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Experimental Analysis of Pin- Fin By Varying Geometry and Material

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Abstract**: *This paper aims to investigate the performance of fin effectiveness, efficiency and to improve the heat dissipation characteristics by varying fin geometries and materials. Here the system flows natural convection and forced convection heat transfer. The greatest 'h' value will be acquired at a specific point by changing the velocity of the fluid. Acquiring maximum efficiency and effectiveness of the pin-fin apparatus can be accomplished at a specific temperature. In this cross-section area of fins are considered as constant. The heat conveyed along the length of the fin, Reynolds number, Nusselts number, Heat Transfer coefficient, Effectiveness and Efficiency of the fins were evaluated and compared with the fluid fluent (CFD) analysis.***

Keywords**: *Reynolds number, Nusselts number, heat transfer coefficient, efficiency, effectiveness, fluid fluent (CFD) analysis.***

I. INTRODUCTION

A fin is an extended surface of an appliance which is used to expand the surface zone such that the heat dissipation rate increment typically among air and heat developing devices. We can utilize any cross-segment zone contingent on prerequisites and space accessible like rectangular or circular. From the newton law of convection Q = hAdT heat dissipation legitimately corresponding to cross-sectional area, heat transfer coefficient, and the temperature difference. To raise the heat dissipation rate, the heat transfer coefficient may be raised or surface range may be enlarged. At times, it is absurd to expect to build the estimation of heat transfer coefficient and the temperature distinction dT and therefore the main option is to expand the surface region of heat dissipation. The surface region is expanded by appending additional material as the bar(rectangular or circular) superficially where we need to develop the heat transfer rate. The extra material associated is known as the all-encompassing surface or fin. Natural convection is mainly caused due to the density difference of the fluid and buoyancy force offered by an entering. Here there is no use of the external device. The fluid medium which is closer to the surface get wormed and will decrease in the thickness results on the liquid assists with streaming up the surface. Here the stream momentum is created because of the distinction in temperature among fluid particles. Convective heat dissipation happens by the development of the fluid particles pertinent to the surface. If the motion of fluid particles is brought about by using outer gadgets, for example, a blower that powers fluid over the surface, at that point the process of heat dissipation is called forced or constrained convection. Convectional heat move has two stream regions in particular laminar and turbulent. The non-dimensional number (Reynolds number) is used to describe whether the flow is laminar or turbulent. If the value of Reynalds number is small it is laminar and if it is large it is turbulent. Computational Fluid Dynamics (CFD) uses numerical analysis and data structures to examine and tackle issues that involve fluid streams. PCs are used to compute the checks required to reproduce the free stream of the fluid, and the association of the fluid with the surface by described limit conditions.

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II. PROBLEM DEFINITION

Heating in several engineering components became a major problem. Due to this heating, the performance of the components will be reduced such that fins are attached to the surfaces of the components such that the heat will be dispatched to the atmosphere quickly. Here are some of the fin applications.

- Economizer in steam power plant
- Heat exchangers
- Motors and transformers
- Electronic equipment, I.C. boards, chips.

For the above-mentioned components based on the space available on the surface, the different geometry and the suitable fin material are selected.

III. METHODOLOGY

- In this experimental setup, the copper and aluminum are used as the fin materials.
- Manufactured circular and rectangular geometry as pin fin.
- The circular fin is machined to 12Ø,150mm from the stock

- The rectangular fin is machined to 150mm(length), 13mm(breath), 8.7mm(height) from the stock.
- The rectangular duct is setup with 550mm(length),150mm(breath),100mm(height)
- The temperatures at various places of the fin are estimated with k type thermocouple.
- A band-type heater with a 12mm adjustable brush is used for the heating of the fin
- The controller with 240V, 1000Watt is attached to the blower to control the velocity of air
- The dimmer is used to control the current and voltage.

Figure-1 Experiment setup

Figure-2 Fins

IV. EXPERIMENTATION PROCEDURE

- Plug the equipment setup to the electrical current supply.
- Adjust the thermocouple switch to the first position.
- Change the dimmer deasil such that the force contribution for the warmer of the heater to the ideal condition and turn on the blower.
- Prepare the airflow to any value by adjusting by altering the distinction of mercury level in the manometer.
- The temperature T_1 to T_6 are observed in the temperature indicator.
- The change in the heads of the manometer is noted and the process is repeated for various electrical intakes to the heater.

V. ANALYSIS

- Create the geometry file into the fluid flow (Fluent).
- Rename the named section as an inlet by selecting a passage of fin.
- Clicking on the generated after giving the name as an inlet.
- Opening of the mesh window.
- Generate the mesh for the geometry file having nodes and elements as fine.
- Opening of set up window.
- Clicking on general set the units.
- Creating materials (copper, aluminum).
- By clicking on the boundary conditions select inlet.
- Starting the initialization by selecting the initialization option.
- Run the calculations by giving some iterations to be performed.
- Opening of the result window for knowing the variations.

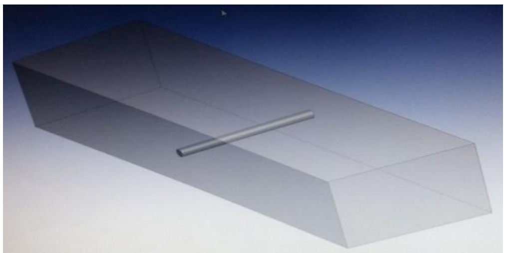

Figure-3 Circular fin geometry file

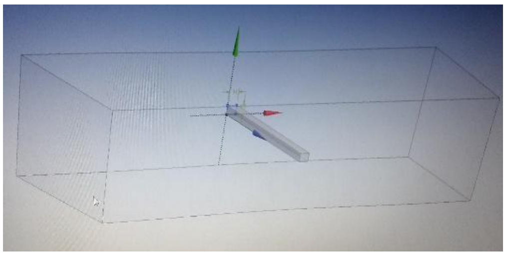

Figure-4 Rectangular fin geometry file

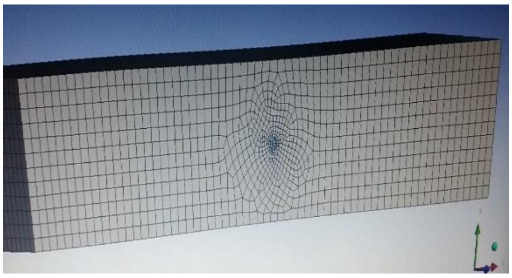

Figure-5 The meshing of circular fin along with channel

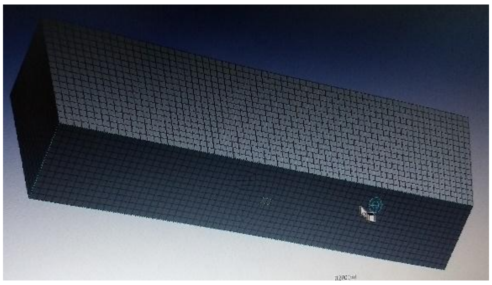

Figure-6 The meshing of rectangular fin along with channel

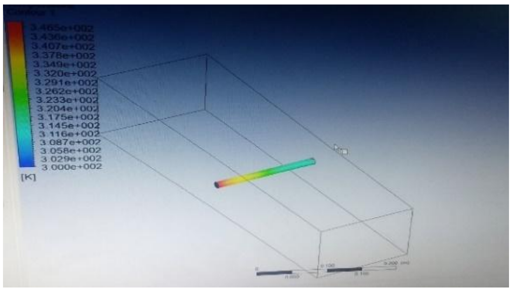

Figure-7 Temperature distribution throughout the range of circular fin

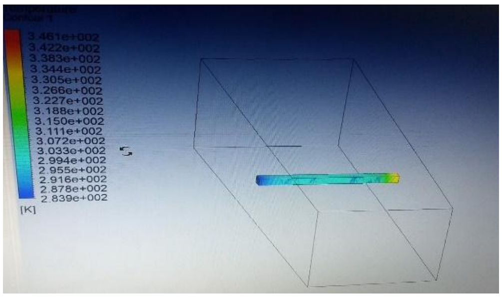

Figure-8 Temperature distribution throughout the range of rectangular fin

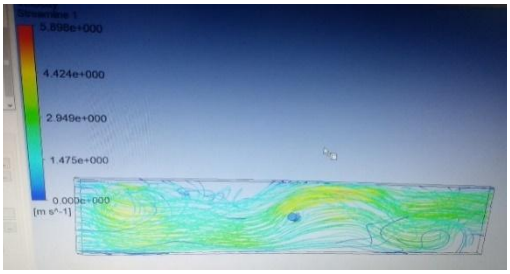

Figure-9 Streamline across the length of the circular fin

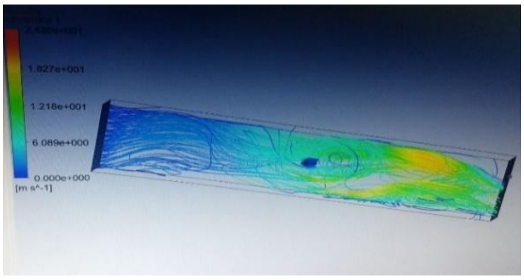

Figure-10 Streamline velocity across the length of the rectangular channel

VI. GRAPHS

A. FREE CONVECTION

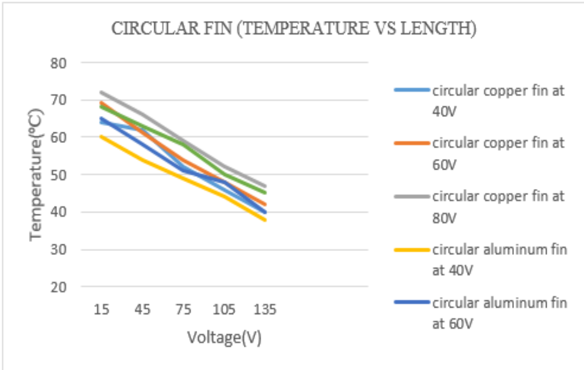

Figure-11 Circular fin (Temperature vs Length)

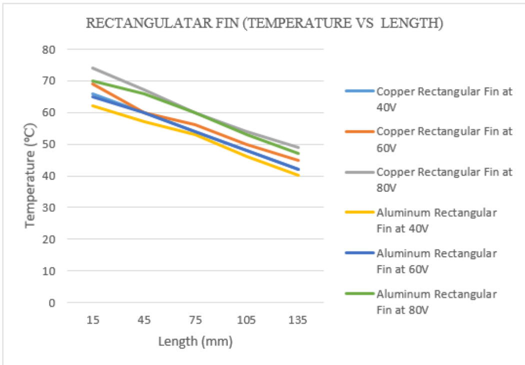

Figure-12 Rectangular fin (Temperature vs Length)

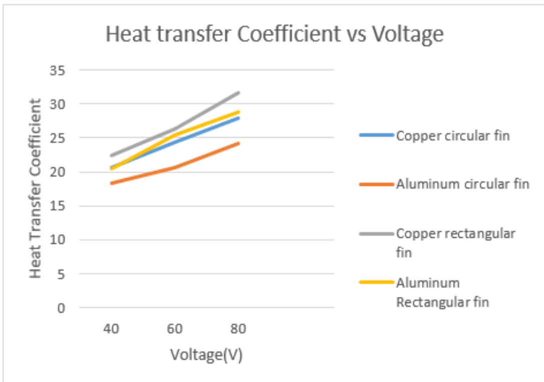

Figure-13 Heat transfer coefficient vs Voltage

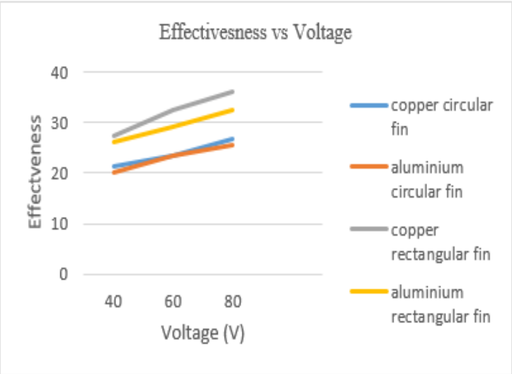

Figure-14 Effectiveness vs Voltage

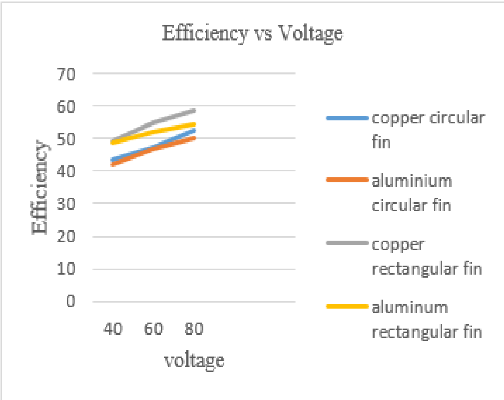

Figure-15 Efficiency vs Voltage

B. FORCED CONVECTION

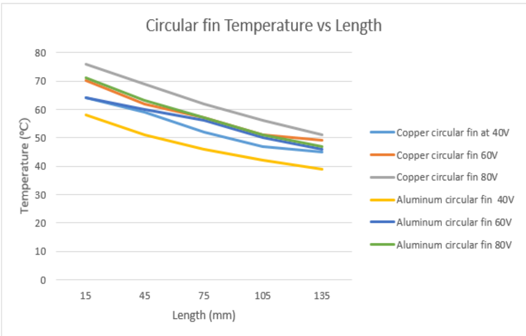

Figure-16 Circular fin (Temperature vs Length)

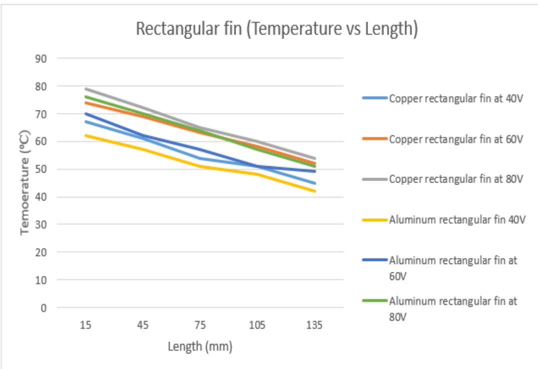

Figure-17 Rectangular fin (Temperature vs Length)

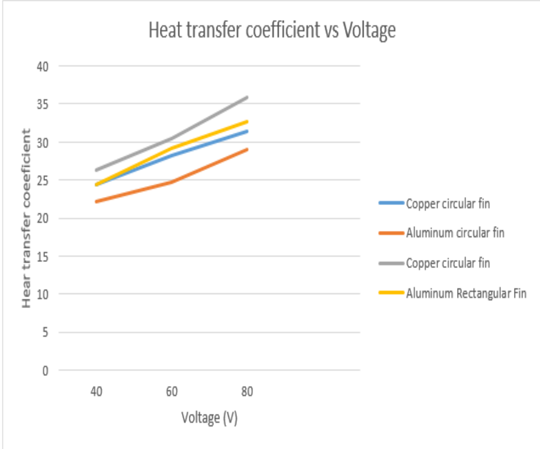

Figure-18 Heat transfer coefficient vs Voltage

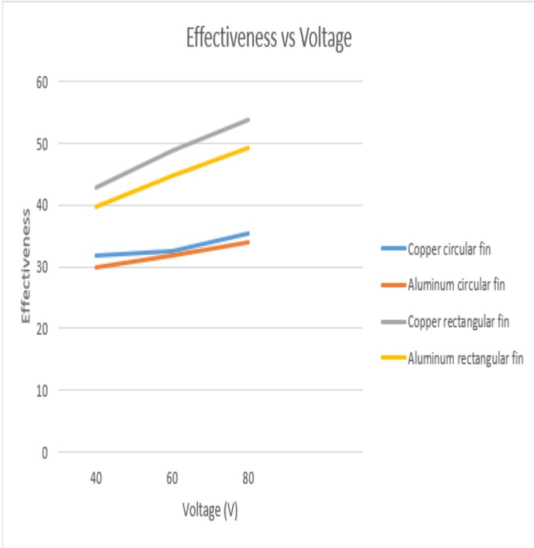

Figure-19 Effectiveness vs Voltage

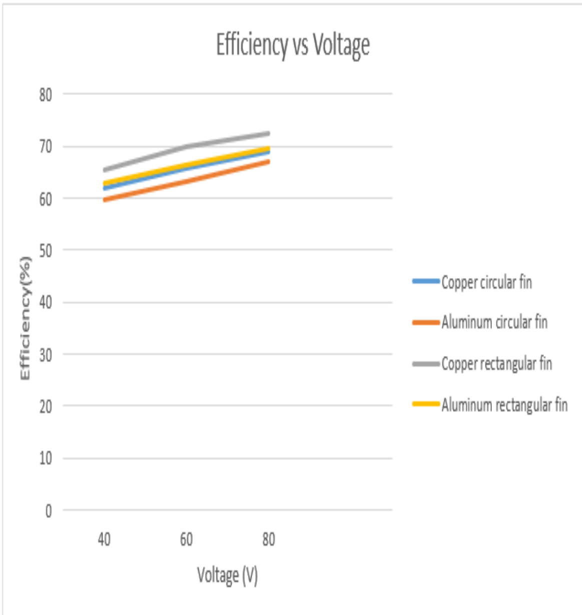

Figure-20 Efficiency vs Voltage

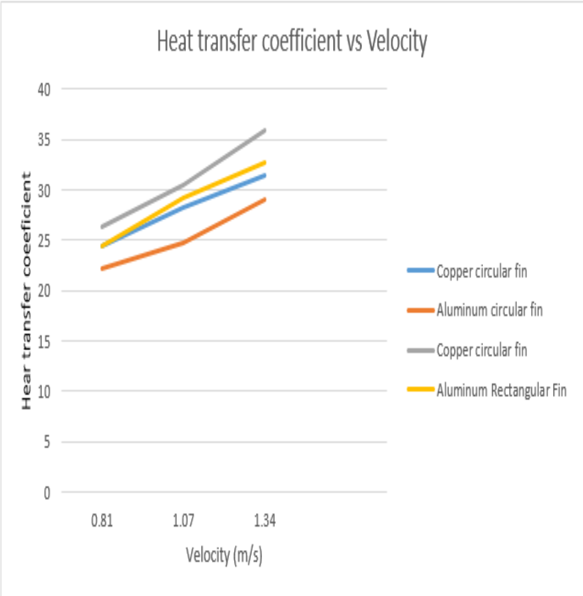

Figure-21 Heat transfer coefficient vs Voltage

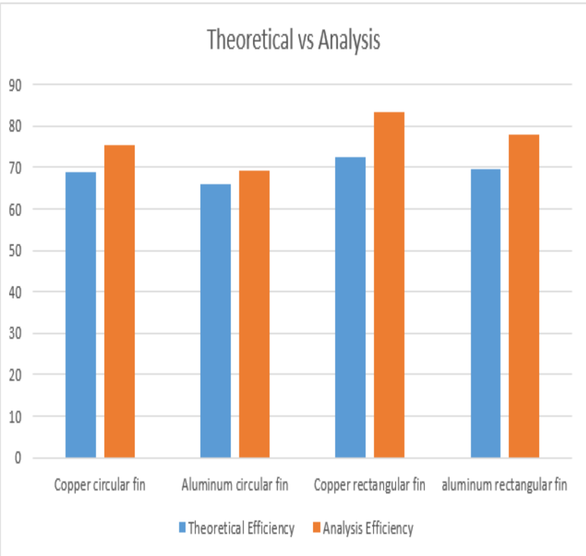

Figure-22 Theoretical vs Analysis

VII. RESULTS

	Effectiveness	Efficiency
Copper Circular Fin	26.46	52.36%
Aluminium Circular Fin	25.39	49.31%
Copper Rectangular Fin	32.79	58.76%
Aluminium Rectangular Fin	31.93	54.96%

Figure-23 Natural convection results at 80 volts

	Effectiveness	Efficiency
Copper Circular Fin	34.48	68.79%
Aluminium Circular Fin	33.96	66.91%
Copper Rectangular Fin	41.70	72.44%
Aluminium Rectangular Fin	39.31	69.59%

Figure- 24 Forced Convection Results at 80 volts

VIII. CONCLUSION

The experimentation and Fluid Flow Fluent (CFD) analysis for the pin fin apparatus with different material and geometry of the fin had completed the calculations gives the effectiveness and efficiency of the fin, from the results we state that copper is producing the high thermal conductivity, the rectangular fin has more effective and efficient, by increasing the voltage the fin can be heated to the higher temperature ranges and by increasing the velocity of the air more heat transfer takes place. The next better option to use is the aluminum material with a rectangular cross-section. The analysis values are higher than the theoretical values.

REFERENCES

1. Allan Harry Richard.T.L, Agilan.H, Experimental Analysis of Heat Transfer enhancement Using Fins in Pin Fin Apparatus, (IJCEM) Volume 2, Issue 1, April 2015, Pages (123-132)
2. Varun R. Yadav, Karan S.Vishe, Sweetan Gnanasundaram, Kamini C.Naik, Experimental Analysis to Investigate the Thermal Performance of Different Types of Fin Geometry, (IRJET) Volume: 06 Issue: 02 | Feb 2019, Pages (2619-2622)
3. V Naga Raju, P Sivakumar (2017). "Steady-state thermal analysis of heat sink with fins of different geometry", (IJMET), volume 8 Issue 5, May 2017, Pages(196-206).
4. N. A Nawale, A. S Pawar. "Experiment on heat transfer through fins having different notches", (IOSR-JMCE), Pages(46-49).
5. Ramkrushna S. More, Rajan I. Mehta, Vaibhav A. Kakade, "Review study of Natural convection heat transfer a heated plate by Different types of fin array", (IJERT), ISSN:2277-9655, Dec 2013.
6. Prasanta Ku. Das "Heat conduction through heat exchanger tubes of the non-circular cross-section", (JHT), volume 130, January 2008.
7. Heat Transfer through walls, measurements of thermal conductivity book 1971, Pages(599-602).
8. Chine-Nan lin, Join-yuh Jang "A two-dimensional fin efficiency analysis of combined heat & mass transfer in elliptic fins".(IJHMT) 45(2002.) Pages(3839-3847).
9. F. Incropera, D. DeWitt, Introduction to Heat Transfer book, 7th Edition.
10. Karan Sanjay, Sudarshan Shinde, Rameez Shanediwan, "Thermal and Parametric Analysis of Pin fin", (IRJET), volume;05 Issue 02, Feb-2018. Pages(708-714).

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