International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June -2018 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL ANALYSIS OF OBLIQUE FINS TO ENHANCE HEAT TRASNSFER

Prof. M. J. Rajale[1], Akash Kadam[2], Dinesh Sonawane[3], Nagesh Shinde[4]

---***---

Abstract- Extended surfaces, commonly known as fins, offer an economical and trouble free solution in many situations demanding natural convection heat transfer heat sinks in the form of fin array on horizontal and vertical surfaces use in variety of engineering applications, study of heat transfer and fluid flow associated with such arrays are of considerable engineering significance the main controlling variable generally available to designer is geometry of fin array Considering the fact that natural convection heat transfer from horizontal rectangular straight fin array and oblique horizontal straight fin array have been investigated experimentally and theoretically. In these two cases that is for straight fins and oblique fins, the base surface of both the fins where supplied with heat input of 6watt, 8watt and 10watt and different thermal parameters where studied and compared between straight fins and oblique fins. It has been found that the performance of oblique fins is greater than the straight fins in case of providing better cooling effect and increase in fin effectiveness

Keyword: straight fin, oblique fin, natural convection, experimental

1. Introduction

Due to the necessity for energy savings in modern industrial systems, the effective heat transfer has become a critical issue in design process recently. Therefore, this issue has been extensively studied. Heat transfer enhancement techniques can be classified into three categories:

(i) Active method: this requires external power like mechanical aids

(ii) Passive method: where inserts are used to obtain surface and geometrical modifications in the flow passage.

(iii) Compound method: combination of active and passive techniques to obtain high enhancement in heat transfer rate. [4]

Passive heat transfer enhancement techniques are mostly preferred by researchers due to their advantageous such as simplicity and applicability in many applications. At the same time, they do not require any external power input to the system. One of the useful ways of passive heat transfer enhancement techniques to take away heat from surface area of thermal device was extended surface or fins. Fins are the most effective instrument for increasing the rate of heat transfer. As we know, they increase the area of heat transfer and cause an increase in the transferred heat amount. Fins are be increased for better heat dissipation. A fin is a surface that extends from an object to increase the rate of heat transfer to or from the environment by increasing convection. Extensions fins isn't sufficient that's why new types of fins must be invented or incorporated. [8]

The principle aims of fins, but the rectangular fin is widely used among them, probably, due to simplicity of its design and its easy manufacturing process widely used in many industrial applications such as air conditioning, refrigeration, automobile, chemical processing equipment and electrical chips. Although there are various types of the but the heat transfer from rectangular this paper is to provide larger area by using oblique fins through which heat transfer rate would on the finned surfaces are used to increase the surface area of the fin in contact with the fluid flowing around it. Thus, the aim is to increase the heat transfer rates from the surface so that the temperature of solid surface is maintained within desired limits to avoid failure of the system. [7]

1.1 Concept of Oblique Fins

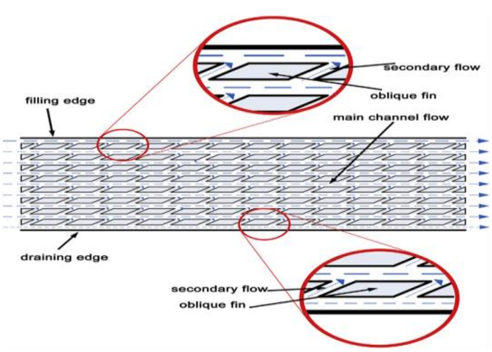


Fig 1: Oblique fins

An oblique fin is nothing but rectangular fins that are arranged in an oblique pattern through which we can get a larger surface area for heat transfer as we are using a natural convection so a larger amount dissipation can take place. The oblique angle that denotes the angle between the main channel and oblique channel is set as - 30°, which is within the range of the angles (20°–40°) that are frequently evaluated in the literatures. Oblique fin channel has a much higher heat transfer surface area to fluid volume ratio. Generally, material which are good conductor of heat are used for fin heat sink such as copper (k= 384W/m k) but sometimes aluminum (k= 238 W/m k) is preferred due to its low cost & weight. Thermal performance is better in case of copper but it has high cost compared with aluminum so copper is used when temperature is to be reduced in large amount otherwise aluminum fins are used.

So, as the surface area increase the more fluid contact to increase the rate of heat transfers from the base surface as compare to fin without the extensions provided to it. The Main cause of using the oblique fin heat exchanger is to reduce the size, cost & increase in heat transfer rate because of greater surface area.

1.2 Objectives

- Design and Fabrication of rectangular oblique fins and straight fins heat Sink & Development of test rig to evaluate performance of individual heat sink set up.
- To investigate heat transfer performance, Analysis and testing of rectangular oblique fins and straight fins heat sink.
- Comparative experimental study of heats sinks setups following parameters: Heat transfer coefficient, Heat transfer rate, Effectiveness.
- Plot comparative graphs of above parameters under various heat inputs (watts).

2. Design and Manufacturing of Fins

2.1 Straight Fins

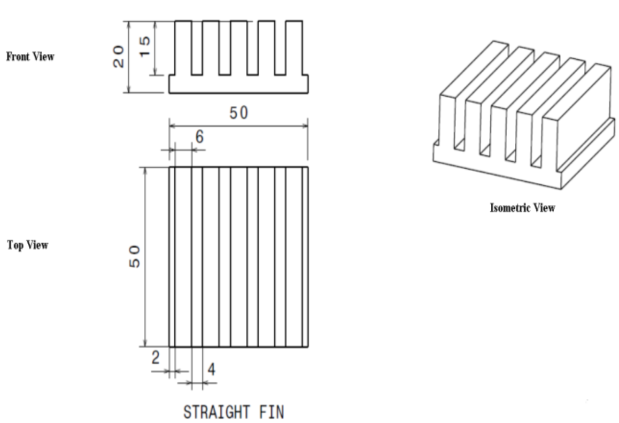


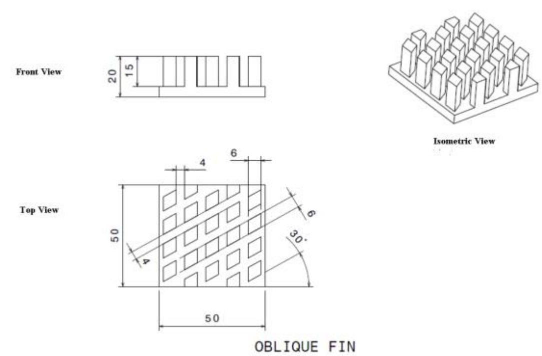
Fig 2.1: Schematic and actual photograph of straight fins

Firstly, we take base plate of size 50mm×50mm take reading of surface and surrounding at 6w and found out value of heat transfer Coefficient (h).

Design of straight fin

- By Using above value of h, we calculate effectiveness of fin for various dimensions.
- Following dimension of fin gives optimum value of effectiveness and it is greater than 2
- Effectiveness greater than 2 indicates that use of fin is profitable following diagram show three views of fin.

2.2 Oblique fins



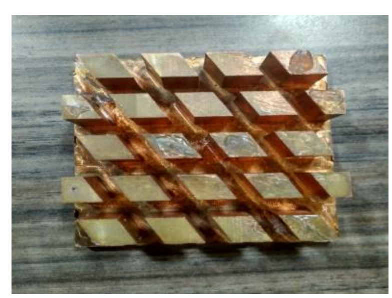


Fig 2.2: Schematic and actual photograph of oblique fins

Design of Oblique fins

- We have to compare straight fin with oblique fin. For design of oblique fin, we take straight fin component as it is.

- Straight fin has only primary channel of flow in oblique fin we have created secondary channel flow by cutting it at 30°.

Experimental Setup

Experimental set up is as shown figure. This set up is used to conduct the experiment in order to obtain natural convective heat transfer characteristics of different horizontal rectangular oblique fin arrays. In this type of fin array the air enters from both sides and gets heated as it moves inwards. Temperature of the air gets increases and decrease in density of air rise upwards. Hence, only less portion of air comes in contact with the central bottom portion of the fin channel. Due to this stagnation zone occurs near the central bottom portion of the fin channel as shown in figure. In order to overcome this complexity some portion of fin is removed near the stagnation zone (notch), to increase the heat transfer coefficient.

Heater is placed below the base plate in order to transfer heat to base plate. Through base plate heat is supplied to fin. No. of thermocouple are used to measure the temperature of various point on base plate and fin tip.

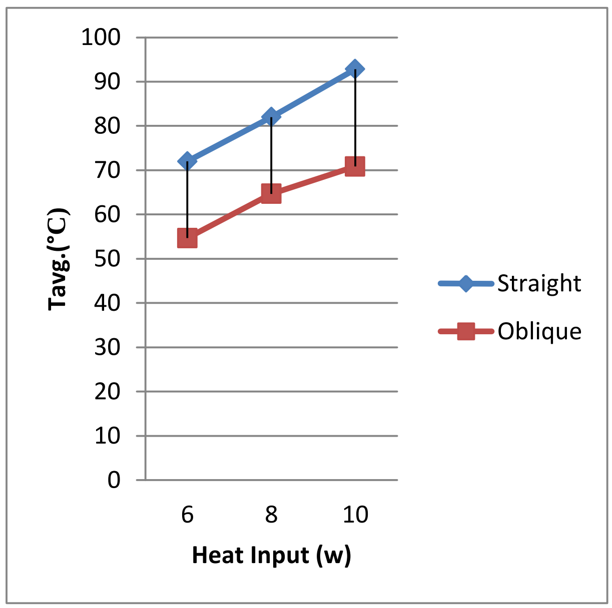
1. Fig 3: Experimental Setup for heat transfer measurement Fin array is assembled and placed in the position, with thermocouples and heaters connected as per requirement.
2. Turn on the experimental setup
3. Check the entire digital meter and thermocouples working and its electric connections.
4. Using dimmerstat regulating current and voltage turn on heater for a particular value.
5. Make sure current and voltage are constant over the period of experiment.
6. Heat the base plate to stabilized temperature.
7. Keep checking the temperature of fins and base plate with the help of thermocouple reading.
8. When the temperature attains a steady state that is temperature reading of fins repeat twice for a particular value make sure it is constant and note down that value.
9. Note down all the required temperature of fins and base plate.
10. Repeat above procedure for various heat input i.e., 6W 8W 10W

3 Result and discussion

3.1 Average temperature of fin surface

Table 4.1: Average temperature of fin surface

Heat Input	T_{avg}	
	Straight Fins	Oblique Fins
6	72	54.66
8	82	64.66
10	92.833	70.833



Graph 1: Heat input vs T_{avg}

Average temperature of body (T_{body}) decreases in case of oblique fins when compared with for 6watt, 8watt, 10watt. For 6watt, average temperature of oblique was 54.66°C whereas for straight fins it was 72°C. Graph shows decrease of 17°C-22°C in oblique fins when compared to straight fins.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June -2018 www.irjet.net p-ISSN: 2395-0072

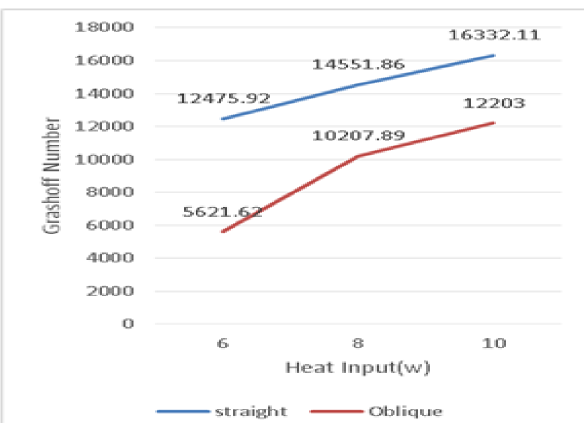
3.2 Grashoff number variation

Grashoff number indicates fluid motion is caused is not due to the external source but due to the difference in densities between two points. It is similar to the Reynold's number in force convection.

Table 4.2 Grashoff number variation

Heat Input	Grashoff Number	
	Straight Fins	Oblique Fins
6	12475.92	5621.62
8	14551.86	10207.89
10	16332.11	12203

Grashoff number is a ratio of buoyancy force and viscous force acting on fluid. In case of oblique fins grashoff number get decreased for 6watt,8watt and 10watt heat input, when compared with straight fins grashoff number get decreased as the viscous forces in the fluid are greater than buoyancy forces in oblique fins. Free convection is usually suppressed at sufficiently small grashoff number.

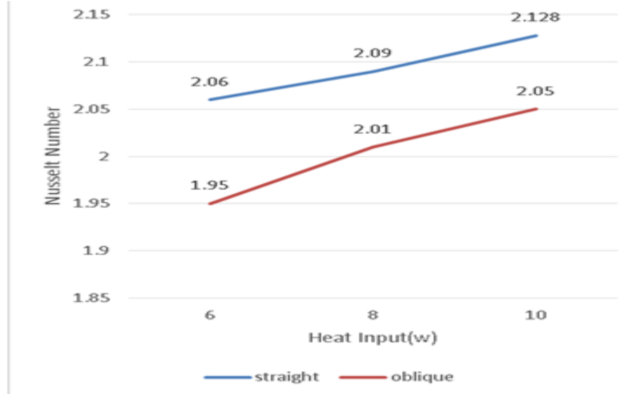


Graph 4.2 Grashoff number variation

4.3 Variation of Nusselt No

Table 4.3 Variation of Nusselt number

Heat Input	Nusselt Number	
	Straight Fins	Oblique Fins
6	2.06	1.95
8	2.09	2.01
10	2.128	2.05



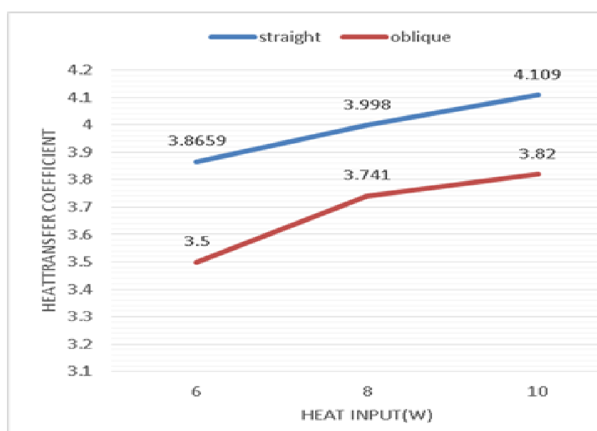
Graph 4.3 Nusselt number variation

As heat input is increased the Nusselt number get increased for 6 watt,8watt,10 watt in straight fins as well as in oblique fins. The Nusselt number shows a decrease in oblique fins when compared to straight fins in 6watt, 8watt and 10watt. This decrease is due to the increase in surface area of the fins which increases the conductive heat transfer in oblique fins.

4.4 Heat transfer coefficient variation

Table 4.4 Heat transfer coefficient variation

Heat Input	Heat Transfer coefficient	
	Straight Fins	Oblique Fins
6	3.867	3.5
8	3.998	3.741
10	4.109	3.82



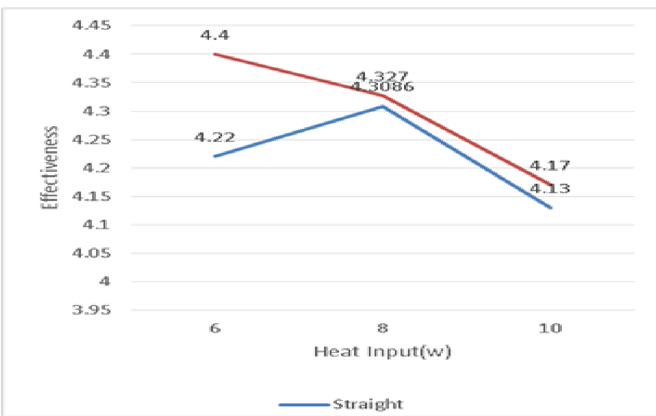
Graph 4.4 Heat transfer coefficient vs heat input

Heat transfer coefficient increases for the 6watt,8watt and 10watt for straight fins and oblique fins. But it decreases in oblique fins for 6watt, 8watt and 10watt heat input when compared to straight fins. It gets decrease due to decrease in Nusselt number, which is directly proportional to heat transfer coefficient for constant temperature and conductivity of fluid.

4.5 Effectiveness variation

Table 4.5 Effectiveness variation

Heat Input(W)	Effectiveness	
	Straight Fins	Oblique Fins
6	4.22	4.4
8	4.3086	4.327
10	4.13	4.17



Graph 4.5 Effectiveness vs heat input

Effectiveness of the oblique fins is greater than straight fins for 6watt,8watt and 10watt. Effectiveness of the fins get increased as the heat input is increase compared to oblique fins with straight fins. It gets increased nearly upto 4.21% for 6 watt, 0.7% for 8watt and 0.96% for 10watt when oblique fins are used. Fins are effective even at higher input applied.

5 Conclusion

- Average temperature of the body in case of oblique fins get decreased due to the more contact of fluid and surface of fins. It gets decreased up to 17°C-22°C. Thus, the oblique fins more cooling effect than straight fins.
- Grashoff number gets decreased in case of oblique fins. It happens due to the creation of oblique fine which creates secondary flow channel to fluid due to which the viscous forces get increased. Grashoff number is inversely proportional to viscous forces.
- Nusselt number shows a decrease in case of oblique fins. As the grashoff number gets decreased. Grashoff number is directly proportional to the Nusselt number.
- Heat transfer coefficient(h) directly proportional to Nusselt number. It gets decreased in the oblique fins. Use of fins is only justified where heat transfer coefficient is (h) is small.
- Fin effectiveness increased in case of oblique fins because the oblique fin increased the ratio of perimeter(P) and cross-sectional area(A_{cs})

REFERENCES

1) Yong Jiun Lee, Pawan K. Singh , Poh Seng Lee, Fluid flow and heat transfer investigations on enhanced microchannel heat sink using oblique fins with parametric study, International Journal f Heat and Mass Transfer 81 (2015) 325–336.

2) Matthew Law, Poh-Seng Lee, Karthik Balasubramanian, Experimental investigation of flow boiling heat transfer in novel oblique-finned microchannels, International Journal of Heat and Mass Transfer 76 (2014) 419–431.

3) Nasi Moua, Poh Seng Lee a, Saif A. Khan b, Coupled equivalent circuit models for fluid flow and heat transfer in large connected microchannel networks – The case of oblique fin heat exchangers, International Journal of Heat and Mass Transfer 102 (2016) 1056–1072.

4) Yan Fan a,b, Poh Seng Lee a, Beng Wah Chua b, Investigation on the influence of edge effect on flow and temperature uniformities in cylindrical oblique-finned mini channel array, International Journal of Heat and Mass Transfer 70 (2014) 651–663.

5) Yan Fan a, c, Poh Seng Lee a, Li-Wen Jin b, Beng Wah Chua c, Experimental investigation on heat transfer and pressure drop of a novel cylindrical oblique fin heat sink, International Journal of Thermal Sciences 76 (2014) 1e10.

6) Yan Fan a,c, Poh Seng Lee a, Li-Wen Jin b, Beng Wah Chua c, A simulation and experimental study of fluid flow and heat transfer on cylindrical oblique-finned heat sink, International Journal of Heat and Mass Transfer 61 (2013) 62–72.

7) Yan Fan a,c, Poh Seng Lee a,⇑, Li-Wen Jin a,b, Beng Wah Chua c, Ding-Cai Zhang a, A parametric investigation of heat transfer and friction characteristics in cylindrical

oblique fin minichannel heat sink, International Journal of Heat and Mass Transfer 68 (2014) 567–584.

8) Bahram Rajabi Far, Shahabeddin K. Mohammadian, Sanjeev K. Khanna, Yuwen Zhang , Effects of pin tip-clearance on the performance of an enhanced microchannel heat sink with oblique fins and phase change material slurry, International Journal of Heat and Mass Transfer 83 (2015) 136–145.

9) Sheam-Chyun Lin, Fu-Sheng Chuang, Chien-An Chou Experimental study of the heat sink assembly with oblique straight fins, Experimental Thermal and Fluid Science 29 (2005) 591–600.

10) Matthew Law, Omer Bugra Kanargi, Poh-Seng Lee , Effects of varying oblique angles on flow boiling heat transfer and pressure characteristics in oblique-finned microchannels, International Journal of Heat and Mass Transfer 100 (2016) 646–660.

11) Matthew Law, Poh-Seng Lee , Effects of varying secondary channel widths on flow boiling heat transfer and pressure characteristics in oblique-finned microchannels, International Journal of Heat and Mass Transfer 101 (2016) 313–326.

12) Dr. S B Prakash, Shashikiran C R, Experimental investigation of natural convection heat transfer enhancement from rectangular fin arrays with combination of V-notch and perforations, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 08 | Aug -2017.

13) Rahul Sonawane1, D.D.Palande" Heat Transfer Enhancement by using perforation: A Review" International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 04 | Apr-2016.

14) "Heat and Mass Transfer Data Hand book'' by C P Kothandaraman and S Subramanyan

15) "Heat and Mass Transfer book" by R.K.Rajput