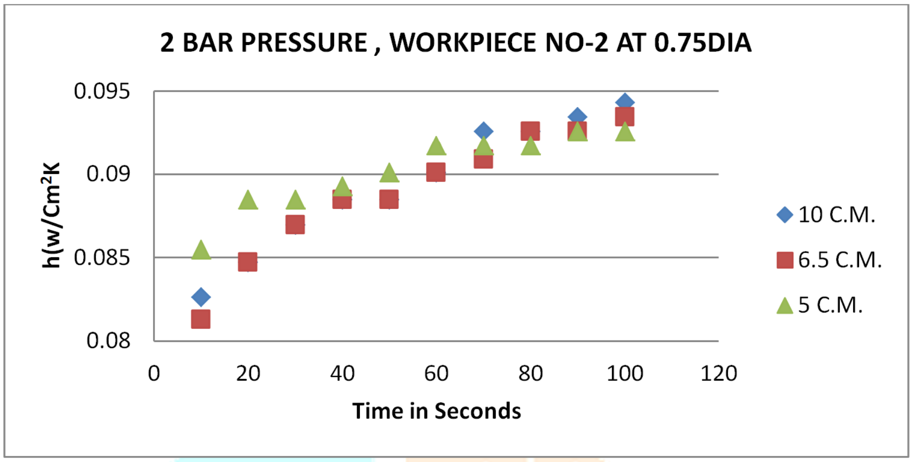

Fig.5.Variation of h, For 2 Bar, Rectangular enhanced surface for surfactant for different standoff distance

At 6 bar, the heat transfer rate and heat transfer coefficient were found maximum at the height of 6.5 cm. The result for 5 cm distance was found slightly less compared to 6.5 cm of distance.

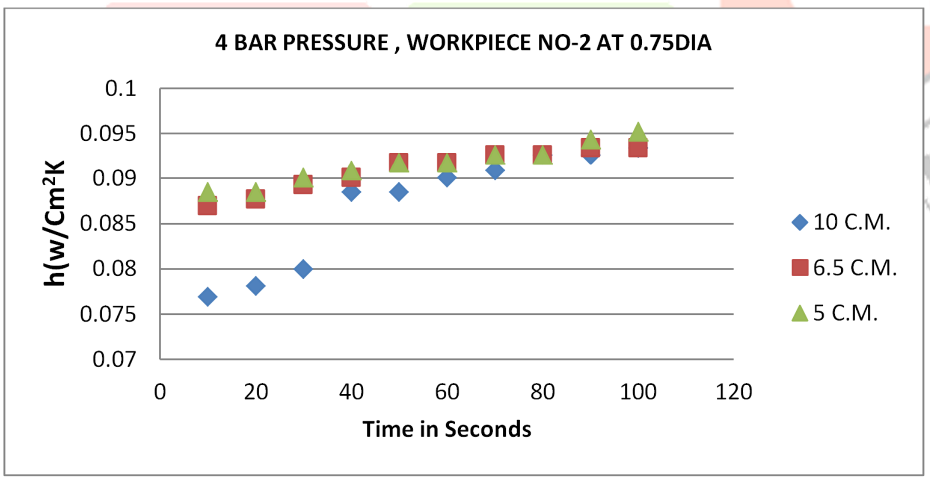

Fig.6.Variation of h,For 4 Bar, Rectangular enhanced surface for surfactant for different standoff distance

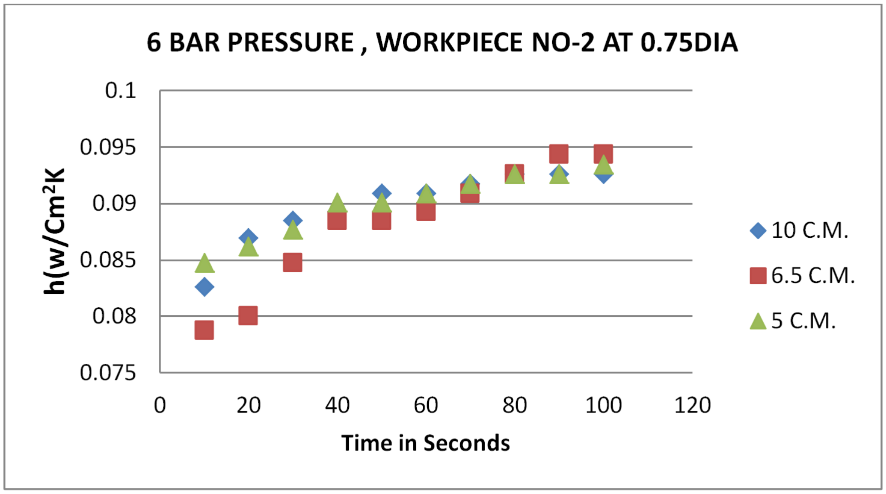

Fig.7.Variation of h, For 6 Bar, Rectangular enhanced surface for surfactant for different standoff distance

So, it may be said that the distance between the nozzle and the heated surface is inversely proportional to the heat transfer coefficient.

1.3 THE EFFECT OF ADDING SURFACTANT TO WATER:

It was found that the addition of surfactant to water increases the heat transfer rates. The surfactant increases the nucleation of bubbles and the formation of spray. The surface tension is also may be reduced by adding surfactant to water. It upgrades the foaming which plays efficient role in increasing heat transfer rates. It is also observed that the cooling time is decreased by adding surfactant. The experiments which were performed using surfactant gave satisfactory results which may be seen in form of heat transfer coefficients, temperature drop and heat transfer rate.

2.0 Conclusions

The aim of present study is to investigate the heat transfer characteristics of the mixture of surfactant(Sodium Lauryl sulphate) with water and water separately. The temperature of heated was taken below saturation temperature at initial stage.

Effect of operating parameters such as nozzle pressure, distance of stand, enhanced surfaces on heat transfer has been studied.

Following conclusions are made during the experiment; these were various effects on cooling of copper enhanced surfaces by changing the different operating parameters of spray cooling are described below:

1. The operating pressure of nozzle is an very important factor to attain required amount of heat transfer which is essential to achieve high heat transfer coefficient.

2. The distance between nozzle and heated surface play an very important role to achieve good results. Increment in distance of height caused the low heat transfer rate. The rate of heat transfer depends on the distance between nozzle and heated surface.

3. To get high heat transfer as well heat transfer coefficient the mass flux should be increased. It helps to get high liquid velocity over the surface which results the thinner thermal boundary layer as droplet impact also increases.

4. The heat transfer rate on triangular enhanced surface is found less compare to rectangular enhanced surface because the area of contact was less so that the layer formation could not happen.

5. The study of surfactant is another key factor. The appropriate amount of mixture should be prepared to obtain proper heat transfer rates.

3.0 Future scope

By the experiment and conclusions of this study. Some additional topics may be discussed in future.

- Investigation of the different surfactant, Nano fluid may be done to get better heat transfer rate.
- Some more enhanced surfaces may be investigated for future study.
- Pressure may be increased to certain limits to see the effect on the heat transfer characteristic.
- The distance between the nozzle and the heated surface may be varied.