

HEAT TRANSFER COEFFICIENT IN NATURAL CONVECTION

AIM:

To determine the heat transfer co-efficient in natural convection for vertical tube

INTRODUCTION:

Heat transfer can be defined as the transmission of energy from one region to another as a result of temperature difference between them. There are three different modes of heat transfer; namely conduction, convection and radiation

Conduction: The property which allows passage for heat energy, even though their parts are not in motion relative to one another.

Convection: is the transfer of heat within the fluid by mixing one portion of fluid with another.

Heat Radiation: The property of emit or to absorb different kind of ratio of electromagnetic waves.

Out of these type of heat transfer the convective heat transfer which of concern, divides into two categories viz.,

Natural Convection: If the motion of fluid caused only due to difference in density resulting from temperature gradients without the use of pump or fan, then the mechanism of heat transfer is known as “natural or free convection”.

Forced convection: If the motion of fluid is induced by some external means such as a pump or blower.

The Newton's law of cooling in convective heat transfer is given by

$Q = h A \Delta T$, where Q = heat transfer rate in watts

A = surface area of heat flow in m^2

ΔT = overall temperature difference between the wall and fluid

h = convection heat transfer co-efficient in watts

This setup has been designed to study heat transfer by natural or free convection

Calculations:

Determination of experimental heat transfer co-efficient: For steady state condition, heat given to heater = Heat lost from the tube surface by natural convection.

Therefore, $Q = h A_s (T_s - T_\infty)$

Where,

$Q = (\text{Ammeter reading}) \times (\text{Voltmeter reading})$, in watts

$D = \text{Diameter of tube} = 45 \text{ mm}$

$L = \text{length of the tube} = 450 \text{ mm}$

$A_s = \text{Tube surface area} = \pi D L = \quad \text{m}^2$

$T_s = (T_1 + T_2 + T_3 + T_4 + T_5 + T_6 + T_7) / 7 = \quad ^\circ\text{C}$

$T_\infty = T_8 = \text{Ambient air temperature} = T_8 = \quad ^\circ\text{C}$

Therefore,

Heat transfer co-efficient, $h_{\text{expt}} = Q / A_s (T_s - T_\infty) = \quad \text{W/m}^2\text{K}$

Determination of Theoretical heat transfer co-efficient:

The theoretical value of the natural heat transfer co-efficient is calculated given by:

Note down the properties of air t from data hand book

$T_m = (T_s + T_\infty) / 2 = \quad ^\circ\text{C}$

At mean temperature properties of air should be noted down from the HMT data hand book.

$\nu = \quad \text{m}^2/\text{s}$

$k = \quad \text{W/mK}$

$Pr =$

$\beta = 1 / (T_m + 273) = \quad \text{K}^{-1}$

$\Delta T = (T_s - T_\infty) = \quad ^\circ\text{C}$

$g = 9.81 \text{ m/s}^2$

$Gr (\text{Groshoff No.}) = (g \beta L^3 \Delta T) / \nu^2 =$

$Nu =$ choose the equation from data book based on $Gr.Pr$

$$\text{Nu} = \frac{hL}{k},$$

$$h_{\text{th}} = \quad \text{W/m}^2\text{K}$$

RESULTS

$$h_{\text{exp}} = \quad \text{W/m}^2\text{K}$$

$$h_{\text{th}} = \quad \text{W/m}^2\text{K}$$