

# Heat Conduction through a Pin Fin Apparatus Using Circular Fins

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**ABSTRACT:** The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main aim of the present paper is to analyze the thermal properties by varying geometry, material and thickness of cylinder fins. Transient thermal analysis determines temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life. We are Using Aluminum and bronze Material used to manufacturing cylinder fin body.

## I.INTRODUCTION

The heat conducted through solids, walls or boundaries has to be continuously dissipated to the surroundings or environment to maintain the system in steady state conduction. In many engineering applications large quantities of heat have to be dissipated from small areas. Heat transfer by convection between a surface and the fluid surroundings it can be increased by attaching to the surface thin strips of metals called fins. The fins increase the effective area of the surface thereby increasing the heat transfer by convection. The fins are also referred as "extended surfaces". Fins are manufactured in different geometries, depending up on the practical applications. Most of the engineering problems require high performance heat transfer components with progressively less weights, volumes, accommodating shapes and costs. Extended surfaces (fins) are one of the heat exchanging devices that are employed extensively to increase heat transfer rates. The rate of heat transfer depends on the surface area of the fin. It increases the contact surface area, for example a heat sink with fins. The heat transferred through the fins provides the problem of determination of heat flow through a fin requires the knowledge of temperature distribution through it. This can be obtained by regarding the fin as a metallic plate connected at its base to a heated wall and transferring heat to a fluid by convection.

The heat flow through the fin is by conduction. Thus the temperature distribution in a fin will depend upon the properties of both the fin material and the surrounding fluid. In this section, we will analyze certain basic forms of fins, with respect to heat rate, temperature distribution and effectiveness. The experiment is conducted to investigate the effect of the pressure loss and heat transfer characteristics in pin-fin channel, where dimples are located on the pin-fins. An aluminum fin of rectangular cross section with various dimple depth is fitted in a long rectangular duct. In the present work aluminum & brass plate were used as a test surface. Variation of Nusselt Number with Reynolds Number is investigated, with various parameter combinations.

The experimental results gives heat transfer

coefficient & efficiency of aluminum fin is greater than brass fin. Most of the engineering problems require high performance heat transfer components with progressively less weights, volumes, accommodating shapes and costs. Extended surfaces (fins) are one of the heat exchanging devices that are employed extensively to increase heat transfer rates. The rate of heat transfer depends on the surface area of the fin. In this the heat transfer rate and efficiency for circular and elliptical annular fins were analyzed for different environmental conditions [2]. From the experimental study it is found that the heat transfer rate in notched fins is more than the unnotched fins. The average heat transfer

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coefficient for without notched fin is 8.3887 W/m<sup>2</sup>K and for 20% notched fins it is 9.8139 W/m<sup>2</sup>K. Also the copper gives more heat transfer rate than aluminum plate. As the notch area of fin increases the heat transfer rate also increases. Copper plate gives better heat transfer rate than aluminum plate.

## II. LITERATURE SURVEY

Experimental studies were performed by for enhancing the heat transfer rate from a horizontal plate. Perforations of various shape such as circular, square, were considered on the vertical fins by the authors. Their results indicated that the perforated fins having high heat transfer rate as compared to the solid fins. Heat transfer rate was found to be increasing with the larger fin perforations. Heat transfer enhancement in a light weight automobile engine using fins. The authors concluded that the performance improvements in fins were observed when the wetted surface area was increased and the delay in thermal flow separation from the fin. The heat transfer characteristics from heat sinks with and without perforations and inline and staggered arrangement of fins. The authors observed that the friction factor was increased when the clearance ratio was decreased. solid pin fin, hollow pin fin, solid pin fin with four equal perforations, and solid pin fin with one large perforation and hollow fins in their experimental study. The results showed that the perforated fins had higher temperature difference as compared to the solid fins thus having better performance hadl study of slot- perforated fin surfaces in a laminar flow field. They had observed that when the slot width was increased, the heat transfer rate increases and In another research, the perforation geometry variation for shapes of circle, square, triangle and hexagon were studied against the solid fins. Fins as compared to the conventional method of perforations at the middle of the fins. The authors had observed the increased flow turbulence created by the perforations resulted in improved heat transfer rate. However, they conclude that as the hydraulic depth had been increased the heat transfer rate reduces. In the experimental study by the influence of number of perforations on an individual pinfin was investigated. The authors had observed a 17% increase in heat transfer rate for the pin-fins with three perforation against the solid pin-fins. A numerical investigation for enhancing the heat transfer rate from the flat plate using pin-fins effects. The circularperforated pin-fins produced better heat transfer rate as compared to the solid fins. Cylindrical pin-fins for improving the heat transfer rate from a flat plate which was placed in a rectangular duct.

## III. PROPERTIES OF MATERIALS

### 1. ALUMINIUM

The three main properties on which the application of aluminum is based are its low density of approximately 2.7, the high mechanical strength achieved by suitable alloying and heat treatments, and the relatively high corrosion resistance of the pure metal. Other valuable properties include its high thermal and electrical conductance, its reflectivity, its high ductility and resultant low working cost, its magnetic neutrality, high scrap-value, and the non-poisonous and colourless nature of its corrosion products which facilitates its use in the chemical and food-processing industries. Still further valuable features are obtained by various treatments of the metal; these will be considered when the applications of aluminium and its finishes are considered.

In its pure state, aluminium is, however, a relatively soft metal with a yield strength of only 34.5 N/mm<sup>2</sup> (5,000 lb/in<sup>2</sup>) and a tensile strength of 90 N/mm<sup>2</sup> (13,000 lb/in<sup>2</sup>). Through the development of a wide range of alloys, however, very varied strengths

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and ductility can be achieved, and this has led to the many applications of today. For example these range from the use of very thin foil material in the packaging industry, ductile materials for drink containers, and highly conductive alloys for electrical purposes, to relatively low-strength alloys for the building industry and high strength materials for aircraft and armoured vehicles.

The metal in its pure state has a relatively high corrosion resistance and needs less protection than most metals. On the other hand, the commercial metal and its alloys, though resistant, are distinctly more sensitive to orrosion development of high strength light alloys, containing quantities of heavy metals such as copper, zinc or nickel, has heightened the need for protective surface treatments. The nature of the heavy metal additions appreciably influences the alloy's susceptibility to corrosion, and high mechanical strength and corrosion resistance have so far proved largely incompatible. The development of satisfactory protective finishes for these metals has been, therefore, of very great importance. Brief consideration is now given to the properties of the various aluminium alloys which are available in relation both to their corrosion resistance and applications.

## 2. BRASS

- Brass is the most common alloy of Cu
- It's an alloy with Zn Brass has higher ductility than copper or zinc.
- Easy to cast - Relatively low melting point and high fluidity
- Properties can be tailored by varying Zn content.
- Some of the common brasses are yellow, naval .
- Brass is frequently used to make musical instruments.
- Copper alloys containing tin, lead, aluminum, silicon and nickel are classified as bronzes.
- Cu-Sn Bronze is one of the earliest alloy to be discovered asCu ores invariably contain Sn.
- Stronger than brasses with good corrosion and tensile properties; can be cast, hot worked and cold worked.
- Wide range of applications: ancient Chinese cast artifacts,skateboard ball bearings, surgical and dental instruments.

## IV. WORKING

A brass fin of circular cross section in fitted across a long rectangular duct. The other end of the duct is connected to the suction side of a blower and the air flows past the fin perpendicular to the axis. One end of the fin projects outside the duct and is heated by a heater. Temperature at five points along the length of the fin. The air flow rate is measured by an orifice meter fitted on the delivery side of the blower. The apparatus consists of a pin-fin placed inside an open duct the other end of the duct to connected to suction side of a blower the delivery side of a blower is taken on through on orifice meter to atmosphere ,the air flow rate can be varied by the blower speed regular and can be measured on the u tube manometer connected to one end of the pin fin. The panel of the apparatus consists of voltmeter ,ammeter and digital temperature indicator , heat regulator in it.

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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. The use of this is variety of shapes (Refer fig. 1 and 2). Circumferential fins around the cylinder of a motor cycle engine and fins attached to condenser tubes of a refrigerator are a few familiar examples.

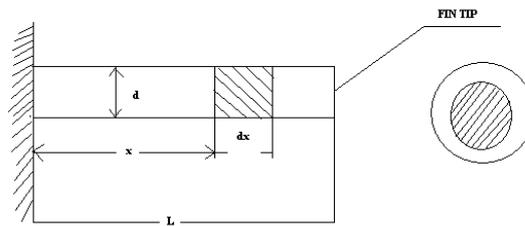


FIGURE 1: Schematic diagram of pin fin apparatus

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 set up is to study temperature distribution in a simple pin fin.

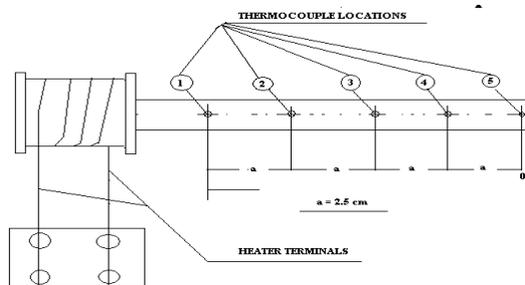


FIGURE 2: Schematic diagram of pin fin apparatus

## V. CALCULATION

$$= \frac{(\quad)}{\quad}$$

$$(\quad)$$

Where  $M = \sqrt{\quad} M^{-1}$

$H = H \text{ THEORETICAL} /$

$C = \text{CIRCUMFERENCE OF FIN (M)}$

$K = \text{THERML CONDUCTIVITY OF FIN } A = \text{CROSS SECTIONAL AREA OF FIN}$

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## VI. CONCLUSION

(1) Heat transfer co-efficient of  
ALUMINIUM =278.5 /

(2) Heat transfer co-efficient of  
BRASS=285.5 /

We are conducted a heat transfer testing by using fin-pin apparatus in two materials such as brass and aluminum. Among two materials the brass gives a better heat transfer rate.

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