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# Investigation of Heat Transfer Co-Efficient in Cylindrical Shaped PIN-FINS

[1]Sharad N. Koyale, [2]Ruturaj N. Londhe [3]Vaibhav G. Talandage
[1][2] U.G. Student [3] Assistant Professor
[1][2][3]Mechanical Engineering Department, Dr. J. J. Magdum College of Engineering, Jaysingpur.

*Abstract:--* **Pin-fin heat sinks show their great merits of thermal management in high heat flux devices in micro-electronics, energy and aerospace and in heat exchange equipment. Compact heat transfer mechanism is needed to remove the heat flux and increasing heat transfer rate. In this study, three cylindrical pin-fins with different materials i.e. mild steel, brass and aluminium are of same sizes studied experimentally with forced heat transfer technique. How the efficiency and heat transfer rate are affected by the changing in Reynolds number. Heat transfer coefficient changes by changing the material and flow properties, result in an increasing heat transfer rate over the plane channel. This study is to experimentally examine the effect of cylindrical pin-fins of brass, aluminium and mild steel on the heat transfer rate at various Reynolds number with considerable practical importance.**

*Keywords:--* **Pin-fin, heat transfer coefficient, Reynolds number**

## I. INTRODUCTION

Extended surfaces of fins are used to increase the heat transfer rate from a surface to a fluid wherever it is not possible to increase the value of the surface heat transfer coefficient or the temperature difference between the surface and the fluid. Circumferential fins around the cylinder of a motorcycle engine and fins attached to condenser tubes of a refrigerator are a few familiar examples.

It is obvious that a fin surface sticks out from the primary heat transfer surface. The temperature difference with surrounding fluid will steadily diminish as one move out along the fin. The design of the fins, therefore, required knowledge of the temperature distribution in the fin. The main objective of this experimental setup is to study the temperature distribution in a simple pin fin.

## II. NOMENCLATURE:

V = Voltage, V

I = Current, Amp

= Difference in manometer, mm

= Average fin temperature,

= Mean film temperature,

= Rise in temperature,

= Duct temperature,

d = Diameter of the orifice, mm

D = Diameter of the pin-fin, mm

L = Length of the pin-fin, mm

= Coefficient of discharge

g = Acceleration due to gravity,

P = Perimeter of the pin-fin, mm

Q = Air flow rate,

V = Velocity of air in the duct,

= Density of water,

= Density of air,

= Thermal conductivity of air,

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= Cross-Sectional area of the fin,

= Kinematic viscosity,

h = Heat transfer coefficient,

= Reynolds's number

= Nusselt's number

M = Slope of heat transfer line,

= Efficiency of fin,

= Emissivity of fin

***Experimental setup*:** A fin of cylindrical shape in fitted across a long rectangular duct. Other end of the duct is connected to the suction side of a blower and the air flow the past the fin perpendicular to the axis. One end of the fin project outside the duct and connect to the heater. Temperature measured at five points along the length of the fin. Air flow rate is measured by an orifice meter fitted on the delivery side of the blower. Current and voltage is measured by ammeter and voltmeter respectively which is fitted on control panel. Dimmer stat is also mounted on control panel which is used to vary the heat input to the base of fin.

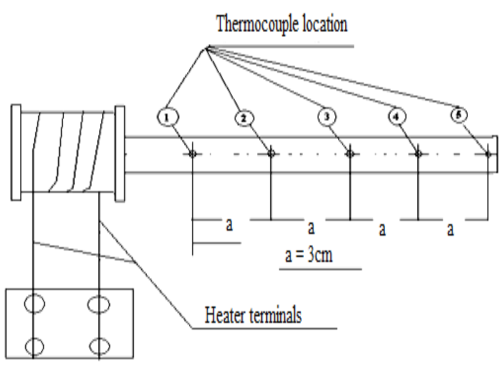


*Fig.1 Cylindrical fin with thermocouple*


*Fig.2 Experimental setup*

***Procedure:***

Start heating the fin by switching ON the heater and adjust dimmer stat voltage equal to 80 volts.

Start the blower and adjust the difference of level in the manometer with the help of a gate valve.

When the steady state is reached, record the final reading (1) to (5) and also record the ambient temperature reading (6).

Repeat the same experiment with different manometer readings.

***Precautions:***

See that the dimmer stat is at zero position before switching ON the heater.

Operate the changeover switch of temperature indicator, gently.

Be sure that the steady state is reached before taking the final reading.

See that throughout the experiment, the blower is OFF.

***Governing equations:***

***1. Average temperature of fin***

$(T_m)$ =

 

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***2. Rise in temperature***

() = ($T_m T_f$)

***3. Mean film temperature***

() = ( )

With the help of we calculate the density of air (), thermal conductivity of air () and kinematic viscosity (υ).

***4. Air flow rate***

(Q)=$d^2C_d$

***5. Velocity of air***

(V) = m/sec

***6. Reynolds's number***

($R_e$) =

***7. Nusselt number***

($N_u$) = 0.683

***8. Heat transfer coefficient***

(h) =

9. m =

10. Efficiency of fin *()* =

11. Effectiveness of fin () =

***Specification:***

Duct size= 150 mm 100 mm.

Diameter of the fin = 12 mm.

Diameter of the orifice = 27 mm.

Diameter of the delivery pipe= 28 mm.

Coefficient of discharge ($C_d$) = 0.64.

Centrifugal Blower 1 HP single-phase motor.

No. of thermocouples on fin = 5.

(1) to (5) as shown in fig.1 and indicated on the temperature indicator.

Thermocouple (6) reads ambient temperature inside of the duct.

Thermal conductivity of fin material (Brass) = 110 w/m $^0$C.

Temperature indicator = 0–300 $^0$C with compensation of ambient temperature up to 50$^0$C.

Dimmer stat for heat input control 230V, 2 Amps.

Voltmeter =0 – 100/200 V.

Ammeter=0–2Amp

***Table1: Observation table***

| Sr. No | Fin Material | V | Fin Temperature | | | | |
|---|---|---|---|---|---|---|---|
| | | | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| 1. | Brass | 80 | 40 | 32 | 30 | 28 | 27 |
| | Aluminium | 80 | 38 | 29 | 24 | 29 | 29 |
| | Mild Steel | 80 | 34 | 24 | 21 | 19 | 19 |
| 2. | Brass | 100 | 59 | 46 | 43 | 39 | 37 |
| | Aluminium | 100 | 57 | 41 | 33 | 41 | 41 |
| | Mild Steel | 100 | 47 | 31 | 26 | 22 | 22 |
| 3. | Brass | 120 | 74 | 57 | 53 | 47 | 46 |
| | Aluminium | 120 | 69 | 52 | 40 | 49 | 49 |
| | Mild Steel | 120 | 59 | 38 | 32 | 27 | 26 |

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*Table2: Result of Observation*

| Sr. No. | Temp^r | $R_e$ | $h_{Brass}$ | $h_{Aluminium}$ | $h_{MildSteel}$ |
|---|---|---|---|---|---|
| 1. | 80 | 715.25 | 31.32 | 31.42 | 31.52 |
| | 80 | 610.94 | 29.18 | 29.14 | 29.11 |
| | 80 | 512.72 | 26.83 | 26.64 | 27.29 |
| 2. | 100 | 696.22 | 31.82 | 31.48 | 31.34 |
| | 100 | 578.88 | 29.57 | 29.55 | 27.98 |
| | 100 | 491.62 | 27.16 | 27.05 | 26.55 |
| 3. | 120 | 679.02 | 31.03 | 31.57 | 31.45 |
| | 120 | 565.24 | 29.80 | 29.62 | 27.99 |
| | 120 | 488.77 | 27.39 | 27.63 | 26.58 |

***Graph 1:***
Overlapping graph of heat transfer coefficient (h) Vs. Reynolds number ($R_e$)

***Graph 2:***
Overlapping graph of heat transfer coefficient (h) Vs. Reynolds number ($R_e$):

***Graph 3:***
Overlapping graph of heat transfer coefficient (h) Vs. Reynolds number ($R_e$):

***Graph 4:***
Column chart of Heat transfer Coefficient (h) Vs. Reynolds Number ($R_e$) for **Brass material**

## III. CONCLUSION:

So, from the above result obtained. We conclude that as Reynolds number increases the heat transfer coefficient of pin fin increases. While material wise Aluminium is the most effective material.

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