iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** IX **Month of publication:** September 2016

DOI:

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A Research Paper on Heat Transfer in Notch Fin and UN Notch Fin

Balendra Singh[1], Satish Singh[2]
[1]M.Tech Scholor , [2]Astt. Professor M Tech. Engg Department
VIST Bhopal

Abstract--We studied the experimental observation and simulation for rectangular unnotched fin validated for different thermal load (i.e., 20W, 30W, 40W, 50W) .After that we also simulated different cases (i.e., 20W, 30W, 40W, 50W) based on applying different forms of constant area as an inverted notched fin. All above result of the distribution of temperature, velocity vector plot, Nussalt no. and the heat transfer coefficient, we are here to conclude that the heat transfer coefficient increased continuously in all cases but inverted triangular notched fin is giving maximum heat transfer rate. Heat transfer coefficient of inverted triangular notched fin is 7.16 W/m^2°k which is highest among all. Heat transfer of inverted circular notched fin in 6.15 W/m^2°k which is second highest. Inverted trapezoidal notched fin give 6.08 W/m^2°k heat transfer coefficient better than inverted rectangular notched fin which give 5.67 W/m^2°k heat transfer. Rectangular unnotched fin give least heat transfer coefficient of 4.66 W/m^2°k, the result are for the case with 20 W load. Nusselt no. of inverted triangular notched fin is 300.02 which is highest among all. Nusselt no. of inverted circular notched fin in 268.02 which is second highest. Inverted trapezoidal notched fin give 251.28 Nusselt no. better than inverted rectangular notched fin which give 234.38 Nusselt no. Rectangular unnotched fin give least heat Nusselt no. of 192.44.These are the results for the case with 20 W load.
Key Words: ANSYS ,Fins, Heat Transfer ,Heat Load ,Heat Flux

I. INTRODUCTION

A. Extended Surface

An extended solid surface in which the transfer of heat by conduction is assumed to be a dimension, while the heat transfer is by convection from the surface in the direction transverse to that of conduction. The fins are commonly used to increase the heat transfer rate of the surface when it is not possible to increase the heat transfer rate is by increasing the heat transfer coefficient on the surface or by increasing the temperature difference between the surface and the surrounding fluid. The vanes are commonly used in small capacity compressors. They are also used for scooters and motorbikes as well as small capacity compressors.

B. Fin Effectiveness

Efficiency of the fin represents the ratio between the heat transfer rates to the heat transfer rates that would exist without fin. The desire is to have value of fin effectiveness as large as possible while maintaining the extra cost of addition as low as possible.

$$\varepsilon_{fin} = \frac{q_{fin}}{h A_b (T_b - T_\infty)}$$

C. Fin Efficiency

Efficiency of the fin for the performance of a actual fin to that of an ideal fin. A fully effective end will be the most effective, i.e. it would dissipate heat at the maximum rate if the entire surface is maintained at the base temperature. This ratio is always less than one.

$$\varepsilon_{fin} = \frac{q_{fin}}{q_{no\ fin}} = \frac{q_{fin}}{hA_b(T_b - T_\infty)} = \frac{\eta_{fin}\, h A_{fin}(T_b - T_\infty)}{hA_b(T_b - T_\infty)} = \frac{\eta_{fin}\, A_{fin}}{A_b}$$

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

II. LITERATURE AND PROBLEM FORMULATION

A. Literature Review

SD Suryavanshi, NK Sane (2009) made study on heat transfer by natural convection through inverted rectangular notched fin arrays.

SS Sane et al. (2010) presented a comparison between the experimental results and the results obtained using CFD (computational fluid dynamics) software .

Dharma Rao, SV Naidu, B. Govinda Rao and KV Sharma (20011)Worked on the problem of heat transfer by laminar natural convection from a network containing a vertical fin and horizontal fin base is theoretically formulated treating the adjacent inner fins as two fin enclosures.

SS Sane et al (2012)Did the experimental analysis of heat transfer through without notch and notch fins. They use fin material is aluminum.

Shivdas S. Kharche and Hemant S. Farkade (2012)Presented a comparison between the heat transfer rate through un-notched and notched fins using copper as a material instead of aluminum.

SH Barhatte1 Mr. Chopade (2012)modified by removing the fins portion centre part by cutting a triangular notch and also analyzed the different proportions of notches for comparison and optimization with respect to heat transfer rate and this é an experimental analysis of the result in a range of heights and fin heat dissipation rate, the CFD software was also used to get the result and compare with experimental results.

SM Wange, RM Metkar (2013) did both the experimental analysis and computational analysis of inverted notched fin (in the central part of the bottom fin) dissipation heat by convection natural and also to compare the results between the method and observed that the heat transfer coefficient values are higher in inverted notch fin arrays giving better performance than normal fins arrays..

Hardik Rathod D. et al (2013) studied various documents relating to the transfer of heat through extended surfaces (fins) and the effect on the heat transfer coefficient changing section, the conditions climate, materials, etc.

Jung Tae Sung Kang, Kook Hwan (2013) Studied the characteristics of convective heat flux and were numerically investigated for a typical sink installed vertically from heat and installed horizontally in a free convection using ANSYS CFX software.

Raaid Jassem R., (2013) made an experimental study to investigate heat transfer by natural convection in a rectangular perforated fin plates and used five fins for the job the first non-perforated fin and other perforated by different shaping the fins the perforation by different shapes (circle, square, triangle, hexagon), but these holes have the same cross-sectional area of 113 mm^2 .

Wadhah Hussein Abdul Razzaq Al Doori (2014) did the study on the optimization of heat transfer by natural convection of rectangular fins of circular perforations experimentally and analytically and found that the perforated flange area of heat transfer surface is a function of the dimensions and geometry of fin-shaped perforation and the temperature drop between the base and the blade tip increases as the diameter of the perforation increases.

Barhatte SH et al (2014) analyzed experimentally and computationally that the heat transfer rate through various types of notches in the fin.

MJ sable1, SJ Jagtap, PS Patil, PR Baviskar Barve & SB (2014) Studied for natural convection adjacent to a vertical plate heated with a multiple V- type partition plates (fins) in the ambient air surrounding.

H. Abdullah Alessa Ayman M. Maqableh and Shatha Ammourah (2014) studied the improvement of heat transfer by natural convection in a horizontal rectangular fin integrated with rectangular perforations aspect ratio of two was examined using the finite element technique.

Mr. Shaeri Mr. Yaghoubi, Jafarpur K. (2014) has three-dimensional numerical calculation is made for turbulent fluid flow and heat transfer by convection around a table of solid rectangular and new perforated fins different no. and two different sizes of perforations.

Yang Yujiea, Li Yanzhong (2015)Generally, the Offset Strip Fin (OSF) in a plate-fin heat exchanger provides a greater heat transfer coefficient than plain plate-fin, but it also leads to an increase in flow friction.

J.M. Gorman M. Carideo (2015)Louvered fins constitute a major methodology for heat transfer enhancement.

Balaram Kundu (2015)A parametric variation followed with Kern’s method of design of extended surface heat exchanger has been made for an snaffled shell-and-tube heat exchanger problem.

Leonardo Micheli K.S. Reddy (2015)In recent times, the micro-technologies have gained prominence in various engineering applications.

Pranab Kanti Roy , Hiranmoy Mondal(2015)This work is aimed at studying the effect of environmental temperature such as

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

radiation sink temperature, convection sink temperature and heat generation number on the temperature distribution and efficiency of a convective–radioactive stationary fin.

Surjan Singh, Dinesh Kumar,(2015)In this paper, we have studied heat transfer process in continuously moving fin whose thermal conductivity, heat transfer coefficient varies with temperature and surface emissivity varies with temperature and wavelength.

Leonardo Micheli K.S. Reddy(2015)The interest in micro-technologies has increased in the last decades, because of the low volumes and high-performance granted by their application.

B. Problem formulation

It is observed from the fins of the literature survey are more demanding to cool electronic equipment, stationary engines and many engineering applications, so we need the optimized designs with minimum material and the maximum rate of heat transfer. But due to many factors such as material, fluid velocity, cross section, the climatic condition affects the heat transfer rate of the fin, the main control variable generally available to the designer is geometry of fin array.

III. METHODOLOGY

A. Problem Identification Chart

Experimental observation for the transfer of heat through plane fin.

↓

Create the 3D geometry of heat sink by using NX 7.5 software.

↓

Import the geometry file in parasolid form to ANSYS design modular.

↓

Mesh geometry by selecting appropriate mesh type in meshing software.

↓

The mesh file will import for read in to fluent 14.0 solver.

↓

Step up all the required input parameter and boundary conditions for the simulation

↓

Initialize the flow in order to solve and execute commonly iteration until it converges

↓

See the result of the simulation by the display control where the flow characteristics and other parameters can be analyzed

IV. RESULT AND DISCUSSION

A. Results

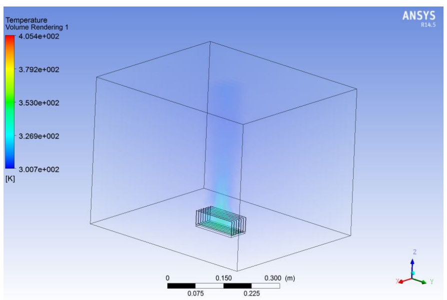


Figure 4.1 Temperature distributions for case 1; maximum temperature is 345.09 ^{o} K

In the figure above the line represent the area of the air that we used to calculation of the temperature and heat transfer from fin to air, the fin is at center of domain red color represent temperature indicated by the outline on the left side of the figure. Above the axis of the fin some dark colors represent the temperature variation on the fin. There is a variation of the temperature due to the reversed notch provided at the mid-section of the rectangular fin.

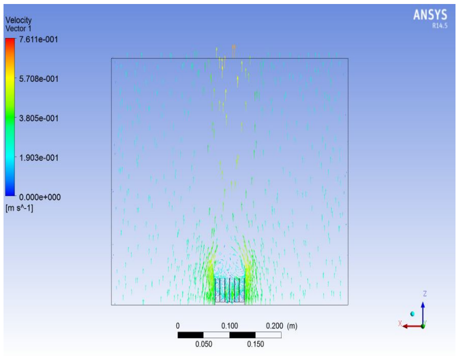


Figure 4.2 Velocity vector plot of Case 1 maximum velocity is 0.57 m / s

The figure above shows the vector field velocity at the middle section of the notch provided in the fin. The figure shows magnitude indicated in the scale in the left corner of the figure. The direction of flow is indicated by the direction of the arrow head, it shows air flows from the outside to the inside space fin through the notch on the fin. In this, we are getting maximum velocity in the center of the fin i.e. 0.57 m / s.

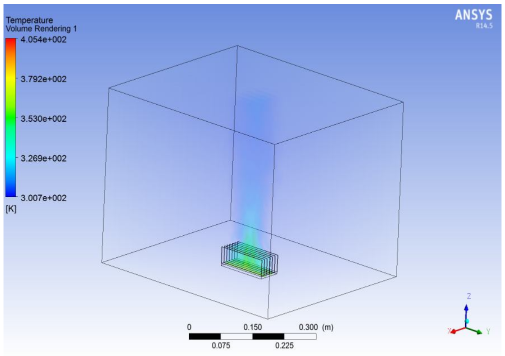


Figure 4.3 Temperature distributions for case 2; maximum temperature is 361.26 ^{o} K

In the figure above the line represent the area of the air that we used to calculation of the temperature and heat transfer from fin to air, the fin is at center of domain red color represent temperature indicated by the outline on the left side of the figure. Above the axis of the fin some dark colors represent the temperature variation on the fin. There is a variation of the temperature due to the reversed notch provided at the mid-section of the rectangular fin.

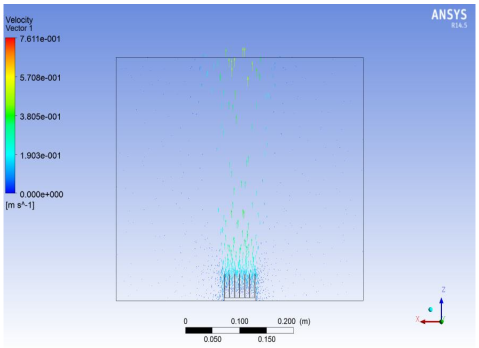


Figure 4.4 Velocity vector plot of Case 2 maximum velocity is 0.21 m / s

The figure above shows the vector field velocity at the middle section of the notch provided in the fin. The figure shows magnitude

Volume 4 Issue IX, September 2016
ISSN: 2321-9653

indicated in the scale in the left corner of the figure. The direction of flow is indicated by the direction of the arrow head, it shows air flows from the outside to the inside space fin through the notch on the fin. In this, we are getting maximum velocity in the center of the fin i.e. 0.21 m / s.

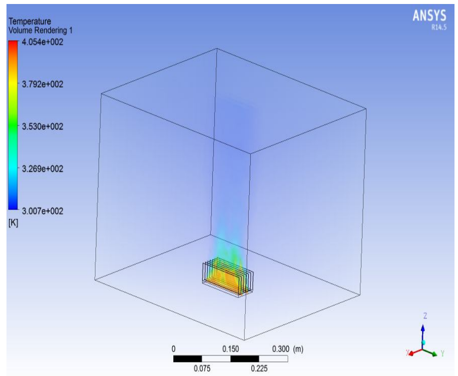


Figure 4.5 Temperature distributions for case 3; maximum temperature is 392.66 ^{o} K

In the figure above the line represent the area of the air that we used to calculation of the temperature and heat transfer from fin to air, the fin is at center of domain red color represent temperature indicated by the outline on the left side of the figure. Above the axis of the fin some dark colors represent the temperature variation on the fin. There is a variation of the temperature due to the reversed notch provided at the mid-section of the rectangular fin.

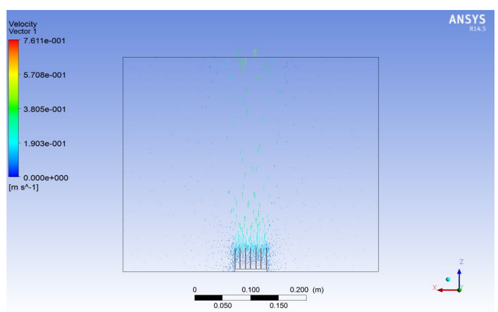


Figure 4.6 Velocity vector plot of Case 3 maximum velocity is 0.38 m / s

The figure above shows the vector field velocity at the middle section of the notch provided in the fin. The figure shows magnitude indicated in the scale in the left corner of the figure. The direction of flow is indicated by the direction of the arrow head, it shows air flows from the outside to the inside space fin through the notch on the fin. In this, we are getting maximum velocity in the center of the fin i.e. 0.38 m / s.

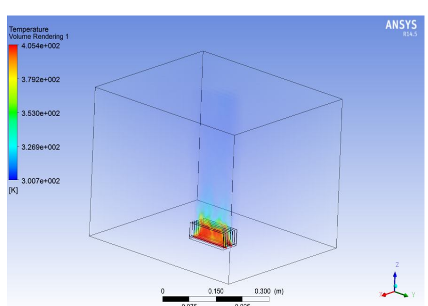


Figure 4.7 Temperature distributions for case 4; maximum temperature is 405.35 ^{o} K

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

B. Simulation Result Of Different Type Of Fins Geometry

Case No.	Fin Geometry	Heat Load	Heat Flux	Heat Transfer coefficient	Nusselt No.
1.	Rectangular unnotched fin	20W	2753	4.66	192.44
2.	Rectangular unnotched fin	30W	4129	5.09	210.68
3.	Rectangular unnotched fin	40W	5506	5.47	226.22
4.	Rectangular unnotched fin	50W	6883	5.63	233.06
5.	Inverted rectangular notched	20W	2753	5.67	234.38
6.	Inverted rectangular notched	30W	4129	6.40	262.46
7.	Inverted rectangular notched	40W	5506	7.14	295.35
8.	Inverted rectangular notched	50W	6883	7.74	320.08
9.	Inverted triangular notched	20W	2753	7.16	300.02
10.	Inverted triangular notched	30W	4129	7.48	315.76
11.	Inverted triangular notched	40W	5506	8.25	332.84
12.	Inverted triangular notched	50W	6883	8.67	358.55
13.	Inverted circular notched	20W	2753	6.15	268.02
14.	Inverted circular notched	30W	4129	7.07	292.19
15.	Inverted circular notched	40W	5506	7.82	323.74
16.	Inverted circular notched	50W	6883	8.43	348.74
17.	Inverted trapezoidal notched	20W	2753	6.08	251.28
18.	Inverted trapezoidal notched	30W	4129	6.97	287.97
19.	Inverted trapezoidal notched	40W	5506	7.82	323.17
20	Inverted trapezoidal notched	50W	6883	8.42	348.07

Table 4.1 Simulation Result of Different Geometry of Fin

C. Comparison Of Heat Load Vs. Heat Transfer Coefficient

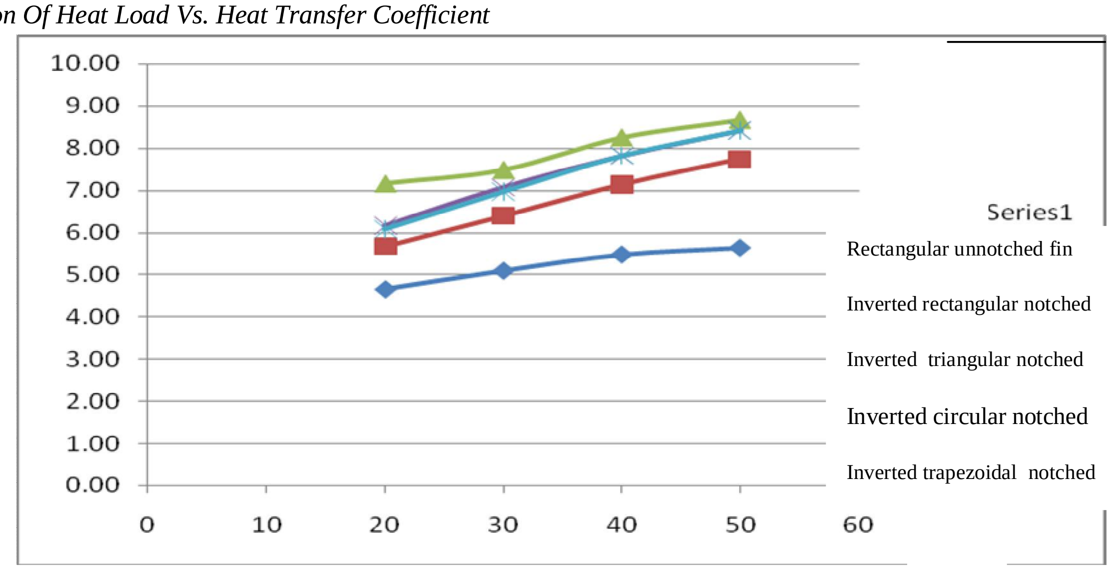


Fig 4.41 Graph Heat load vs. heat transfer coefficient

Volume 4 Issue IX, September 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Fig 4.41 shows the comparison between inverted trapezoidal notched fin, inverted circular notched fin, inverted triangular notched fin, inverted rectangular notched fin and rectangular unnotched fin. Here inverted triangular notched fin give the maximum heat transfer coefficient for all heat load in all cases where as inverted circular notched fin and inverted trapezoidal notched fin give nearly same heat transfer coefficient for all heat load. Inverted rectangular notched fin give better heat transfer coefficient than plane rectangular unnotched fin.

D. Comparison Of Heat Loads vs. Nu

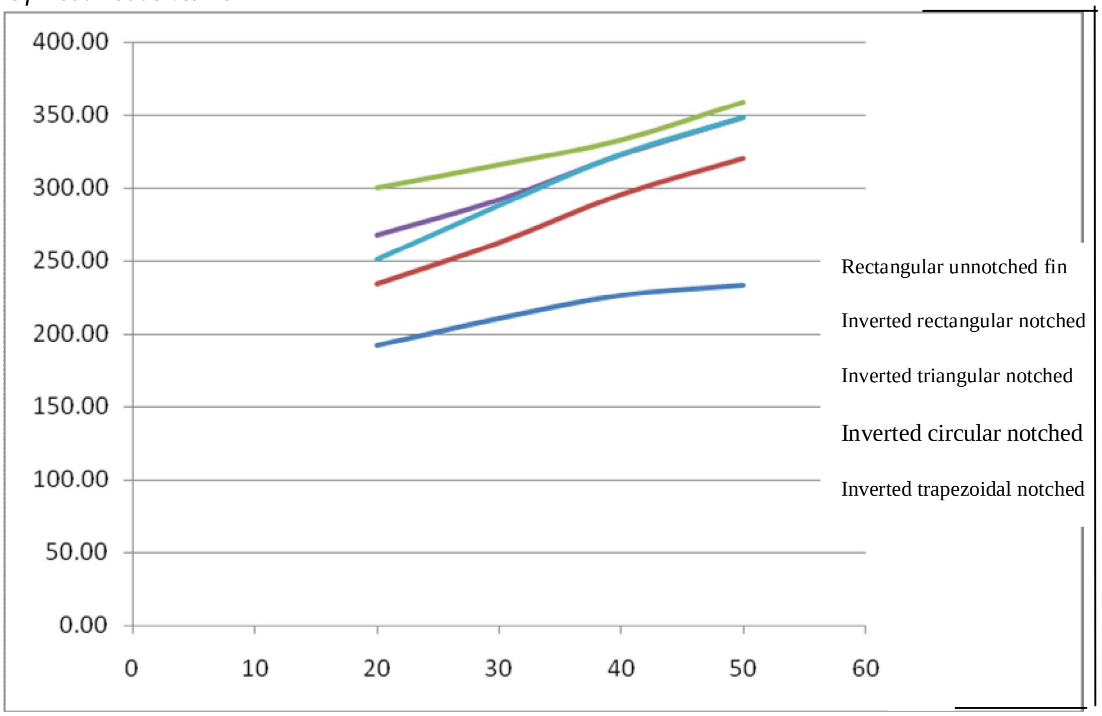


Fig 4.42 Graph of Heat Loads vs. Nu

Fig 4.42 shows the comparison between inverted trapezoidal notched fin, inverted circular notched fin, inverted triangular notched fin, inverted rectangular notched fin and rectangular unnotched fin. Here inverted triangular notched fin give the maximum Nusselt No. for all heat load in all case where as inverted circular notched fin and inverted trapezoidal notched fin give nearly same Nusselt No. for all heat load, Inverted rectangular notched fin give better Nusselt No. than plane rectangular unnotched fin.

V. CONCLUSION

As per the result, we also conclude that heat transfer rate of inverted triangular notched fin has been increased by almost 50.51% as compared to rectangular unnotched fin. We also find that the increase in average heat transfer rate of inverted triangular notched fin, inverted trapezoidal notched fin, inverted circular notched fin and inverted rectangular notched fin with respect to plane rectangular fin are 50.51%, 36.81%, 37.98% and 26, 01% respectively. Hence, we recommend use of inverted triangular notched fin.

REFERENCES

[1] S M.Wange, R.M.Metkar "Computational Analysis of Inverted Notched Fin Arrays Dissipating Heat by Natural Convection" ,International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 11, May 2013.
[2] Hardik D. Rathod, Ashish J. Modi, Prof. (Dr.) Pravin P. Rathod "Effect of Different Variables on Heat Transfer Rate of Four-Stroke SI Engine Fins - Review Study" , international journal of mechanical engineering and technology, Volume 4, Issue 2, March - April (2013), pp. 328-333.
[3] Jung, Tae Sung ; Kang, Hwan Kook ; "Investigation of Natural Convective Heat Flow Characteristics of Heat Sink" Transactions of the Korean Society of Mechanical Engineers B, Volume 37, Issue ,1, 2013, pp.27-33.
[4] Raaid R. Jassem, "Effect the Form of Perforation on the Heat Transfer in the Perforated Fins" , Academic Research International, vol. 4 No. 3 May 2013.
[5] Shivdas S. Kharche, Hemant S. Farkade " Heat Transfer Analysis through Fin Array by Using Natural Convection" , International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 4, April 2012.
[6] S. H. Barhatte, M. R. Chopade, "Experimental and Computational Analysis and Optimization for Heat Transfer through Fins with tringular Notches",

International Journal of Emerging Technology and Advanced Engineering,Volume 2, Issue 7, July 2012.

[7] Wadhahhussein Abdul razzaq al- doori, “Enhancement of natural convection heat transfer from the rectangular fins by circular perforations”, international journal of automotive and mechanical engineering (ijame), volume 4, pp. 428-436, july-december 2011.

[8] Barhatte. S. H, Chopade. M. R, Kapatkar V. N, “Experimental and Computational Analysis and Optimization for Heat Transfer through Fins with different types of Notches”, Journal of Engineering Research and Studies, Volume II, Issue I, January-March 2011.

[9] M.J. Sable, S.J. Jagtap, P.S. Patil, P.R. Baviskar, S.B. Barve “Enhancement of Natural Convection Heat Transfer on Vertical Heated Plate by Multiple v-fin array”, IJRRAS 5 (2) November 2010

[10] S. D. Suryawanshi, N. K. Sane, “Natural Convection Heat Transfer from Horizontal Rectangular Inverted Notched Fin Array”, ASME Journal of Heat Transfer, Vol. 131, Iss. 8, pp. 29-42, 2009.

[11] Abdullah H. AlEssa, Ayman M. Maqableh and ShathaAmmourah “Enhancement of natural convection heat transfer from a fin by rectangular perforations with aspect ratio of two”, International Journal of Physical Sciences Vol. 4 (10), pp. 540-547, October, 2009.

[12] M.R. Shaeri, M. Yaghoubi, K. Jafarpur “Heat Transfer analysis of lateral perforated fin heat sink”, Applied energy 86 (2009) 2019-2029.

[13] S.s. Sane, n. K. Sa ne, g.v.parishwad “ computational analysis of horizontal rectangular notched fin arrays dissipating heat by natural convection”, 5th european thermal-sciences conference, the netherlands, 2008.

[14] Dharma Rao, S.V. Naidu, B. GovindaRao and K.V. Sharma “Combined Convection and Radiation Heat Transfer from a Fin Array with a Vertical Base and Horizontal Fins”, Proceedings of World Congress on Computer science 2007 WCECS 2007, october 24-26,2007, San Francisco, USA.

[15] Sane N.K., Sane S.S., and Parishwad G.V, January 2006, Natural Convention Heat Transfer Enhancement in Horizontal Rectangular Fin Array with Inverted Notch, 18th National & 7th ISHMT-ASME Heat and mass Transfer Conference IIT, Guwahati, 312- 317.

[16] Yunus A. Çengel, 2004, “Heat Transfer- a Practical Approach”, SI units 2nd Edition, Tata McGraw Hill Co., Pg. No. : 156-168, 333-352& 459-500.

[17] Krikkis, R. N., and Razelos, P., 2002, "Optimum Design of Spacecraft Radiators with Longitudinal Rectangular and Triangular Fins," Journal of Heat Transfer, 124(5), pp. 805-810.

[18] BaskayaSenol, SivriogluMecit, and Ozek Murat, 2000, Parametric study of natural convection heat transfer from horizontal rectangular fin arrays, Int. J. Thermal Science, 39, 797–805.

[19] Marlow E. Springer, Karen A. Thole “Experimental design for flowfield studies of louvered fins”, Experimental Thermal and Fluid Science 18 (1998) 258±269.

[20] Incropera F. P., DeWitt D. P., 1996, “Fundamentals of heat and mass transfer”, 4th Edition, John Wiley & Sons, Pg. No. : 147-172.

[21] Misumi Toshiyuki and Kitamura Kenzo “Natural convection heat transfer from a vertical heated plate.” Heat transfer –Japanese Research, Vol-19 No.1 pp-57.1990.

[22] Mohammad Mashud, Md. IliasInam, ZinatRahmanArani and AfsanulTanveer “Experimental Investigation of Heat Transfer Characteristics of Cylindrical Fin with Different Grooves”, International Journal of Mechanical & Mechatronics Engineering IJMME Vol.: 9 No: 10.

[23] Abdullah H. AlEssa and Mohammed Q. Al-Odat “Enhancement of Natural Convection Heat Transfer From a Fin by Triangular Perforations of Bases Parallel And Toward Its Base”, The Arabian Journal for Science and Engineering, Volume 34, Number 2B.

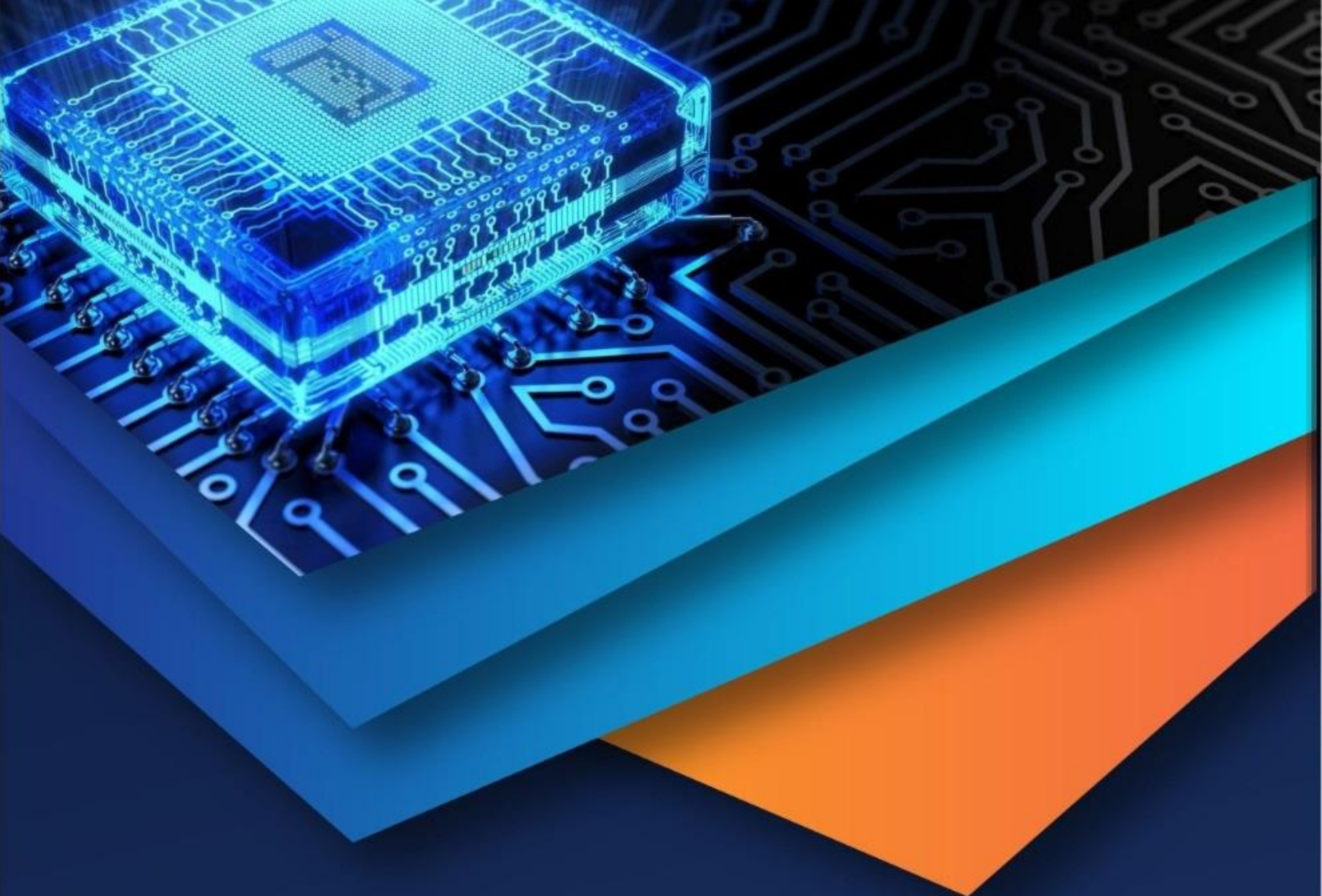
[24] D. Soodphakdee , M.Behnia, and D. Copeland,” A comparison of fin geometries for heat sinks in laminar forced convection; part 1- Round, elliptical and plate fins in staggered and in-line con figure rations”, International journal of Microcircuits and Electronic Packaging,pp.3510-3517,2001.

[25] M. Christen, “Static Heat Transfer analysis of Fin”, Department of Mechanical Engineering, The University of British Columbia, pp. 2-10, 2004.

[26] B. Yazicioglu, and Yuncu, “A Correlation for Optimum Fin Spacing of Vertically-Based Rectangular Fin Arrays Subjected to Natural Convection Heat Transfer”, Journal of Thermal Science and Technology, pp. 99-105, 2009.

[27] M.V. Matkar, Thermal Analysis of Copper Fin by FEA, pp. 1229-1236, 2011.

[28] Dong-kwon Kim, “Thermal optimization of plate-fin heat sinks with fins of variable thickness under natural convection”, International Journal of heat and mass transfer, Department of Mechanical Engineering, Ajou University, Suwon, Republic Korea, pp. 752-761, 2012.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY