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 form one region 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 =over all 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

Apparatus:

1. A metallic tube of diameter (d) 45 mm and length (L) 450mm with a electrical heater coil along the axis of the tube.

- 2. Seven thermocouple are fixed on the tube surface.
- 3. Control panel instrumentation consists of multichannel digital display
 - a)Temperature indicator to measure surface temperature T1 to T7 of the tube and ambient temperature T8.
 - b) Digital ammeter and voltmeter to measure power input to the heater.
 - c) Regulator to control the power input to the heater.
- 5. Front transparent acrylic enclosure for safety of the tube when not in use.

OPERATIONAL PROCEDURE:

- 1. Keep the tube in vertical position.
- 2. Switch ON the mains and the control.
- 3. Set the regulator to set the heat input.
- 4. Wait for sufficient time to allow temperature to reach steady values.
- 5. Note down temperatures T1 to T8 using channel selector and digital temperature indicator.
- 6. Note down the Ammeter and Voltmeter readings.
- 7. Tabulate the heat input and transfer co-efficient using the procedure.
- 8. Calculate the convection heat transfer co-efficient using the procedure given below.
- 9. Repeat the experiment by changing the heat input.

Sl.NO	Heat	Input		Temperature along the tube							Average tube Temperature	Ambient Temperature	Convective heat transfer coefficient	
	V	Ι	Q	T1	T2	T3	T4	T5	T6	Τ7	T_{av}	Τ8	h _{th}	h _{ex}

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 As (Ts-T∞)

Where,

Q = (Ammeter reading) x (Voltmeter reading), in watts D D= Diameter of tube= 45 mm L= length of the tube = 450 mm As=Tube surface area = π D L = m² Ts= (T1+T2+T3+T4+T5+T6+T7)/7 = °C T ∞ = T₈ = Ambient air temperature=T8= °C Therefore, Heat transfer co-efficient, h_{expt}= Q/As (Ts-T ∞) = W/m²K

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

 $Tm = (Ts+T\infty)/2 = ^{\circ}C$

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

 $v = m^2/s$

k= W/mK

Pr=

 $\beta = 1/(Tm + 273) = K^{-1}$

$$\Delta T = (Ts - T\infty) = ^{\circ}C$$

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

Gr (Groshoff No.) = (g $\beta L^3 \Delta T$)/ ν^2 =

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

Nu = hL/k,

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

RESULTS

h_{exp=} W/m²K

 $h_{th=}$ W/m²K