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HEAT TRANSFER THROUGH BONDED AND COATED COMPOSITE FINS

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ABSTRACT

Fin is a surface that extends from an object to increase the rate of heat transfer by increasing convection. In general the heat transfer from fins depends upon different factors, like the material used to make the fin, thermal conductivity of the material, its shape, surface area, mode of heat transfer allowed, size of fin, etc.
This paper focuses on the study of the composite fins to increase the heat transfer rate. Fins of same thickness with more than one material when in bonded, coatings are considered for analysis and comparison of heat transfer rate is made between the fins of same material, fins of composite material when in bonded contact and fins of composite material made of coatings. The overall heat transfer rate and overall efficiency will be increased in composite fins when in bonded contact of same surface area than that of fins made of coatings, than that of fins made of same material.

Keywords: Fins, Composite Fins, Heat Transfer Rate, Efficiency.

I. INTRODUTION

Fins are commonly used in many engineering applications to enhance heat transfer. A number of studies have been performed in order to increase the heat transfer effectiveness and to reduce the dimensions and weight of heat exchangers. The necessity to reduce the volume and weight of heat exchanger has become more important in many engineering applications like IC Engines, Heat exchangers, etc. Efficient design of fins can improve system performance considerably [1]. This is especially important in modern electronic systems, in which the packaging density of circuits is high. In order to overcome this problem, thermal systems with effective emitters as fins are desirable. In order to achieve the desired steady-state rate of heat dissipation, with the least.

As for handling the heat sink problem, the size of its outward design, the amount of fin flake, the gap of fin flake, the area of its outward surface all have an intimate relation on enhancing its convection effect and increasing its heat sink ability[2]. The only controllable variable to enhance the convection heat transfer rate is the geometry of the fins. The designer must optimize the size and the spacing of the fin arrays otherwise; using fins can bring more disadvantages than its advantages to the design.

There are numerous situations where heat is to be transferred between a fluid and a surface [2]. In such cases the heat flow depends on three factors namely (i) area of the surface (ii) Temperature difference and (iii) the convective heat transfer coefficient.

The base surface area is limited by design of the system. The temperature difference depends on the process and cannot be altered. The only choice appears to be the convection heat transfer coefficient and this also cannot be increased beyond a certain value. Any such increase will be at the expense of power for fans or pumps. Thus the possible option is to increase the base area by the so called extended surfaces or fins. The fins extend form the base surface and provide additional convection area for the heat conducted into the fin at the base. Fins are thus used.

Fin efficiency is defined as the ratio of actual heat transferred by fin to the maximum heat transferable by fin, if entire fin area were at base temperature [3]. The maximum heat transfer would occur if the temperature of the extended surface was equal to the base temperature. The effectiveness of fin is defined as the ratio of heat transfer rate from a surface with fin to heat transfer rate from a surface without fin.

II. EXPERIMENTAL SET-UP

The experimental set up for perforated fins [7-8] as shown in Fig.1.It consists of main parts of experimental set-up are

(A) Main Duct (Tunnel) (B) Heater Unit (C) Base Plate (D) Data Unit

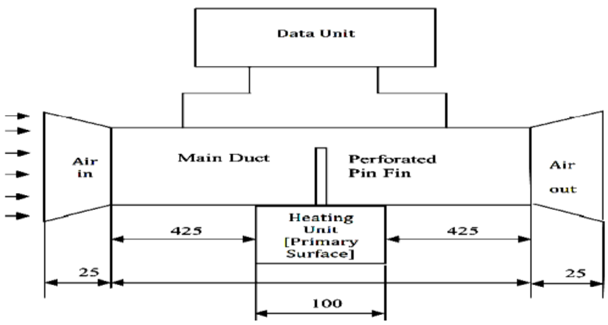

Fig.1. Experimental set-up for Perforated Fin

III. METHODOLOGY

1) First of all attach all the measuring instruments on their specific positions i.e. RTD sensors, Display control panel, Heater etc.

2) Put the base plate on heater.

3) Move the heater unit and base plate upward with the help of screw jack.

4) The base plate touches the RTD sensor and check the positions of two other sensor i.e. inlet outlet RTD sensor.

5)Then Switch on the main supply, the heater gets ON , As the temperature raised up to T˚C, the controller of RTD sensors is get activated & it will cut off the power supply.

6)Next step is to start the blower and by using digital anemometer measure the velocity of inlet air and maintain inlet air velocity constant as per specified (i.e.2, 3, 4,5 and 6 m/s) with the help of blower regulator.

7) Now through tunnel air will flow over heated Fin plate.

8) Measure the outgoing warm air with the help of RTD outlet temperature sensor.

9) As soon as the temperature of base plate decreases, due to forced convection, than heater gets start to achieve constant temperature of T˚C.

10) Apply the same procedure for velocities 3m/s, 4m/s, 5m/s, and 6m/s and take down the readings.

IV. RESULTS AND DISCUSSIONS

From paper [1-2] It was observed that when compared with single material, composite material bonded shows higher heat transfer rate, efficiency and lower the heat transfer coefficient as shown in below table

Table 1: Contains Heat transfer coefficient, Heat transfer Rate and Efficiency

S. No.	Fin material	Heat transfer coefficient (h) W/m^2-K	Heat transfer rate Q (W)	Efficiency %
1	Al	56.77	21.19	67.7
2	Cu	57.05	20.56	77.64
3	Brass + Al	43.5	35.22	89.12
4	Cu + Al	44	29.51	94.76

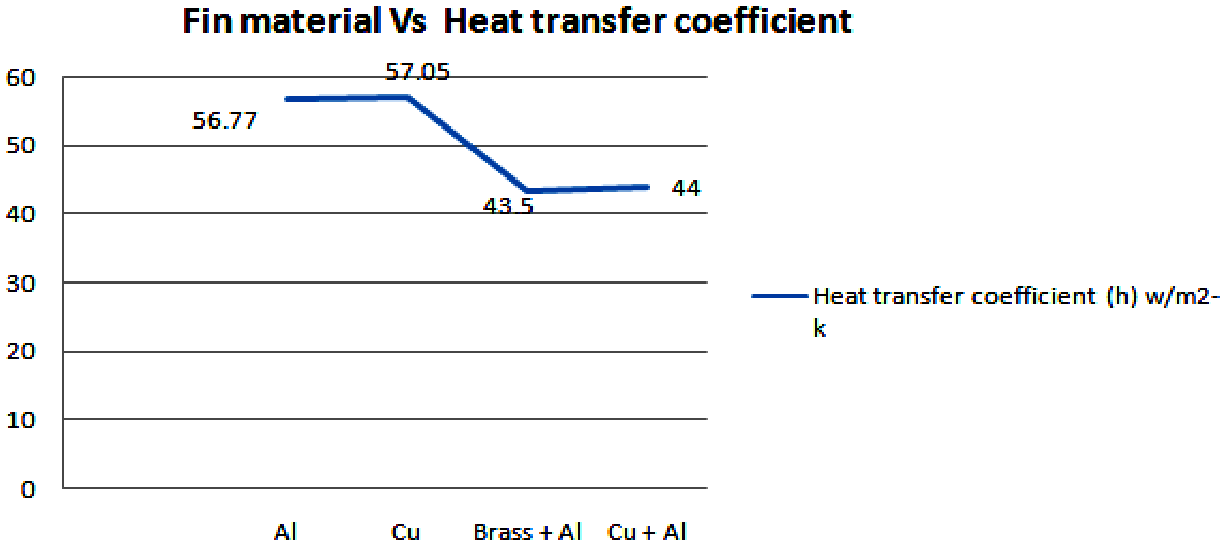

Fig.2. Graph shows variation of Fin materials with Heat transfer coefficient

In the above graph fin material Cu has high 57.05%, Brass + Al has least 43.5% Heat transfer coefficients when compared with the others

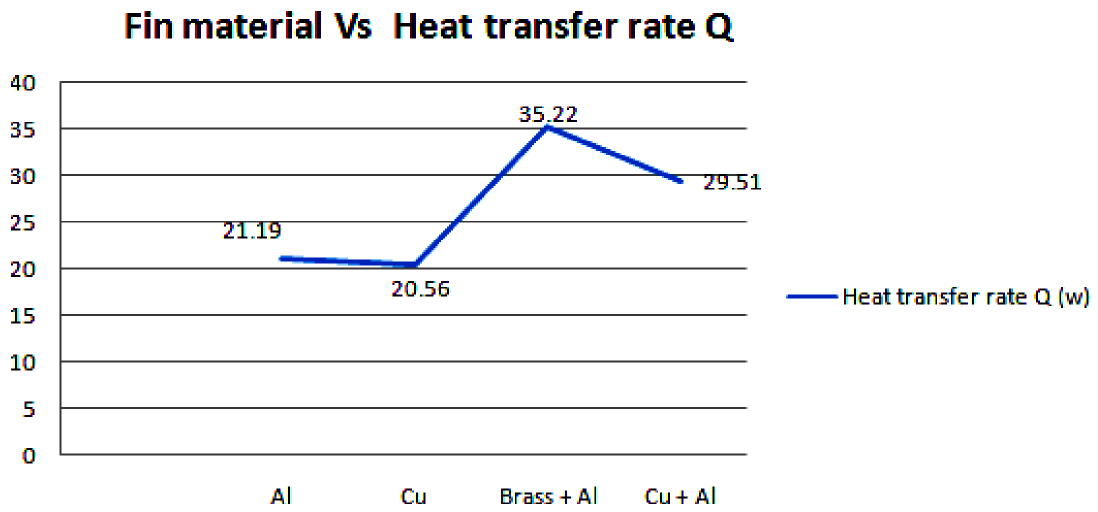

Fig.3. Graph shows variation of Fin materials with Heat transfer rate

In the above graph fin material Brass + Al has high 35.22%, Cu has least 20.56% Heat transfer Rate when compared with the others

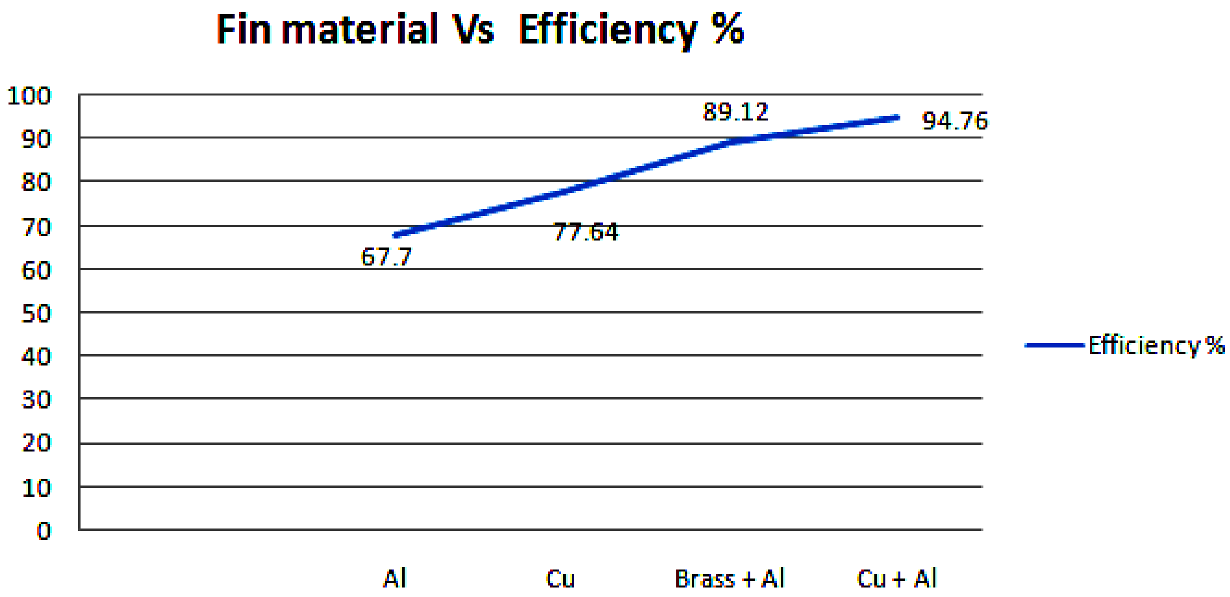

Fig.4. Graph shows variation of Fin materials with Efficiency

In the above graph fin material Cu+Al has high 94.76%, Al has least 67.7% Efficiency when compared with the others From the below table it has be observed that composite material (Brass + Al) has Heat transfer rate, Efficiency nearly 39.83%, 24.03 % greater than the Al. similarly it has be observed that composite material (Cu + Al) has Heat transfer rate, Efficiency nearly 28.19%, 28.55 % greater than the Al. and it has be observed that composite material (Cu + Al) has Heat transfer rate, Efficiency nearly 30.3%, 18.6 % greater than the Cu.

From the below table it has be observed that composite material (Brass + Al) has Heat transfer coefficient nearly 30.5 % Lower than the Al. similarly it has be observed that composite material (Cu + Al) has Heat transfer coefficient nearly 29.02 % Lower than the Al. and it has be observed that composite material (Cu + Al) has Heat transfer coefficient nearly 29.65 % Lower than the Cu.

Table 2: Contains the percentage of variation and nature of heat transfer coefficient, Heat transfer rate and efficiency of bonded composite fins

S. No.	Fin material	Heat transfer coefficient % (Reduction)	Heat transfer rate % (Increase)	Efficiency % (Increase)
1	Brass + Al > Al	30.5	39.83	24.03
2	Cu + Al > Al	29.02	28.19	28.55
3	Cu + Al > Cu	29.65	30.3	18.06

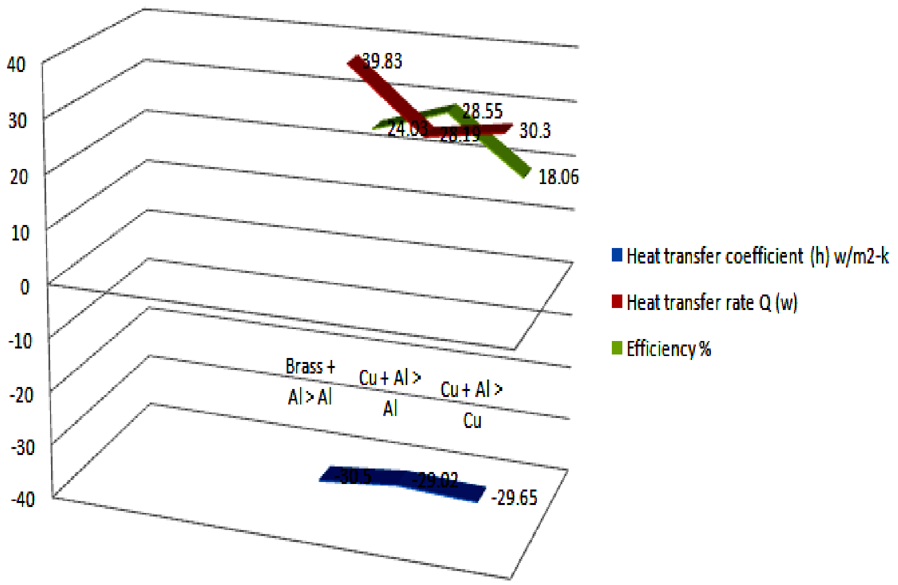

Fig.5. Graph shows the variation between Fin materials with Increase in % of Heat transfer coefficient, Heat transfer rate & Efficiency

From papers [3- 6] the efficiency of annular composite fins with rectangular profile, when coated with Zinc and Zinc alloy, under two dimensional steady state conditions

It was observed that when compared with single material, composite material coatings Shows higher efficiency ratio is 10.46 – 24.45% for zinc coating fin and zinc alloy coating fin from the literature. And if we observe that the average increase in efficiency ratio is 17.45%.

V. CONCLUSIONS

This paper provides information on composite fin with bonded and coatings.

- Increasing the surface area of fin has been increase the heat dissipation rate through fin
- Increase the efficiency of fin by coating with different materials
- Fins are coated with a high thermal conductivity materials is to increases the efficiency of the fins were

obtained

- Efficiency and corresponding the efficiency ratio of the zinc alloy coated fin is greater than the zinc coated fin
- Fins are bonded with different materials are high efficiency than the normal fin
- Bonded composite fin give more efficiency and more heat transfer when compared with single fin
- Bonded composite fins gives more efficiency and more heat transfer when compared with composite fins made of different materials coatings.
- Fins made of coatings are lighter in weight, volume and economical when compared with bonded composite fins.

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REFERENCES

[1] Mr. Pratapa Reddy, Mr.B. Jithendra Kumar, Mr.G. Raju and Dr. Ch. Srinivasa Rao "Fabrication and Thermal Analysis of Composite Pin-Fin" in International Journal of core Engineering and management with ISSN: 2348 9510

[2] Mr.S.Arun, Mr.A.Ananth, Mr. Arul Murugan, Mr.S.Arulvendhan, Mr.E.Aswin Kumar "Experimental Analysis of Fin Coated with Yetrium Oxide to Improve Heat Transfer" International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Special Issue 8, May 2016.

[3] Mr. Balaji, Mr. N. V Srinivas, Mrs. Lalitha Narayana "Effect of Coatings on FIN Efficiency of Annular FIN", IJRMET Vol. 2, Issue 2, May - Oct 2012.

[4] Mr. T.Kanthimathi, Mr.G.Naga Sai Ram "Heat Transfer Through Annular Composite Fins", Journal of Mechanical Engineering and Technology (JMET) Volume 4, Issue 1, Jan-June 2016, pp. 01-10.

[5] Mr. Padma Lochan nayak, Mr.suvendu mohanty "Evaluation Performance of an Annular Composite Fin by Using MATLAB Programming", Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 5, Issue 4, (Part -1) April 2015, pp.83-89.

[6] Mr. Ashish Giri, Mr.S.A.K. Jilani "Evaluation of the Performance of Annular Composite Fin using ANSYS", International Journal of Computer Applications (0975 – 8887) Volume 44– No15, April 2012.

[7] Mr. Md. Farhad Ismail, Mr. Muhammad Noman Hasan, Mr. Suvash Mr. C. Sahac, "Numerical study of turbulent fluid flow and heat transfer in lateral perforated extended surfaces". Elsevier.

[8] Mr. Raaid R. Jassem, "Effect the Form of Perforation on the Heat Transfer in the Perforated Fins", Academic Research International, ISSN-L: 2223-9553, ISSN: 2223-9944Vol. 4 No. 3 May 2013.