International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 7 July 2022, pp: 143-148 www.ijaem.net ISSN: 2395-5252

Fabrication and Analysis of Different Geometry Micro Fins

Dr.D. Deepa[1], Ashokkumar T[2], Ganeshmoorthy S[3], Kumaresan T[4], Logesh C[5]

Associate Professor[1], Muthayammal Engineering College, Rasipuram-637408
Student[2345], Muthayammal Engineering College, Rasipuram-637408

Submitted: 25-06-2022 Revised: 01-07-2022 Accepted: 06-07-2022

ABSTRACT: In recent days, increasing the usage of high performance computers, electronic hardware which occurs more heat generation. With use of convective heat transfer heat is transferred from object to surrounding medium. This will reduce the damage and overheating of components. The micro-fins are act as main role to transfer the excess heat through convection. This paper is about design and fabricate the different types of micro fins and make the experiment on fins to investigate the performance of each fins. The material which used to make the fin is copper were fabricated by Wire-cut Electro Discharge machining (WEDM) process. The different profiles of micro-fins are rectangular, triangular and parabolic fins. Each fins have spacing of 5mm, height of 4mm and base thickness of 5mm are fabricated on the test specimen. This study shows that which profile of copper fin have high heat transfer coefficient.

KEYWORDS: Micro-fins, Copper, WEDM, Convective heat transfer, Straight fins, Configuration of fins.

I. INTRODUCTION

Overheating of electronic components will damage the electric circuit and boards. In present electrical and electronic hardware the heat generation is unavoidable one. Hence, there is need for enhance the heat transfer from components to surrounding medium. Fins or extended surfaces are more efficient to increase the convective heat transfer. Various configurations of fins have different volume, area and heat transfer rate. So in this study about which of the fin profile has high heat transfer coefficient. Due to the high thermal conductivity of copper, the micro fins were made by copper metal.

Some researches were conducted on different types of fins and experiments. HanocaPremakara (2015), Studied the heat transfer enhancement from a verticalrectangular fin embedded with circular perforations under naturalconvection compared to the equivalent solid (non- perforated) fin. They found that there is an improvement in perforated fin heat dissipation over that of the equivalent non perforated solid fin.

Ganesha B.B et al (2019), they did experimental study on aluminium rectangular fins with triangular, rectangular and circular perforated fins are made under forced convection with different voltages, air velocities and fin spacing of 8 mm. They found heat transfer rate for perforated fins were compared with solid fins under some conditions also there is a weight reduction up to 23.6% compared to solid fins.

GavaskarDatlaet al (2019), they have done the analysis of the rectangular profile with three different materials are brass, copper and nickel using number of fins ranging from one to five. The purpose of their paper is that how the efficiency is changed with respect to number of fins and fin material.

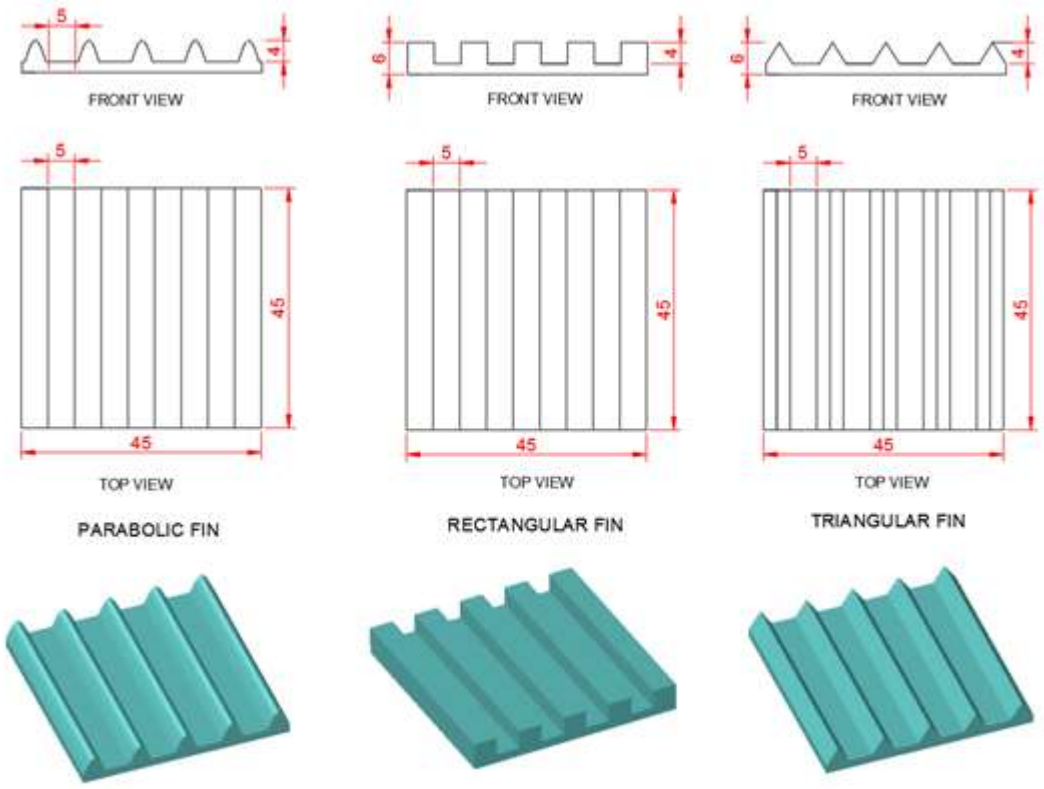
Dr.Umakantet al (2020), studied about different types of fins are used along with different shapes and various materials to understand the effect of heat transfer and improve it for better shape and material for enhance the heat transfer and compared the results with experimental analysis. Our paper is focused on fabricatethe different configurations of copper fin and compare its heat transfer rate.

R. Nagargoje, et al (2020), their study is to experimentally obtain the performance of a triangular fin and rectangular heat sink by conducting free convection test. They have studied triangular fin heat sink which having several advantages as compared to rectangular type heat sink. Hence their study about extended surfaces tells that as area increases heat transfer rate also

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 7 July 2022, pp: 143-148 www.ijaem.net ISSN: 2395-5252

increases. From their result concluded that base plate temperature is less for triangular fin as compared to rectangular fin and heat transfer coefficient is higher for triangular fin.

II. VARIOUS GEOMETRY OF MICRO FINS



III. EXPERIMENTATION

The material used to make micro fins are copper. Due to its physical, chemical and thermal properties of copper we have select copper as a fin material. The main properties of fins should have high thermal conductivity, corrosion resistance. Those properties are perfectively fit for copper to make micro fins. The three different geometry of micro fins are Rectangular fin, Triangular fin and Parabolic fin. The dimension of the specimen are 45 x 45 x 6mm and each fins have height of 4mm, thickness and spacing of 5mm. The various geometry micro fins are fabricated through wire-cut EDM (WEDM) due to its precision and accuracy of machining.

The experimental setup consists of micro fins, ammeter, voltmeter, electric heater and auto transformer. The test specimen of size 45 x 45 x 6 mm were fabricated through wire cut electric discharge machining process (WEDM). The test piece is made up of copper metal, due its high thermal conductivity, corrosion resistance etc. The specimen is held on the electric heater to heat the test pieces. An ammeter is connected series between power supply and electric heater. A voltmeter is connected parallel to the power supply. An auto transformer is used to regulate the voltage of power supply given to heater. Totally three different configuration of micro fins (rectangular, triangular and parabolic) were fabricated by copper metal. An electric heater is used to heat the test pieces and 8W power supply is given to the heater. The heat of the electric heater is controlled through auto transformer.

The test piece is placed in a square pocket made up of acrylic glass (PMMA) of dimension 10 x 10 x 4.2 cm. The entire setup is surrounded by styropor (Expanded polystyrene) of dimension 20 x 23 x 10 cm. The specimen is covered in all sides, except only the top surface of the test piece will have heat transfer. The temperature of top side, bottom side and top air temperature is measured by thermocouple. The experiment is conducted for 4 hours and the temperature readings were noted. The thermocouple which is connected to process indicator to check the temperature of micro fins.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 7 July 2022, pp: 143-148 www.ijaem.net ISSN: 2395-5252

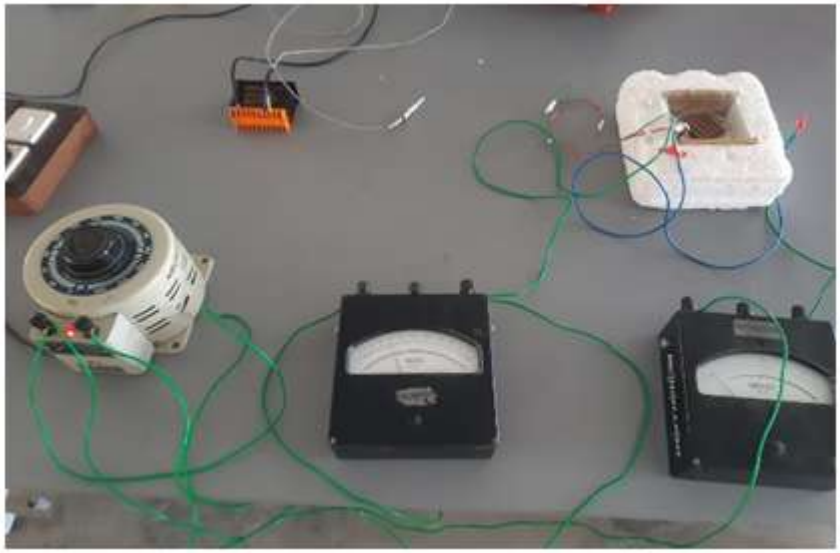


Fig 1 Experimental Setup

The experimentation procedure of this concept is described below:

- AC Power supply is given to heating element through auto transformer.
- With use of auto transformer vary the voltage (0-45V) across the heating element.
- The specimen gets heated by electric heater.
- The heat gets transfer by natural convection of atmospheric air and fin surface.
- The fin surface temperature and fin bottom temperature is noted. Similarly, the top air temperature also noted by thermocouple.
- By calculating the obtained readings, the heat transfer and efficiency of fin were found.
- This same experiment has conducted for different profiles of fins namely rectangular, triangular and parabolic fin.
- The experiment is conducted for 4 hours and the temperature readings were noted in every one hour.

IV. EXPERIMENTAL OBSERVATIONS OF MICRO FINS

The Observations contains top air temperature, top surface temperature of fin and bottom surface temperature of each fins. The readings were noted in every in one hour. The thermocouple is used to take the readings of base and top surface temperature of micro fins. All temperature readings were taken by degree Celsius.

The temperature readings of three different configurations of micro fins namely rectangular fin, triangular fin and parabolic fin are given below the table:-

Table1 Observation Table for Rectangular fin

S.no	No of hours	Top air temp ^{o}C	Top surface temp ^{o}C	Bottom surface temp^{o}C
1	1sthour	34	76	77
2	2ndhour	36	84	87
3	3rdhour	38	88	90
4	4thhour	39	89	93

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 7 July 2022, pp: 143-148 www.ijaem.net ISSN: 2395-5252

Table 2 Observation Table for Triangular fin

S.no	No of hours	Top air temp ^oC	Top surface temp ^oC	Bottom surface temp^oC
1	1st hour	35	76	77
2	2nd hour	39	81	85
3	3rd hour	43	83	88
4	4th hour	46	85	90

Table 3 Observation Table for Triangular fin

S.no	No of hours	Top air temp ^oC	Top surface temp ^oC	Bottom surface temp^oC
1	1st hour	36	77	79
2	2nd hour	40	80	85
3	3rd hour	42	84	87
4	4th hour	45	86	90

Fig 2 Different Configuration of Micro fins

Sample Calculation
Length of each fin =4mm
Thickness of each fin = 5mm
Width of each fin = 45mm
Q = hAΔT
Q = V*I=35*0.23 = 8.05 W
Q = Heat Input
h = Heat transfer Coefficient
ΔT = Temperature difference
ΔT= (Ts-Ta)
Ts= Average surface temperature
Ta= Ambient temperature

1. Rectangular fin calculation
L= 0.004m
W = 0.045m
t = 0.005m
Lc = L + t/2 = 6.5 x 10^{-3}m
A_{fin} = 2wL_c = 5.85 × $10^{-4}m^2$
Area of 5 fins = 2.925 × $10^{-3}m^2$
h = Q/A * ΔT
h = 65.12 W/m^2K

2. Triangular fin calculation
L= 0.004m
W = 0.045m
t = 0.005m

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 7 July 2022, pp: 143-148 www.ijaem.net ISSN: 2395-5252

$A_{fin} = 2w\sqrt{L^2+(\frac{t}{2})^2} = 4.24529 \times 10^{-4} m^2$
Area of 5 fins = $2.1226\times 10^{-3} m^2$
h = $Q/A * \Delta T$
h = 64.55 W/m^{2}K

3. Parabolic fin calculation
L= 0.004m
W = 0.045m
t = 0.005m
$C_1 = \sqrt{1+(\frac{t}{l})^2} = 1.60078$
$A = wL[C_1 + (\frac{L}{t})\ In(\frac{t}{L}) + C_1] = 4.3899 \times 10^{-4} m^2$
Area of 5 fins = $2.1949\times 10^{-3} m^2$
h = $Q/A * \Delta T$
h = 88.89 W/m^{2}K

Table 4 Heat transfer Coefficient of micro fins

S.no	No of hours	h for Rectangular fins	h for Triangular fins	h for Parabolic fins
1	1st hour	65.12	64.55	88.89
2	2nd hour	52.98	63.01	91.12
3	3rd hour	54.70	66.66	86.78
4	4th hour	55.81	67.86	88.89

V. CONCLUSION

- Micro fins are the simplest in design and very effective mode for convective heat transfer.
- The performance of the micro fins were measured and we found very small difference in the experiential value of heat transfer and the theoretically calculated values.
- The parabolic copper test piece was showing maximum heat transfer coefficient 91.12 W/m^{2}k and efficiency of 99.04% and rectangular fins have heat transfer coefficient of 65.12 W/m^{2}k and triangular copper fins have heat transfer coefficient of 67.86 W/m^{2}k. Hence, copper fins are used to enhance the heat transfer compared to other materials.
- Thus, Parabolic micro fins are well suitable for electronic hardware to increase the heat transfer.

REFERENCES

[1]. Ganesha B B, G V Naveen Prakash, "Forced Convection Heat Transfer through the Rectangular Fins of Different Geometry of Perforations" International Journal of Recent Technology and Engineering (IJRTE), Volume-8 Issue-12, May 2019.
[2]. Dr.Umakant V. Kongre, Bhushan W. Jadhav, Sairaj D. Tatad and Ajinkya N. Shastri, "Design and Fabrication of Fins by using Different Materials and Geometries" International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET), Volume 9, Issue 6, June 2020.
[3]. Pankaj V. Baviskar, Kapil A. Saner, Nilesh P. Salunke and Vijay B. Jadhav, "To Analyze the Effect of Varying Fin Shapes for Microprocessor Cooling" International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 4, April 2016.
[4]. R. Nagargoje, R. R. Navthar, S. D. Kathwate, "Experimental Investigation of Heat Transfer Performance of Rectangular and Triangular Fin Heat Sink" International Journal of Advanced Research in Science & Technology (IJARST), Volume 7, Issue 3, July 2020.
[5]. S.Anandhavaradhan, YashkumarIyer, Aashiq Ahmed and S Prabhu, "Analytical investigation of copper substrate fins of various profiles for heat transfer applications" International conference on Advances in Mechanical Engineering (ICAME 2018).
[6]. Yunus A. Cengel and Afshin J. Ghajar, "Heat and Mass Transfer - Fundamentals and Applications" Tata McGraw Hill Education Private Limited.
[7]. Kota LeelaSaiBharath,V Pradeep Kumar, "Design and Analysis of a Rectangular Fin with Comparing by Varying Its Geometry and Material, With Perforation and Extension" Turkish Journal of Computer and Mathematics Education, Vol.12 No.2 (2021).
[8]. Mathias Ekpu, Raj Bhatti, Ndy Ekere, Sabuj Mallik and Emeka Amalu, "Investigation of Effects of Heat Sinks on Thermal Performance of Microelectronic Package" IEEE International Conference on Adaptive Science and Technology (ICAST 2011).
[9]. Pankaj V. Baviskar, Kapil A. Saner, Nilesh

P. Salunke and Vijay B. Jadhav, "To Analyze the Effect of Varying Fin Shapes for Microprocessor Cooling" International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 4, April 2016.

[10]. S.Anandhavaradhan, Yashkumar Iyer, Aashiq Ahmed and S Prabhu, "Analytical investigation of copper substrate fins of various profiles for heat transfer applications" International conference on Advances in Mechanical Engineering (ICAME 2018).

[11]. S. V. Kadbhane and D. D. Palande, "Experimental Study of Natural Convective Heat Transfer from Vertical Rectangular Fin Array at Different Angle of Inclination", International Journal of Current Engineering and Technology, Issue-5 (June 2016).

[12]. K.Balashowry, T.Saikrishna, K.Sri Hari Charan Reddy and Mandhula Kalyan, "Effect of heat Transfer Through Arbitrary Shaped fins using Computational Fluid Dynamics" International Journal of Engineering and Advanced Technology (IJEAT), Volume-10 Issue-1, October 2020.