Experiment On Heat Transfer Through Fins Having Different Notches

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Abstract: *Extended surfaces, commonly known as fins, often offer an economical and trouble free solution many situations demanding natural convection heat transfer. Heat sinks in the form of fin arrays onhorizontal and vertical surfaces used in variety of engineering applications, studies of heat transfer andfluid flow associated with such arrays are of considerable engineering significance. The main controllingvariable generally available to designer is geometry of fin arrays. Considering the above fact, naturalconvection heat transfer from vertical rectangular fin arrays with and without notch at the centre have been investigated experimentally and theoretically. Moreover notches of different geometrical shapes have also been analyzed for the purpose of comparison and optimization. In a lengthwise short array where the single chimney flow pattern is present, the central portion of fin flat becomes ineffective due to the fact that, already heated air comes in its contact. In the present study, the fin flats are modified by removing the central fin portion by cutting a notch. This paper presents an experimental analysis of the results obtained over arrange of, fin heights and heat dissipation rate. Attempts are made to establish a comparison between the experimental results.*
Key-words: *Fin, notches.*

I. Introduction

Natural convection heat transfer in a fluid layer confined in a closed enclosure with partitions like fins is encountered in a wide variety of engineering applications of passive cooling of electronic equipment such as compact power supplies, portable computers and telecommunications enclosures. In the design of electronic packages, there are strong incentives to mount as much electronic components as possible in a given enclosure. This leads to high power generation density and this may raise the temperature of the packages above the allowable limit. To overcome this problem the heat transfer rate from the packages must be maximized. The most common technique of maximizing heat transfer rate is by using finned surfaces. The enhancement ratio of heat transfer depends on the fins orientations and the geometric parameters of fins arrays. The most common configurations of using fins arrays in heat sinks involve horizontal or vertical surface plate to which fin arrays are attached.

A. Heat Transfer Augmentation Techniques

Augmentation techniques are broadly classified as passive methods, which require no direct application of power or as active schemes, which require external power. Practically useful, augmentation techniques are, however, mostly passive ones. Passive techniques are treated and structured surfaces, rough surfaces, extended surfaces, displaced enhancement devices, swirl flow devices, additives for liquids and gases, etc.

II. Need Of Dissertation

Specially designed finned surfaces called heat sink, which are commonly used in the cooling of electronic equipment and stationary engines needs optimized design with minimum material and maximum heat transfer from them. In the natural cooling of fins, the temperature drops along the fins exponentially and reaches the environment temperature at some length. But heat transfer from the area near the tip is low. It results in wastage of material for small heat transfer rate. Cutting this portion of fins, results in the complete elimination of heat transfer from that region. Also the central portion of the fin flat becomes ineffective due to the fact that, already heated air comes in its contact. In this dissertation, the fin flats were modified by removing the central fin portion by cutting a notch of different geometrical shapes and adding it at the arrays entrance on the two sides, where it is more effective and thereby keeping fin surface area same.

A. Objectives Of Dissertation

The objectives of dissertation can be listed as

1. To carry out study on the rectangular fins with horizontal array and its analysis for natural convection.
2. To study influence of different geometry and dimensions on heat transfer rate
3. To determine the type of geometry and its dimensions for optimum heat transfer rate.
4. This module will calculate minimum material for maximum heat transfer and Convective heat transfer coefficient.

III. Thepory Of Convection

Natural Convection Over Surfaces

Natural convection heat transfer on a surface depends on the geometry of the surface as well as its orientation. It also depends on the variation of temperature on the surface and the thermo-physical properties of the fluid involved.

A. Natural Convection From Finned Surfaces

Natural convection flow through a channel formed by two parallel plates is commonly encountered in practice. When the plates end, rises it is heated under the effect of buoyancy, and the heated fluid leaves the channel from the upper end. The plates could be the fins of a finned heat sink. The plates can be approximated as being isothermal (T_S= constant) in the first case, and isoflux (q_S= constant) in the second case.

B. Mass Flow Rates Through The Space Betwwen The Plates

As we mentioned earlier, the magnitude of the natural convection heat transfer is directly related to the mass flow rate of the fluid, which is established by the dynamic balance of two opposing effects: buoyancy and friction.

C. Dimensionless Numbers

Each physical phenomenon can be expressed by an equation giving relationship between different quantities such quantities can be dimensional or non-dimensional. It is important to understand the physical relationship between such quantities and forming a non-dimensional parameter. Some of the important and relevant non-dimensional parameters are discussed in the following few pages.

IV. Experimental Set-Up

To investigate the performance of the heat transfer fins with and without notches, the experimental setup consists of a base plate made up of aluminium material. Five slots are created on this base plate so that five fins may be attached to this base plate. A set of five fins with or without notches depending on the type of case are mounted on this base plate. The whole experimental setup is enclosed in box made out of card board so as to avoid external wind disturbances. The enclosure also helps in developing a pure natural convection transfer through the set of fins by isolating the experimental setup from the surrounding effects.

A. Base Plate And Set Of Fins

The most important element of the experimental setup is the set of fins and the base on which these fins are mounted. Base plate and set of fins are shown in Fig. Base plate and all the sets of fins are made out of aluminium having thermal conductivity of 202.4 w/mk and density of 2719 kg/m^3. Sheets of aluminium are purchased directly from the shops available in the market. The sheets required for this purpose are of thickness 3 mm which are available in that thickness. All the sets of fins and the base plate are cut and machined in the workshop. Fins with rectangular notch are cut very easily with the hacksaw as the machining of aluminium is very easy.

B. Wooden Case And Support

As shown in the figure, wooden case and support form an essential part of the experimental support in the sense that it functions both as support to the base plate-set of fins and also as an insulator. The heating element is placed between this wooden case and the base plate. Thus when heating element gets heated by electrical supply provided, the wooden case does not allow the heat to escape in the downward direction towards the table.

C. Digital Temperature Indicator

A provision is made in the experimental setup to measure the temperature at various points on the fin surfaces, on the base plate and also in the surroundings. A temperature indicator is used for this purpose. The temperature indicator is purchased directly from the market shop. There is provision for the measurement of twelve temperatures simultaneously. A rotating knob is provided to indicate different temperature.

D. Dimmer Stat

The dimmer stat used for the experimentation purpose is as shown in the figure given below. The function of dimmer stat in the experimentation is to regulate the voltage provided to the heating element. Regulation of voltage is done to control the base plate temperature. The experimentation is performed at two base temperatures of 60 and 80 degrees. A care is taken while operating the dimmer stat that, the knob of dimmer stat is varied slowly so that there is no sudden fluctuation of voltage supplied to the heating element. This reduces the time required for the experimentation to reach the steady state condition.

V. Experimental Procedure

A. Procedure

1. Connect the dimmer stat to the heating element.
2. Bring the knob of dimmer stat to zero
3. Connect the probes of digital temperature indicator at different locations on the base plate and on the fins as per requirement.
4. Switch on the mains supply.
5. Increase the voltage supply to the heating element by rotating the knob slowly.
6. Switch on the power supply of digital temperature also.
7. See the temperature of the base plate indicated by the digital temperature indicator by rotating the knob provided.
8. Increase or decrease the voltage supply provided to the heating element depending on the temperature required at the base plate.
9. Wait until the temperature indicated by digital temperature indicator becomes steady. If the temperature indicated is steady then it means that the experiment has reached steady state.
10. Once the steady state is reached, note down the temperatures at various locations on the base plate and also on fin tops.
11. Tabulate the temperatures so noted properly in the form of a table so that it becomes easy for further calculations

B. Procedure

Following procedure is adopted while taking the observations.

Repeat the procedure from 1 to 9.

10. Once the steady state is reached, note down the temperatures at various locations on the base plate and also of the fins. In this method of recording the temperature is slightly different from earlier one.

i. Temperature of individual fin T_1, T_2, T_3 & T_4 is recorded along its length at equal distances.
ii. Record the temperature at the fin tip
iii. Take the average of T_1, T_2, T_3 & T_4
iv. Follow the same procedure from A to C for remaining fins

11. Tabulate the temperatures so noted properly in the form of a table so that it becomes easy for further calculations.

VI. Result Table

A.H.T.C FOR DIFFERENT SHAPES OF NOTCHES

Sr.No.	Notch Geometry of fin	Heat transfer coefficient (W/ m^2 k)	
		Tbase60 °c	Tbase80 °c
1	Fin without notch	6.1329	6.8023
2	Fin with Rectangular notch	6.1503	6.935
3	Fin with Circular notch	6.1258	6.9204
4	Fin with Triangular notch	6.1610	6.9541

B.H.T.C. FOR DIFFERENT HEIGHTS OF TRIANGULAR NOTCH

Sr.No.	Notch Geometry of fin	Heat transfer coefficient (W/ m^2 k)	
		Tbase60 °c	Tbase80 °c
1	Fin with 25mm height	6.1610	6.9541
2	Fin with 30mm height	6.17922	7.0548
3	Fin with 35mm height	6.1833	7.0999
4	Fin with 40mm height	6.1973	7.1014

VII. Conclusion

It is proved beyond doubt that the heat transfer coefficient is highest for the set of fins with triangular notch (6.9541 W/ m2k). This has been shown by the experimental analysis. From the experimental analysis it has been observed that temperature distribution for the notched fins is more uniform than the fins without notch. The same methodology of experimental investigation can be used further for different types of notches and fins. This concept can be implemented to the application where the fins are used such as D.C. motors, Transformers, I.C. engines, Heat exchangers, Electronics components (micro-processors).Providing notches to the fins not only results into increase in Heat Transfer Coefficient but also it saves the fin material. From the experiment it has been observed that H.T.C is highest for the set of fins with triangular notch at 40mm height (7.1014 W/m2k).

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