EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER BY FORCE CONVECTION ON ALLUMINIUM CASTED V-SHAPED FIN ARRAY

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Abstract

Heat generation in different industrial devices is very common problem. Fins are commonly used to dissipate heat by natural or forced convection. Fins are employed on industrial devices such as heat exchanger, reciprocating compressor and engine, electric motor, transformer and many electronic devices. The material, dimensions and geometry of the fin is the challenging factor in today's scenario, as optimum fin geometry can enhance heat transfer rate. It is observed that many manufacturers are using different fin geometry to increase the heat transfer rate such as rectangular, triangular fins with notches etc. Recently, the research has been carried out on v-shaped fin array. The comparative study between rectangular fin array and v-shaped fin array shows that V-shaped fin array has large improvement on heat transfer rate. The basic objective of this experiment is to generate the experimental data for the V-shaped fin array carrying a force convection. Hence to analyze the heat transfer rate from the aluminum casted v-shaped fin array without slots on notches and with slots on notes by providing angles to the basic fin plate.

Keywords: *Fin array, Force convection, slots, experimental study*

Introduction

Heat generation in industrial product is common problem in industry. This heat generation can effect on a performance of the product and also on the efficiency. The system of the product may lead to failure if there is a overheating of the product The heat transfer takes place by natural convection or force convection. Her preferred a force convection for heat transfer through fins as it is economical and has a less study data. Fins are employed to dissipate heat at faster rate, but proper geometry, no. of fins, spacing between fin and fin material is a big task for a designer. Increasing the number of fins can also decreases the rate of heat transfer. Therefore, the exact number of fins is also a very important factor, as a greater number of fins may lead to the resistance to the flow of air. Forced convection is a mechanism or a type of transport in which fluid motion is generated by an external source like pump, fan, suction device etc. subject of thermal-engineering. In general, the heat transfer from heated surfaces are enhanced by increasing the coefficient of convection heat transfer between a heated surface and it's ambient or by fins and fins array to increase the surface area of heat transfer or by both methods. The most commonly used fin array is rectangular fin array. Later on, triangular, vertical, diamond shaped fin array. Latest research is going on v-shaped fin array. The researchers have also worked on V-shaped fin array with different manufacturing process of fin array such as v-shaped fin array manufactured by CNC, welding of fins on the flat plate, sticking the fins with the glue on the flat plate. Also, the different material is used in manufacturing of the fins such as cast iron, aluminum, aluminum alloy etc. In the present experiment the fins are manufactured in aluminum LM-16 material by sand casting method. The material selected is due to its higher thermal conductivity and material availability. The objective of the experiment is force convection heat transfer through Aluminum casted V-shaped fin array without slots and with slots to the fins.

1.1 Description of problem and the solution

The experimental investigation is performed to check the force convection heat through Aluminum casted V-shaped fin array without slots and with slots to the fins. The sand casted aluminum base plate is of dimension, height=390mm, width=200mm, thickness= 12mm. The test plate consists of 20 fins. 2 small fins and 18 large fins. Other dimensions are length= 100mm, width= 20mm and thickness= 5mm. The angle of fin is 30^0 from horizontal plane of the fin plate when kept vertical.

2. Experimental Procedure

The electrical power is supplied to the heater which mounted on the back side of the test plate. The exact power supplied is measured by wattmeter. Below the surface plate two 12 volts fan are attached with SMPS for forcing the air. After steady state is reached the temperature readings were measured for the calculation. The flow chart of experimental procedure is shown in fig. which shows the steps how experiment is carried out. The power input supplied was 25W, 50W, 75W and 100W. The number of temperature readings measured on test plate were for 90^0 angles base temperature (t_b)= 40; fin temperature (t_f)= 40; slots temperature (t_s)= 40; ambient temperature (t_a)= 40. Similar procedure is done for the angle 60^0 and 30^0. For 60^0 the temperatures were measured and total number of readings were taken are : surface temperature (t_b)= 40; fin temperature (t_f)= 40; slot temperature (ts)= 40; ambient temperature (t_a)= 40. Similarly, for 30^0 angles the surface temperature (t_s)= 40; fin temperature (t_f)= 40; slot temperature (t_s)=40; ambient temperature (t_a)=40; This was the one part of the experiment whose surface plate having V-shaped inclined fins. But the another readings were taken on the surface plate whose fins having a parallel 12mm distance slots on both sides of each fins . Similar procedure was done on another surface plate which contains slots. Readings were taken on the inclination of 90^0, 60^0 and 30^0. For each angle we have taken total number of readings: surface temperature (t_b)= 40; fin temperature (t_f)= 40; fin slots temperature (t_s)= 40; ambient temperature (t_a)= 40; So the total number of readings for surface plate without slots on fin array are for surface plate (t_b)= 120; fin temperature (t_f)= 120; slots temperature (t_s)= 120 and ambient temperature (t_a)=120. Similarly the total number of readings for the surface plate having a slots in fin array are: for surface plate (t_b)= 120; fin temperature (t_f)= 120; slots temperature (t_s)= 120 and ambient temperature (t_a)=120. After having all the readings we took average temperature readings for each factor and calculations are done for the fin array. Then the graphs and excels are plotted and analyzed to calculate average heat transfer coefficient, Nusselt number, Rayleigh number and Grashof number for both the surface plates without slots on fin and with slots on fins. Again the 12 mm slots are taken on the fin parallelly. Slots were made on the fin with the help of milling machine. And then after applying angles the same temperature readings were taken. Total number of readings are : for surface plate (t_b)= 120; fin temperature (t_f)= 120; slots temperature (t_s)= 120 and ambient temperature (t_a)=120. Similarly, the total number of readings for the surface plate having a slots in fin array are: for surface plate (t_b)= 120; fin temperature (t_f)= 120; slots temperature (t_s)= 120 and ambient temperature (t_a)=120.

3. Photographic view of test plate

Fig 3.1 three-dimensional view of fin array without slots in fin

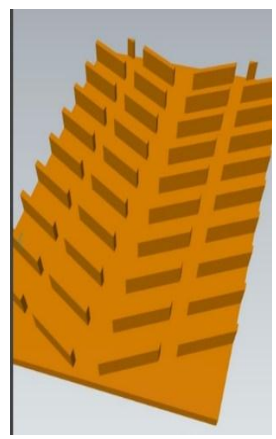

Fig 3.2 three-dimensional view of fin array with slots

4. Results and discussion

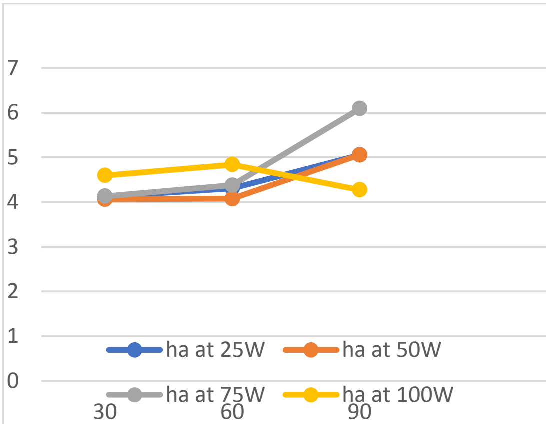

Fig 4.1 the values are of heat transfer coefficient (ha) at different inclinations.

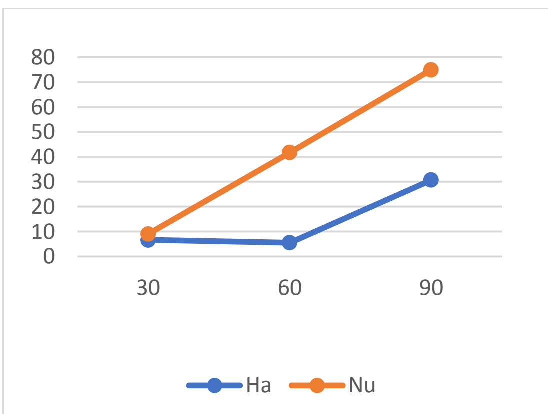

Fig 4.2 Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. At 25W

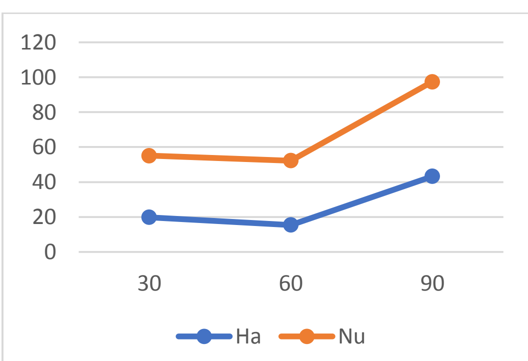

Fig 4.3Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. At 50W

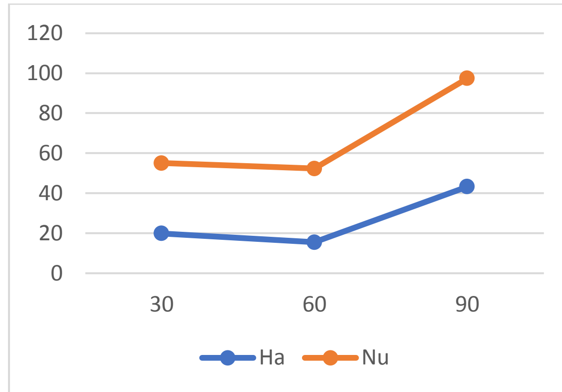

Fig 4.4 Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. At 75W

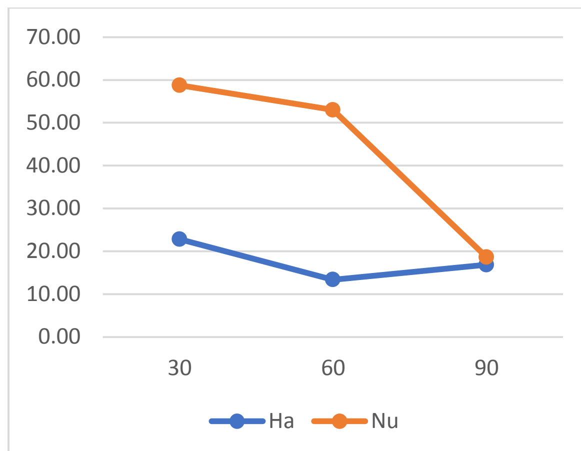

Fig 4.5 Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. At 100W

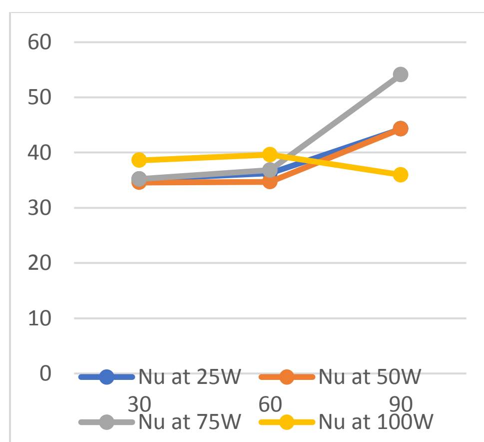

Fig 4.6 Values for without Slots of Avg. Nusselt No. (Nu) Against Different Inclinations

Fig 4.7 Values for without Slots of Avg. Heat transfer coefficient (Ha) Against Different Inclinations

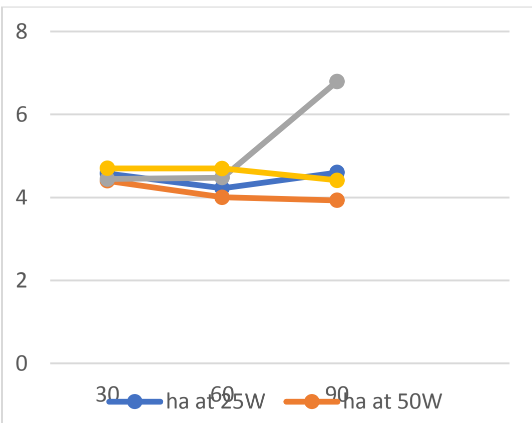

Fig 4.8 the values of heat transfer coefficient (ha) at different inclinations

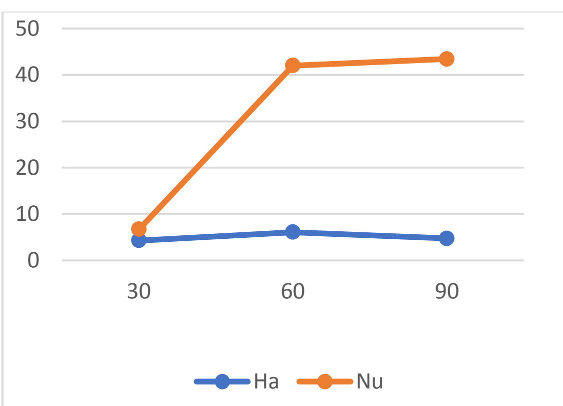

Fig 4.9 Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. at 25W

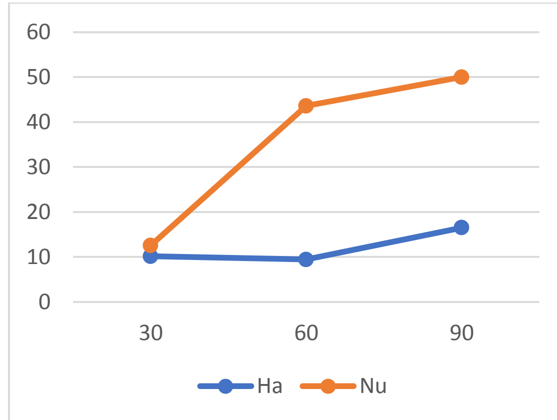

Fig 4.10 Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. at 50W

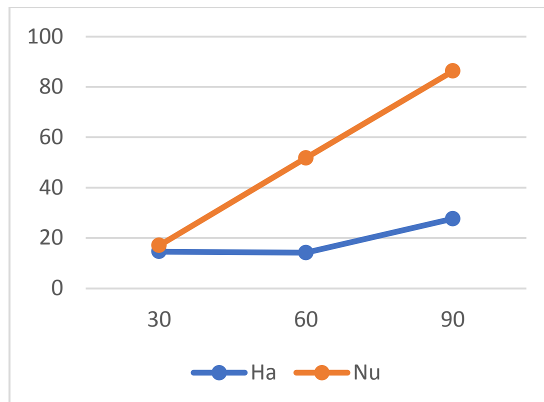

Fig 4.11 Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. at 75W

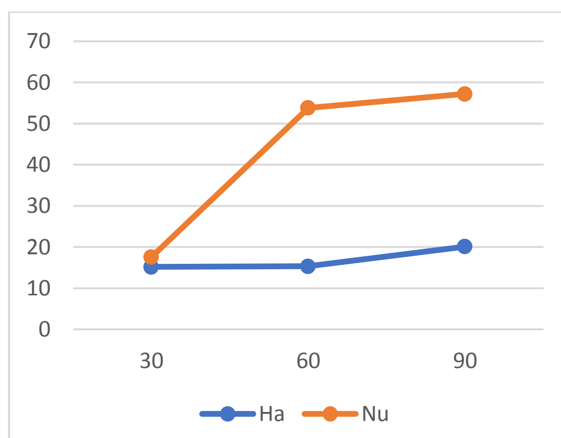

Fig 4.12 Values of Avg. Heat Transfer coefficient and Avg. Nusselt No. at 100W

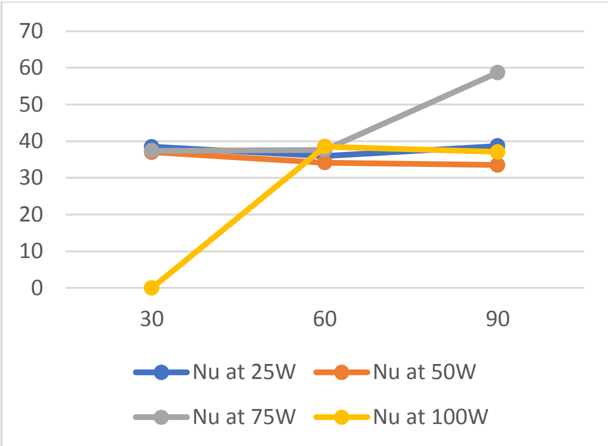

Fig 4.13 Values for with Slots of Avg. Nusselt No. (Nu) Against Different Inclinations

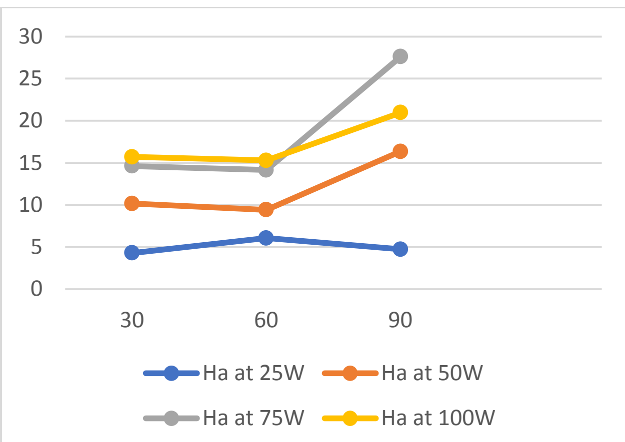

Fig 4.14 Values for with Slots of Avg. Heat transfer coefficient (Ha) Against Different Inclinations

5. Conclusion

A. Without slots

1. Heat transfer coefficient increases at 25W, 50W and 75W.
2. Heat transfer rate and Nusselt number increases on 25W and 75W.
3. Heat transfer rate and Nusselt number decreases on 50W.
4. The average Nusselt number and Heat transfer rate is greater at 90^0.
5. The heat loss is less.

B. With slots

1. Heat transfer coefficient increases at 25W and 75W.
2. Nusselt number and Heat transfer rate increases at 50W, 75W and 100W.
3. The average Nusselt number is greater at 90^0 and 75W.
4. The average Heat transfer rate is greater at 90^0.
5. Heat loss is more

6. Future scope

1. The present experiment investigation is carried out on 30^0, 60^0, 90^0 inclinations. The investigation may be extended to inclinations from 10^0 to 180^0 with the interval of 10^0inclinations.

2. Same experiment can be carried out on natural convection

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