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Fabrication and Experimental Analysis of Heat Sink Fins

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ABSTRACT

In this project we had fabricated the different types of fins like circular and square. This fins made up of aluminium because it is low cost and high heat transfer rate. The experiment is carried out on fins test rig. We took the different temperatures of fins with help of this test rig and the results of this fins has been compared with efficiency and heat transfer rate. Finally, we want to conclude that which fin has high rate heat transfer and efficiency

1. INTRODUCTION

Heat transfer is the study of the flow of heat. In chemical engineering, we have to know how to predict rates of heat transfer in a variety of process situations. For example, in mass transfer operations such as distillation, the overhead vapour has to be condensed to liquid product in a condenser, and the bottoms are boiled off into vapour in a reboiler. Often the feed stream is preheated using the bottoms product in a heat exchange.

Another example is the production and use of process steam, which is brought to various locations in a plant through steam pipes as a heating utility. Also, these steam pipes need to be insulated to minimize heat loss to the ambient air. Such insulation is also important when transporting hot fluids from one place to another.

A similar application is the transport of refrigerated liquids through piping – here we need to insulate to avoid transferring heat into the liquid from the ambient air. Chemical reactors can generate heat if the reaction is exothermic, and this heat must be removed to avoid a runaway reaction; likewise, endothermic reactions need a supply of heat to maintain the reaction. Heat transfer also is important in our daily lives.

For example, we heat our homes in the winter using hot water in baseboard heaters. We boil water routinely for cooking purposes. If you look inside a modern personal computer, you'll see a fan that is used to cool the electrical circuitry, which becomes warm because of the flow of electrical current through resistances. Sometimes when the circuits are dense, a refrigerant is used in a sealed tube that is boiled at one end where it is warm, to take away the heat, and condensed at the other end where it is cooler.

The three basic mechanisms of heat transfer.

They are conduction, convection, and radiation. Next, we discuss each of these mechanisms in some detail.

1.1 Modes of Heat Transfer

Conduction

Conduction is an electronic/atomic mechanism of transferring energy from one place to another in solids, and a molecular mechanism of heat transfer in liquids and gases. We begin with a simple example of heat conduction through a window when the inside of the room is warm and the outside is cold.

Let us assume that we know the temperatures of the inside and outside surfaces of the window, and build a steady state model of heat flow by conduction through the window. We model the window as a tall and wide rectangular slab, and refer to it as a slab in subsequent discussion, because the model is applicable to many other situations besides heat transfer through a window.

Convection

When an element of fluid moves from one place to another, it brings its energy content with it, so that this is another mechanism for transferring energy from one place to another.

Convection can be forced, which means that we are using some means to cause the motion – this can be a pressure difference in a conduit that is generated by a pump or a storage tank at some elevation, or by a fan blowing air, and so on. The alternative to forced convection is free or natural convection, which refers to flow that occurs naturally, without any intervention. Natural convection is caused by the action of density gradients in fluids in conjunction with the gravitational force. Typically, we see less dense fluid rise when it is located next to more dense fluid, while the more dense fluid sinks. Thus, a baseboard heater at home warms the neighboring air, and the warm air rises, allowing cooler air to move toward the heater and get warmed in turn. Incidentally, the "radiator" in older homes, is really not a radiator, but is similar to a baseboard heater that uses natural convection in its operation.

Natural convection is the source of all of the weather patterns that we experience. It also causes mixing in oceans and lakes. Density differences that lead to natural convection can arise from temperature variations in a fluid in a heat transfer context, or from composition variations, which can occur in mass transfer equipment.

Radiation

Radiation heat transfer is ubiquitous, because all matter emits and absorbs electromagnetic radiation. The electromagnetic radiation spectrum is huge, but heat transfer is mostly concerned with a small part of it, called thermal radiation. The wavelength of this radiation is in the approximate range of $0.1\ 100 - \mu m$, and includes the visible portion, in the approximate range of $0.35\ 0.75 - \mu m$. Because of the limited time we have in this course, we shall not be able to spend much time on radiative heat transfer.

All we can do is to introduce some definitions, and discuss very simple cases of radiative heat transfer between two surfaces. All matter above absolute zero emits radiation. In a solid, radiation that is emitted by a layer is re-absorbed within the next few atomic layers. Thus, our main concern in describing radiation heat transfer between objects is to consider radiation emitted by a solid surface and radiation absorbed by that surface.

We define irradiation G as the radiant energy that is incident on a solid surface per unit area per unit time. Thus, the units of G in SI would be [W/m^2]. Likewise, we define the radiosity J of a surface as the radiant energy emitted by a surface per unit area per unit time. The units of J also are [W/m2].

DESCRIPTION OF COMPONENTS

- Square Fin
- Circular Fin
- Heater
- Thermocouples and Digital Temperature Indicator
- Voltage Regulator and Digital Indicator
- Current Output Digital Indicator
- Main Switch

Heat Transfer Test Rig

2. METHODOLOGY

The heat transfer from a heated surface to the ambient surrounding is given by the relation, q = h A ΔT. In this relation hc is the convective heat transfer coefficient, ΔT is the temperature difference & A is the area of heat transfer. To increase q, h may be increased or surface area may by increased. In some cases it is not possible to increase the value of heat transfer coefficient & the temperature difference ΔT & thus the only alternative is to increase the surface area of heat transfer. The surface area is increased by attaching extra material in the form of rod (circular or rectangular) on the surface where we have to increase the heat transfer rate. "This extra material attached is called the extended surface or fin."

The fins may be attached on a plane surface, and then they are called plane surface fins. If the fins are attached on the cylindrical surface, they are called circumferential fins. The cross section of the fin may be circular, rectangular, triangular or parabolic.

Rate of heat flow

$$Q = (T - T_\infty)\sqrt{(hcPkA)}\tanh(ML)$$

Efficiency of a fin

$$\dot{\eta} = \tanh(ML)/(mL)$$

Where

T = Temperature of the fin

T_∞ = Ambient temperature

L = Length of the fin

$m = \sqrt{(hP/KA)}$

Where

h = convective heat transfer coefficient

P = Perimeter of the fin

A = area of the fin

K = Thermal conductivity of the fin

.

Apparatus

The setup consists of a two fins i.e. Square and Circular. Each having Thermocouples are mounted on their surfaces to measure the temperatures of the surface and one more to measure the enclosure/ambient temperature. This complete arrangement is fixed in a closed chamber .Temperatures are indicated on the digital indicator. Heater regulators are provided to control and monitor the heat input to the system with voltmeter and ammeter for direct measurement of the heat inputs. The heater controller is made of complete aluminium body having fuse.

Experiment Procedure

1. Before Starting the Experiment Ensure that all ON/OFF switches given on the panel are at OFF position.
2. Ensure that Heater Controller knob is at zero position provided on the panel.
3. Switch on the Mains
4. Operate the Heater Controller dimmer very slowly and give same power input to both the heaters Say Point 1 or 2 or 3 …….
5. Note down the temperatures for every 10min, from T_5 to T_8 by rotating the temperature selection switch.
6. Repeat the experiment for different heat inputs.
7. After experiment is over, switch off heater first by adjust Heater Controller then Switch off the Mains on.

3. RESULT

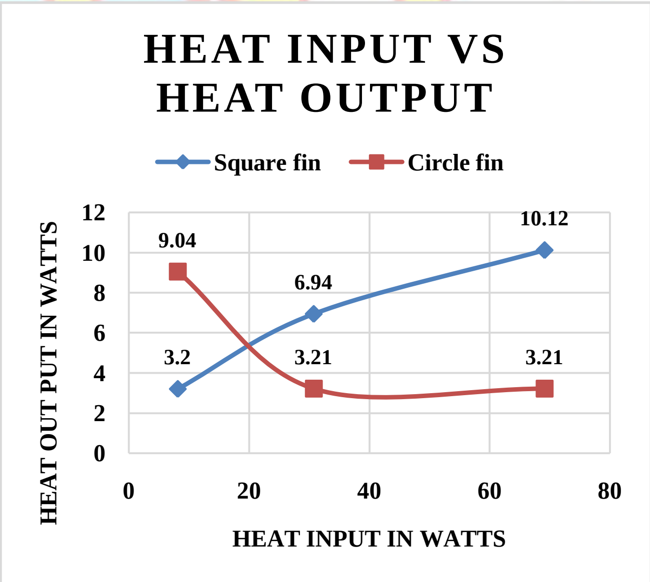

Figure 1

The final result of square fin and circular fin is on figure 1. The figure show on the when gradual increase of heat input and change in heat output can be seen in above figure1.

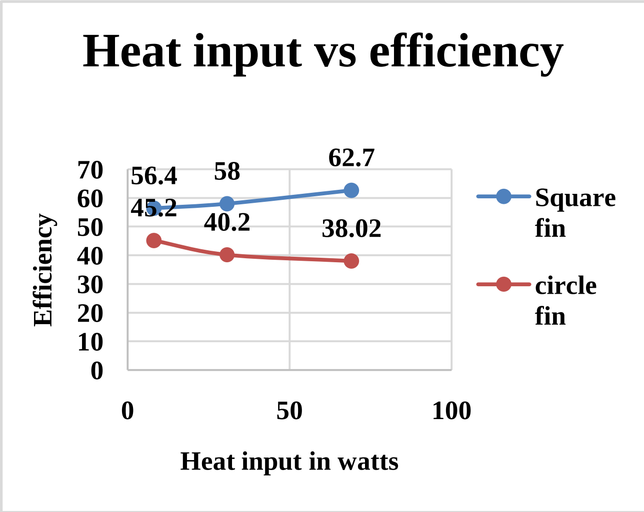

Figure 2

The final result of square fin and triangular is on figure 2. The figure show on the when gradual increase of heat input and change in efficiency can be seen in above figure2.

4. CONCLUSION

We successfully concluded and when we compared to square fin with the circular fin the heat transfer in square fin is high also they are made up of aluminium because it is low in cost and weight and it is easily available. The rate of heat transfer increases with the increase in surface area of the fin. Thus the results of rate of heat transfer and efficiency is high in the square fin

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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