Investigating on heat transfer through fins having trapezoidal shape

Harsh N. Pandya[1],M.J. Zinzuwadia[2], V.H. Chudhari[3]

[1]P. G. Student, [2]Associate Professor, [3]Assistant Professor

MechanicalEngineeringDepartment, BirlaVishvakarmaMahavidyalayaEngineeringCollege, VallabhVidyanagar–388120, Gujarat, India.

Abstract- **In the industries or any automobiles components where heat is generated at high temperature because of that heat machine overheating and engine blasting happened so avoid this situations we are consider a fins for cooling the system and less consumption of power. For better cooling heat transfer rate fins size and shape is very important. In this research three different shapes covered which is rectangular, trapezoidal and inverted trapezoidal. Material selection based on research paper. In this research for better size and shape analysis and compare data on ANSYS WORKBENCH and EXPERIMENTAL setup.**

Keywords: **Rectangular fin, Trapezoidal shape, Inverted trapezoidal shape, Natural and Forced convection setup, ANSYS WORKBENCH**

I. INTRODUCTION

- Extended surface commonly known as fins. Fins are used in air conditioner, transformer, IC engine, electronic circuit. Designed finned surfaces called heat sink. Which are commonly used of cooling electronic material and maximum heat transfer. Centre portion in the flat fins is ineffective. Removing centre fins portion by cutting notch of different geometric shapes.

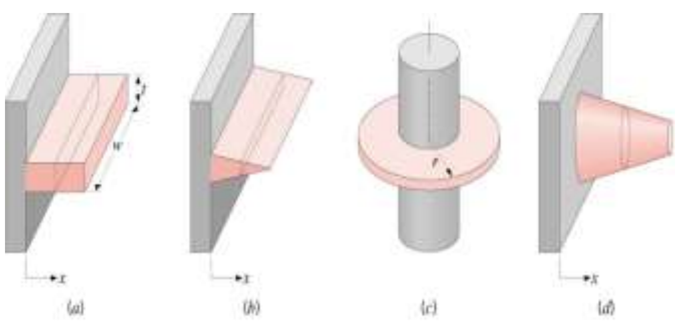


Figure 1 Different shape of fins

Convective heat transfer between a surface and the surrounding has been a major issue and a topic of study for along time. In this project, the heat transfer performance of fin is analyzed by ANSYS workbench for the design offin with various design configuration such as cylindrical configuration and rectangular configuration.[2]

- The use of fin (extended surface)provide efficient heat transfer.
- The optimum size fins of rectangular configuration will reduce the cost for heat transfer process and also increase the rate of heat transfer.

Fins are often used to act as an a betterment technique to give rise in heat transfer rate from the system to the environment which can be stated that it is an essential thermal working system which is being used for cooling purposes in various fields as per the need. study the optimized heat transfer rate with different materials. Material also plays an important role so for dissipation of heat process.**[3]**

- fins geometry with materials would be utilized for the better optimization of heat transfer rate.
- it can be stated by implementing notches in the design of fins leads to the dissipation of heat from surface.

Base temperature (°C)	Temperature at the tip of fn (°C)	Q_{fin} (W)	Efficiency η	Effectiveness ε
100	93.979	11.04	79.47	17
80	75.527	8.016	77.55	17
60	57.148	4.99	78.62	17

Sr No	Material	$\Delta h_{w\,(cm)}$	R_e	ε	η
1	Brass	80	207.143	32.643	79.726
		60	177.737	33.035	80.683
		40	144.62	33.592	82.043
		20	102.024	34.485	84.223
2	Brass with knurling	80	207.351	32.646	79.733
		60	179.006	33.056	80.732
		40	145.337	33.605	82.075
		20	102.262	34.492	84.242
3	Brass with holes	80	209.099	32.672	70.642
		60	178.351	33.045	71.447
		40	145.087	33.601	72.689
		20	102.389	34.495	74.583
4	Aluminium	80	205.386	36.337	88.746
		60	176.59	36.588	89.359
		40	143.49	36.93	90.195
		20	101.039	37.471	91.518

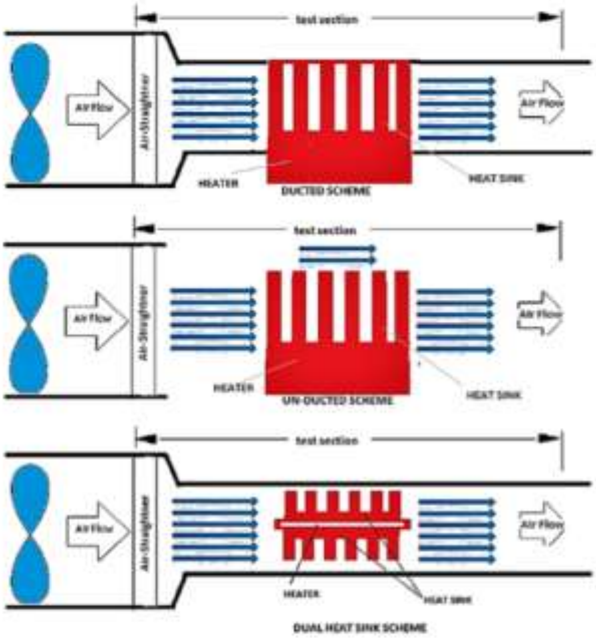
Extended surfaces or fins are commonly found on electronic components ranging from power supplies to transformers. The dissipation and subsequent rejection of potentially destructiveself-produced heat is an important aspect of electronic equipment design. The dissipation of heat is necessary for its proper function. The heat is generated by the resistance encountered by electric current. Unless proper cooling arrangement is designed, the operating temperature exceeds permissible limit. As a consequence, chances of failure get increased[4]

- The Trapezoidal Heat sink shows the lowest thermal resistance and the maximum heat transfer coefficient.
- Heat transfer coefficient and surface Nusselt number is Maximum in Trapezoidal heat sink

Fin Profile	Fin pitch	Heat input	overall heat transfer coefficient W/M2 K	Max temperature K	Nusselt Number	Thermal resistance K/W
Rectangular	2mm	50W	30.50709	325.8217	1260.624	0.6161
		75W	32.84953	341.2246	1357.418	0.6163
		100W	34.16299	356.636	1411.694	0.6163
Trapezoidal	2mm	50W	36.32706	325.1658	1501.118	0.6033
		75W	38.9974	340.2493	1611.463	0.6033
		100W	40.47094	355.1844	1672.353	0.6011
Parabolic	2mm	50W	33.38483	328.7138	1379.538	0.6741
		75W	35.61325	345.56387	1471.622	0.6741
		100W	36.84299	362.42621	1522.438	0.6741

This study initiates with brief and comprehensive discussion regarding importance of heat sinks, its methodology; it's suitability for present day heat dissipation issues, statistical data of various heat sink designs and a rich discussion of the work so far. The sole aspiration for this article is digging out the literature available so far with emphasis on experimental techniques and to propose strategy for future research. The outcome of the research will validate the concept of improved heat transfer approach, provide useful data for innovative design and help better understand the cooling capabilities of the pin fin technology.[5]

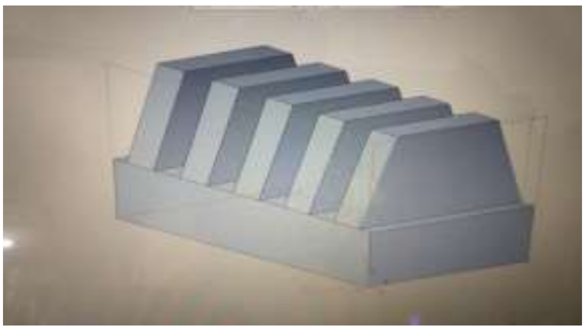
Major active and passive heat transfer enhancement techniques have been presented, including fresh and innovative enhancement solution towards Fin geometries, flow medium, cooling fluid flow directions, additives in fluid, effect of vibration, obstruction in flow, surface roughness, and so on with the inference that passive technique as most attractive area of research so far.



Heat transfer in the thermal entrance region of trapezoidal microchannels is investigated for hydrodynamically fully developed, single-phase, laminar flow with no-slip conditions. Three-dimensional numerical simulations were performed using a finite-volume approach for trapezoidal channels with a wide range of aspect ratios. Correlations are also developed for the local and average Nusselt numbers in the thermal entrance region as a function of a dimensionless axial length variable.[6]

Numerical results are obtained and summarized for thermally developing flow (TDF) with the boundary condition in trapezoidal microchannels with sidewall angles 54.7° and 45° over a wide range of aspect ratios.

III. CREO, WORKBENCH AND EXPERIMENTAL SETUP



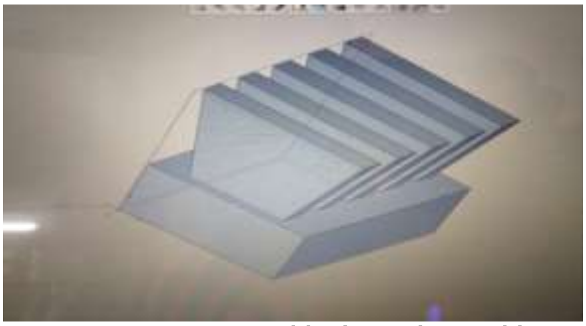


Figure : trapezoidal and inverted trapezoidal

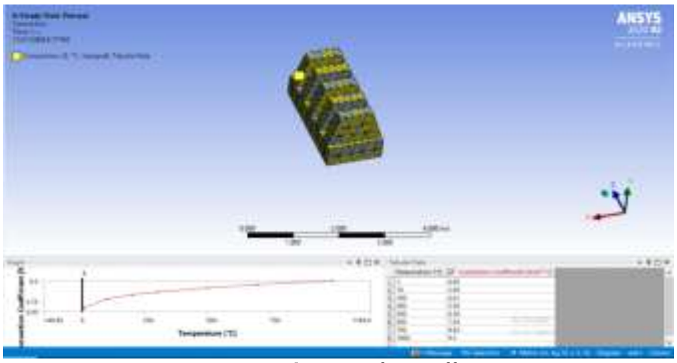
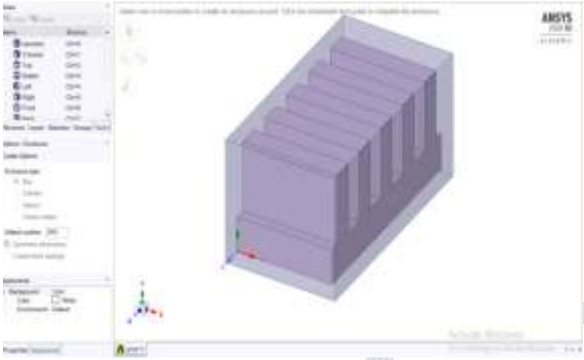
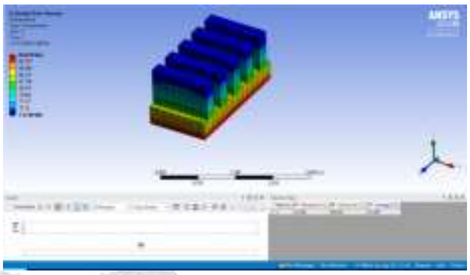
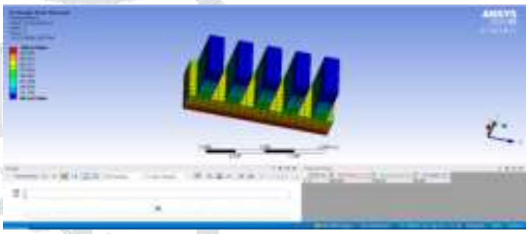


Figure varying heat transfer co-efficient







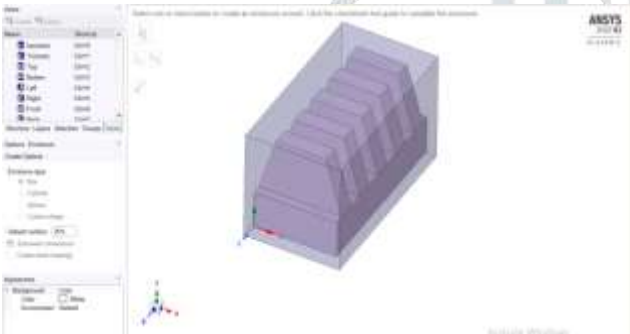


Figure 4 Digital thermometer

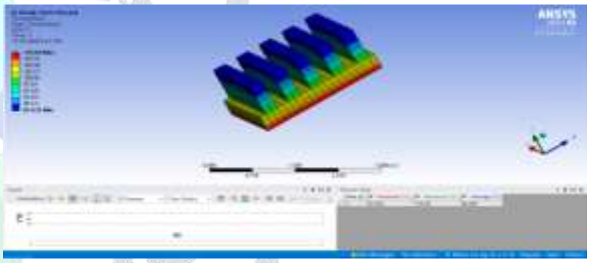
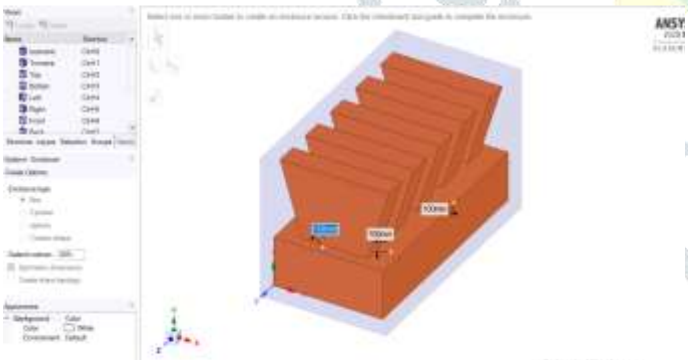
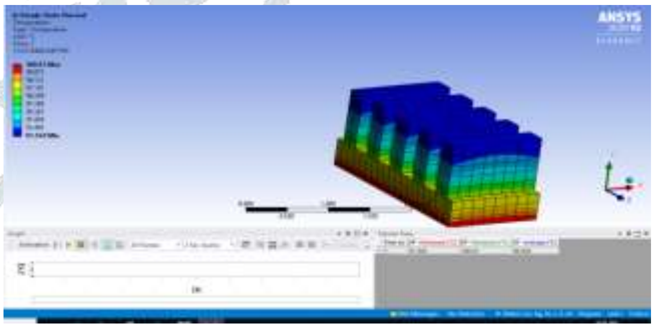
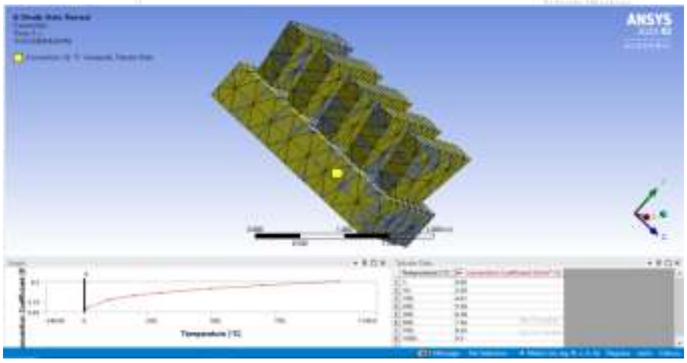
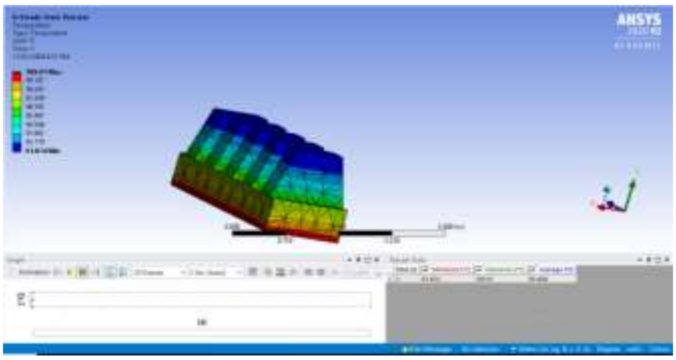


Figure rectangular with different length









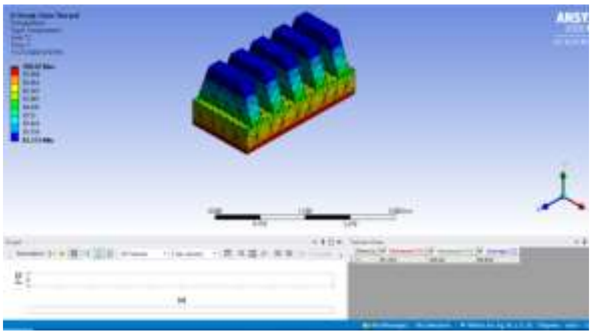
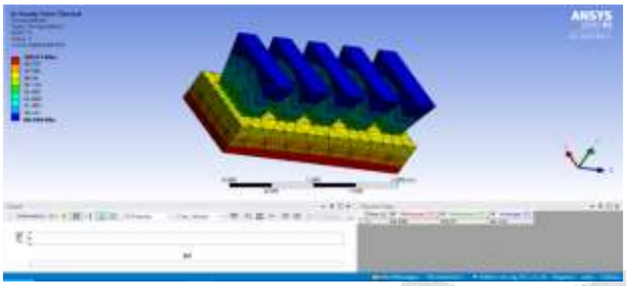
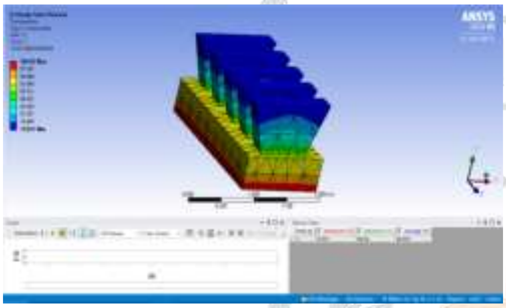


Figure: material aluminium and structural steel





Trapezoidal and Inverted trapezoidal shape:

IV. Experimental Setup:

	Efficiency	effectiveness	h	Q
Natural convection	95.54%	38.09	30.29	360W
Forced convection	79.98%	31.80	17.42	1250 W

- **Natural convection machine:**
- **V= 110-115V**
- **I= 0.12-0.15A**
- **T= 102 C**
- **$Nu = 1.1(Gr.Br)^{(1/6)}$ $10^{(-1)}<Gr.Pr<10^{(4)}$**
- **$0.53(Gr.Br)^{(1/4)}$ $10^{(4)}<Gr.Pr<10^{(9)}$**
- **$0.13(Gr.Br)^{(1/3)}$ $10^{(9)}<Gr.Pr<10^{(12)}$**

Forced Convection machine:

- **T= 101 C**
- **$Nu=0.615(Re)^{(0.466)}$ $40<Re<4000$**
- **$=0.174(Re)^{(0.618)}$ $4000<Re<40000$**
- **$v=Q/A$**

VII. RESULTS

Workbench	shape	Material	Base temp.	Tip temp.
(natural-Connection)	rectangular	s.s	90	73.54
	rectangular	s.s	100	80.64
	rectangular	s.s	110	87.63
	trapezoidal	s.s	100	81.25
	Inverted trapezoidal	s.s	100	75.92
	rectangular	al	100	91.54
	trapezoidal	al	100	91.87
	Inverted trapezoidal	al	100	88.99
Experimental (natural)	trapezoidal	s.s	102	80.70
	Inverted trapezoidal	s.s	102	78.20
Experimental (forced)	trapezoidal	s.s	101	82.20
	Inverted trapezoidal	s.s	101	81.40

VIII. FUTURE SCOPES

1) Complex shape will be adapted in fins for better heat transfer rate.

CONCLUSION

- Efficiency and effectiveness is decreased in forced convection compare to natural convection.
- Heat transfer rate is high in forced convection.
- Temperature difference is high in inverted trapezoidal shape and low in trapezoidal shape.

ACKNOWLEDGEMENT

We are gratefully acknowledge contribution of college principal, head of department and lab assistant for our work.

REFERENCES

1) H. S. Kang, D. C. Look, International Journal of Applied Engineering Research, Two dimensional trapezoidal fins analysis,1997.
2) Hyung Suk Kang , Universal Journal of Mechanical Engineering, Analysis of Reversed Trapezoidal Fins using a 2-D Analytical Method,2015.
3) L.Prabhu,M.Ganesh Kumar, DESIGN AND ANALYSIS OF DIFFERENT TYPES OF FIN CONFIGURATIONS USING ANSYS, International Journal of Pure and Applied Mathematics,2018
4) Sayed Zaidshah,Viveksheel Yadav, Heat transfer from different types of fins with notches with varying materials to enhance rate of heat transfer a Review, Iinternational Journal of Applied Engineering Research,2019
5) John P. McHale,S V. Garimella, Heat Transfer in Trapezoidal Micro channels of Various Aspect Ratios, Cooling Technologies Research Center,2010
6) International journal of heat and mass transfer.
7) Jun hong hao, Qun chen, Applied Thermal Engineering, An experimental study on the offset strip fin geometry optimization of a plate-fin heat exchanger based on the heat current model,2019.
8) Pulkit sagar,H.C thakur, International Journal of Applied Engineering Research, Heat transfer analysis and optimization of engine fins of varying geometry,2016
9) N.A. Navale, A.S. Pawar, International Journal of mass and heat transfer, Experiment on heat transfer through fins having different notches,2016.
10) Mr. Omkar Nakadi,Mr. Nitish I Hukkeri,Mr. Jotiba Belgaonkar, Effect of Different Fin Geometries on Heat Transfer Coefficient, International Journal Of Scientific & Engineering Research,2016
11) Roody Charles, Chi-Chuan Wang, A novel heat dissipation fin design applicable for natural convection augmentation, International Communications in Heat and Mass Transfer,2014
12) Zulfiqar Khattak,Hafiz Muhammad Ali, Air cooled heat sink geometries subjected to forced flow: A critical review, International Journal of Heat and Mass Transfer,2019
13) Ambeprasad.S.Kushwaha,Prof. Ravindra Kirar, Comparative Study of Rectangular, Trapezoidal and Parabolic Shaped Finned Heat sink, *IOSR Journal of Mechanical and Civil Engineering,2013*