A PROJECT REPORT

ON

"DESIGN AND ANALYSIS ON EFFECTS OF DIFFERENT FIN PERFORATIONS ON MOTOR"

Submitted to

UNIVERSITY OF MUMBAI

In Partial Fulfillment of the Requirement for the Award of

BACHELOR'S DEGREE IN MECHANICAL ENGINEERING

BY

SHAIKH MUBASHSHIR MUSTAQ	16DME175
SHAKH YUSUF MANSOOR	16DME172
SHAIKH FATRU MUSA	15ME100
SHAIKH DANISH AKBAR ALI	15ME99

UNDER THE GUIDANCE OF
PROF. RIZWAN SHAIKH

DEPARTMENT OF MECHANICAL ENGINEERING
Anjuman-I-Islam's Kalsekar Technical Campus
SCHOOL OF ENGINEERING & TECHNOLOGY
Plot No. 2 3, Sector - 16, Near Thana Naka,
Khandagaon, New Panvel - 410206

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CERTIFICATE

This is certify that the project entitled

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submitted by

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SHAIKH YUSF MANSOOR	**16DME172**
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is a record of bonafide work carried out by them, in the partial fulfilment of the requirement for the award of Degree of Bachelor of Engineering (Computer Engineering) at ***Anjuman-I-Islam's Kalsekar Technical Campus, Navi Mumbai*** under the University of MUMBAI. This work is done during year 2018-2019, under our guidance.

Date: / /

(Prof. RIZWAN SHAIKH)
Project Supervisor

(Prof.RIZWAN SHAIKH)
Project Coordinator

(Prof.ZAKIR ANSARI)
HOD, Mechanical Department

DR. ABDUL RAZAK HONNUTAGI
Director

External Examiner

Acknowledgements

I would like to take the opportunity to express my sincere thanks to my guide **PROF RIZWAN SHAIKH**, Assistant Professor, Department of Mechanical Engineering, AIKTC, School of Engineering, Panvel for his invaluable support and guidance throughout my project research work. Without his kind guidance & support this was not possible.

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At last we must express our sincere heartfelt gratitude to all the staff members of Mechanical Engineering Department who helped me directly or indirectly during this course of work.

SHAIKH MUBASHSHIR MUSTAQ
SHAIKH YUSUF MANSOOR
SHAIKH FATRU MUSA
SHAIKH DANISH AKBAR ALI

Project Approval for Bachelor of Engineering

This project entitled ***D̈ESIGN AND ANALYSIS ON EFFECTS OF DIFFERENT FIN PERFORATIONS ON PERFORMANCE OF MOTOR*** ¨ by ***SHAIKH MUBASHSHIR MUSTAQ ,SHAIKH YUSUF MASOOR,SHAIKH FATRU MUSA, SHAIKH DANISH AKBAR ALI,*** is approved for the degree of ***Bachelor of Engineering in Department of Mechanical Engineering.***

Examiners

1. ....
2. ....

Supervisors

1. ....
2. ....

Chairman

....

Declaration

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Student Name
Roll Number:

TABLE OF CONTENTS:

ABSTRACT:

In many engineering applications extended surfaces known as fins, are used to enhance convective heat transfer. The problem of natural convection heat transfer for perforated fins was investigated in this work. An experimental study was conducted to investigate the natural convection heat transfer in a rectangular fin plate with no perforations ,square perforations and circular perforations. The investigation is conducted to compare heat transfer rate of different fins (3 fins) with a size of 300x75 mm embedded with different types of perforations. The patterns of perforations on rectangular fins contain of 10 hole. The temperature distribution was examined for rectangular fins. Experimental results shows the temperatures distribution and heat transfer coefficient calculated analytically and also using Ansys Workbench 16.2 and Furthermore, for different perforation , the heat transfer rate and the coefficient of heat transfer also varied giving better results.

The work done on various types of fins, effect of perforation shape or geometry on the heat transfer was simulated on motor in ANSYS using actual motor dimensions(3D modelled in Autodesk Inventor 2019) to determine best type of fin to be used in motor.The comparison between experimental result and software result between the types of fins perforation was analysed for the heat transfer coefficient to clarify the best perforation shape for the motor.The difference between experimental and numerical results was reported for temperature distributions when the heat supplied are respectively.The overall conclusion shows different perforations analysed and their results are tabulated and also shown in the graphical format.

LIST OF FIGURES:

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CHAPTER 1

Introduction

1.1 GENERAL INTRODUCTION

Fins are a useful way to increase heat transfer with minimal increase in volume • Fins transfer heat either through free or forced convection • Convection: Heat transfer between a solid surface and a moving fluid. Therefore, to increase the convective heat transfer, one can • Increase the temperature difference (Ts-Ta) between the surface and the fluid. • Increase the convection coefficient h. This can be accomplished by increasing the fluid flow over the surface since h is a function of the flow velocity and the higher the velocity, the higher the h. Example: a cooling fan. • Increase the contact surface area A. Heat exchangers are widely used in various, transportation, industrial, or domestic applications such as thermal power plants, means of heating, transporting and air conditioning systems, electronic equipment and space vehicles. In all these applications improvement in the efficiency of the heat exchangers can lead to substantial cost, space and material savings. Hence considerable research work has been done in the past to seek effective ways to improve the efficiency of heat exchangers.

The major heat transfer enhancement techniques that have found widely spread commercial application are those which possess heat transfer enhancement elements. All passive techniques aim for the same, namely to achieve higher values of product of the heat transfer coefficient and heat transfer surface area. A distinguish between the way how the heat transfer enhancement is achieved, is common in the heat transfer community. Here in the present work, a terminology similar to the literature is followed although for practical applications are irrelevant how the heat transfer enhancement is achieved.

APPLICATIONS

1. Economizers of steam power plants
2. Heat exchangers of a wide variety, used in different industries
3. Cooling of electric motors, transformers
4. Cooling of electronic equipments, chips,I.C boards etc.
5. Radiators for automobiles
6. Air-cooling of cylinder heads of Internal
7. Combustion engines (e.g. scooters, motor cycles, aircraft engines etc.), air compressors

<u>Universal IE2 7.5kW (10HP</u>) three phase 2 pole B3 Foot mounting 132S frame AC Induction Motor for 230V or 400V 3 phase supply. Suitable for use with a Variable Frequency Inverter Drive with 3ph output. Dimensions: 265mm wide x 437mm long x 318mm high overall. Mounting: Foot mount on 12mm holes at 216mm wide x 140mm centres 89mm back from the shaft shoulder. Shaft: 38mm diameter, 80mm long with 10mm key. Construction: Aluminium Weight: 48.00kg

1.2 PROBLEM DEFINATION/OBJECTIVE

I. 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.

II. 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.

OBJECTIVE:

1) To construct a setup to allow experimental data to be obtained under different fin profiles (Non perforated, Square perforated and circular perforated fin) & conditions.
2) To investigate the heat transfer rate of various fins
3) To find out the effect of geometrical parameters of fins.

To create a experimental setup of heat transfer of fins and analyse it using different methods analytically

A. Using Newton's Law of Convection
B. Using Nusselt Number (For vertical plates).
C. And also using software(ANSYS Workbench 16.2) to determine temperature distribution and heat transfer parameters of different types of fin perforations having same thermal conductivity & varied cross sectional area.

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I. LITERATURE SURVEY

Thamir K. Ibrahim.[2] Heat sink with perforated and non-perforated fins were investigated.Perforated fins increase the heat coefficient of the heat sink by 35.82–51.29%.The difference between experimental and numerical results was about 8% and 9% for temperature distributions when the power supplied are 150 W and 100 W respectively.The fluid and heat transfer properties of heat sink were studied experimentally and numerically using CFD.Heat sink with perforated fins showed significant effect on the performance of forced convection heat transfer.

L.Prabhu[3].Heat transfer performance of fin is analysed by ANSYS workbench for the design of fin with various design configuration such as cylindrical , square and rectangular configuration. The heat transfer performance of fin with same base temperature is compared. In this thermal analysis, Aluminium was used as the base metal for the fin material. Fins are design with the help of CATIA V5R16. Analysis of fin performance done through the software ANSYS 15.0.

M. Sabri Sidik[4].An analysis was conducted to study the heat transfer of in-wheel electric motor cooling fin for light electric vehicle application. This study focuses on motor housing design and heat transfer analysis of different cooling fins arrangement for motor housing.Three types of cooling fin arrangement on the motor housing has been selected and modelled in CATIA software. There were straight fin, slanting fin and transverse fin. Then, all models were exported to ANSYS for heat transfer analysis purpose. This suggests that the straight fin arrangement has the highest efficiency of heat dissipation and distribution compare to the slanting and transverse fin arrangement

Zan WU[5]. Natural convection heat transfer enhancement of perforated fin array with different perforation diameter 4-12mm and a different Angles of inclination (0-90) increase in the heat transfer coefficient was achieved with perforated fins of 12mm perforation diameter of the Angle of orientation 45 degree which shows about 32% enhanced heat transfer coefficient with saving 30% material.

Pardeep Singh[6] In this research, the heat transfer performance of fin is analysed by design of fin with various extensions such as rectangular extension, trapezium extension, triangular extensions and circular segmental extensions. The heat transfer performance of fin with same geometry having various extensions and without extensions is compared. Near about ranging 5% to 13% more heat transfer can be achieved with these various extensions on fin as compare to same geometry of fin without these extensions. Fin with various extensions design with the help of software AutoCAD. Analysis of fin performance done through the software Autodesk Simulation Multiphysics. In this thermal analysis, temperature variations w.r.t. distance at which heat flow occur through the fin is analysed. Extensions on the finned surfaces is used to increases the surface area of the fin in contact with the fluid flowing around it.So, as the surface area increase the more fluid contact to increase the rate of heat transfers from the base surface as compare to fin without the extensions provided to it. On comparison, rectangular extensions provide on fin gives the greatest heat transfer than that of other extensions having the same length and width attached to finned surface

. CHAPTER 2

Preliminary considerations on heat transfer and enhancement techniques.

2.1 BASIC HEAT TRANSFER:

2.1.1 HEAT TRANSFER AND THERMODYNAMICS:

The study of transfer phenomenon which includes transfer of momentum, energy, mass etc has been recognized as a unified discipline of fundamental importance on the basis of thermodynamic fluxes and forces. The transfer of such phenomena occurs due to a conjugate force of temperature gradient, velocity gradient, concentration gradient chemical affinity etc. The transfer of heat energy due to temperature difference or gradient is called heat transfer.

2.1 TYPES OF CONVECTION:

2.2.1 NATURAL CONVECTION:

Natural convection is a mechanism, or type of heat transfer in which fluid motion is not generated by any external source like pump, fans, suction devices etc but only due to density difference in the fluids occurring due to temperature gradient.

The driving force of natural convection is Buoyancy, a result of difference in fluid density. Because of this the presence of a proper acceleration which would provide sufficient resistance to gravity or an equivalent force is essential for natural convection.

2.2.2 FORCED CONVECTION:

Forced convection is mechanism, or type of heat transfer in which fluid motion is generated by an external source like pump, fans, suction devices etc. it is considered as the main method of useful heat transfer as significant amount of heat energy can be transferred by this process.In forced convection cases some amount of natural convection is always present. This type of convections is called as MIXED CONVECTION.

2.3 NATURAL CONVECTION:

The measures of Natural convection are:

2.3.1 REYNOLDS NUMBER (R_e):

The Reynolds Number, the non-dimensional velocity, is defined by the ratio of dynamic pressure (ρ u2) and shearing stress (μ u / L)

$$R_e = \rho u L / \mu$$

2.3.2 NUSSELT NUMBER (N_u):

In heat transfer at a boundary (surface) within a fluid, the Nusselt number is the ratio of convective to conductive heat transfer across (normal to) the boundary. In this context, convection includes both advection and conduction. It is a dimensionless number. The conductive component is measured under the same conditions as the heat convection but with a (hypothetically) stagnant (or motionless) fluid.

$$\mathrm{Nu}_L = \frac{hL}{k_f}$$

2.3.3 PRANDTL'S NUMBER (P_r):

The Prandtl number is a dimensionless number; the ratio of momentum diffusivity (kinematic viscosity) to thermal diffusivity.

$$P_r = V / \alpha$$

2.3.4 GRASHOF'S NUMBER (G_r):

The Grashof number is a dimensionless number in fluid dynamics and heat transfer which approximates the ratio of the buoyancy to viscous force acting on a fluid. It frequently arises in the study of situations involving natural convection.

$$\mathrm{Gr}_L = \frac{g\beta(T_s - T_\infty)L^3}{\nu^2}$$ for vertical flat plates

$$\mathrm{Gr}_D = \frac{g\beta(T_s - T_\infty)D^3}{\nu^2}$$ for pipes

$$\mathrm{Gr}_D = \frac{g\beta(T_s - T_\infty)D^3}{\nu^2}$$ for bluff bodies

=

2.3.5 RAYLEIGH'S NUMBER (R_a):

is defined as the product of the Grashof number, which describes the relationship between buoyancy and viscosity within a fluid, and the Prandtl number, which describes the relationship between momentum diffusivity and thermal diffusivity. Hence the Rayleigh number itself may also be viewed as the ratio of buoyancy and viscosity forces times the ratio of momentum and thermal diffusivities.

$$\mathrm{Ra}_x = \mathrm{Gr}_x \mathrm{Pr} = \frac{g\beta}{\nu\alpha}(T_s - T_\infty)x^3$$

2.4 HEAT TRANSFER BY EXTENDED SURFACE:

Convection heat transfer is governed by the relation: $Q = h\,A\,(T_S - T_A)$

To increase the heat transfer rate the following ways can be adopted.

1. Increasing heat transfer co-efficient (h). However increasing the value of h does not significantly influence the value of Q.
2. Surrounding fluid temperature (T_S) can be decreased. But it is often impractical as in most cases the surrounding is atmosphere.
3. Hence the only way is by increasing the surface area across which convection occurs.

The increase in cross sectional convection area can be achieved by using fins that exted from the wall of the convection shell. The thermal conductivity of the fin material has a very strong effect on the temperature distribution across the wall of the convection shell and thus the degree to which the heat transfer rate is enhanced.

Various types of fins are usually used:

- Straight fins of uniform cross section
- Straight fins of non-uniform cross section
- Annular fins
- Cylindrical fins
- Pin fins
- Perforated fins

2.5 FIN PERFORMANCE:

2.5.1 FIN EFFECTIVENESS:

Fin effectiveness is defined as the ratio between heat transfer rate with fin and heat transfer rate without fin.

$€_f = Q_o / hA\ \theta_o$

while using a fin for increasing heat transfer rate we should consider that, the fin itself represents a conductive resistance to heat transfer from original surface. Therefore it is not necessary that by using fins the heat transfer rate increases.

This facto is calculated by fin effectiveness

When $€_f < 2$, the use of such fins are not justified. Fin effectiveness can be enhanced by,

1. Choice of material of high thermal conductivity. Eg. Aluminium, Copper
2. Increasing ratio of area to the perimeter of the fins. The use of thin closely placed fins is more suitable than thick fins.
3. Low values of heat transfer coefficient (h).

2.5.2 FIN EFFICIENCY:

This is the ratio of the fin heat transfer rate to the heat transfer rate of the fin if the entire fin were at the base temperature.

$$\eta_f = \frac{q_f}{h.A.\theta_o}$$

CHAPTER 3

METHODOLOGY:

MATERIAL SELECTION:

- The material which is selected for farbrication of fins plates is aluminum (6061) .It is an hardened aluminum alloy ,containing magnesium and silicon as its major alloying elements.It is used commonly for manufacturing fins materials.

MACHINE TOOLS USED:

- We have used different types of machine tools such as Hand cutting machine to cut aluminium plate into required size
- Then we have used drilling machine to drill holes of 8.5mm/9.5mm/10mm on the plate.
- Then we used hand Grinding machine to polish the surface of the material.

DESIGN &FABRICATION:

- We have fabricated 3 types of plates which are
- :-Non perforated plate:-The cross sectional area of fin is (300x75mm).
- square perforated plate:-The cross sectional area of fin is (300x75mm).There are 10 square holes is drilled at the surface of the plate with equidistance(45mm) between two holes vertical and the horizontal distance.And the bottom space is left for the heater arrangment.
- circular perforated plate:-The cross sectional area of fin is (300x75mm).There are 10 circle holes is drilled at the surface of the plate with equidistance(45mm) between two holes vertical and thehorizontal distance.we have desgin the fin plates model by AUTODESK INVENTOR

PROCEDURE:-

- we have perform experiment to find the heat coefficient rate of different types of fins by using fin convection apparatus provided by college.
- The apparatus consist of blower, duct, thermo couples, digital screen ,voltage and current regulator.
- The size of duct (700x300x20mm) with blower is assembled at the bottom side of the duct.Duct is open from the top side .
- Specification of blower:- 240v,1.3A,60w,50HZ&280rpm.
- we had placed 5 thermocouples i.e.(t1,t2,t3,t4,t5) at fins plate to note down the temperature at various distance of plate and one is left for ambient temperature(t6).
- we had attached heater at fin plate at the bottom of plate and give the diferent heatinput (i.e. 65v,70v,75v).By using voltage regulator knob we have adjust the heatinput (65vx0.8A),(70vx0.9A),(75vx0.1A).
- We had noted the temperature reading at steady temperature.

ANSYS ANALYSIS:-

- we have analyize on cases of fins with motorcasing attached with it in ansys software .we had got different results through which we get which one has better heat coeficient rate.

COMPARISON:-

- The heat coefficient of non perforated plate is less as compared to other fins .The square fin has the more heat coefficient amoung the all fins we have tried.

CHAPTER 4

EXPERIMENTAL SETUP AND DATA COLLECTION

PROJECT SETUP

IMAGE:ACTUAL SETUP

IMAGE:DUCT IN WHICH FINS ARE PLACED AND SENSORS ATTACHED

EXPERIMENTAL SETUP & DATA COLLECTION:

- We had performed experiment on fin convection apparatus .This setup consist of blower,duct,table, thermocouples, sensor indicators and voltage &current regulator.
- The size of duct (700x300x20mm) with blower is assembled at the bottom side of the duct. Duct is open from the top side .
- Specification of blower:- 240v,1.3A,60w,50HZ&280rpm.
- we had placed 5 thermocouples i.e.(t1,t2,t3,t4,t5) at fins plate to note down the temperature at various distance of plate and one is left for ambient temperature(t6).
- we had attached heater at fin plate at the bottom of plate and give the different heat input (i.e. 65v,70v,75v).By using voltage regulator knob we have adjust the heat input (65vx0.8A),(70vx0.9A),(75vx0.1A).
- Heaters specification:-230v AC,400^0C,50-60Hz & cast iron material.
- Voltmeter specification: analog voltmeter 0-300volts.
- Ammeter specification:0-15amp.
- Temperature indicator is digital panel type,it can sense eight temperature at a time.
- Glass wool is used for insulating material wounded on heater surface.

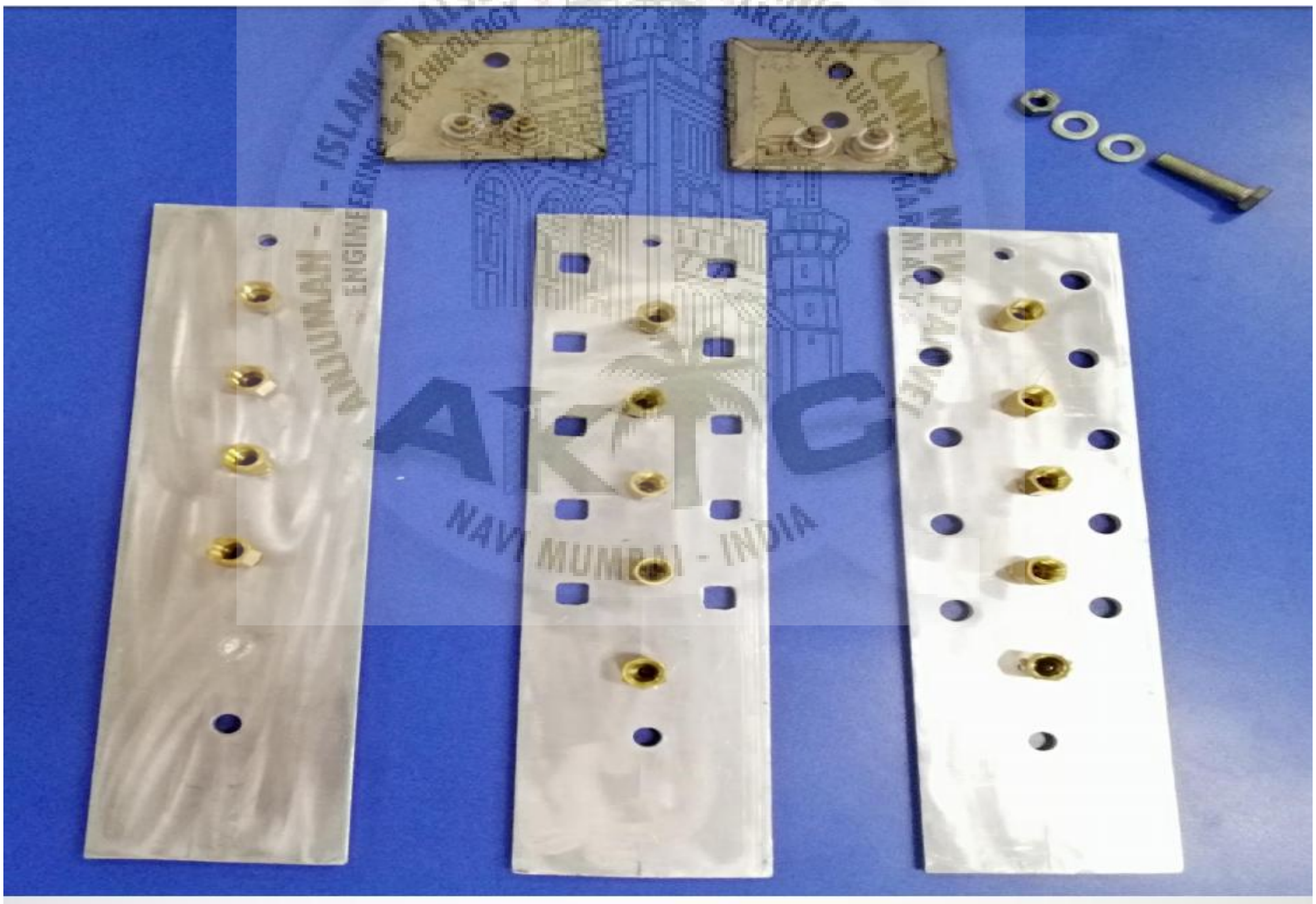
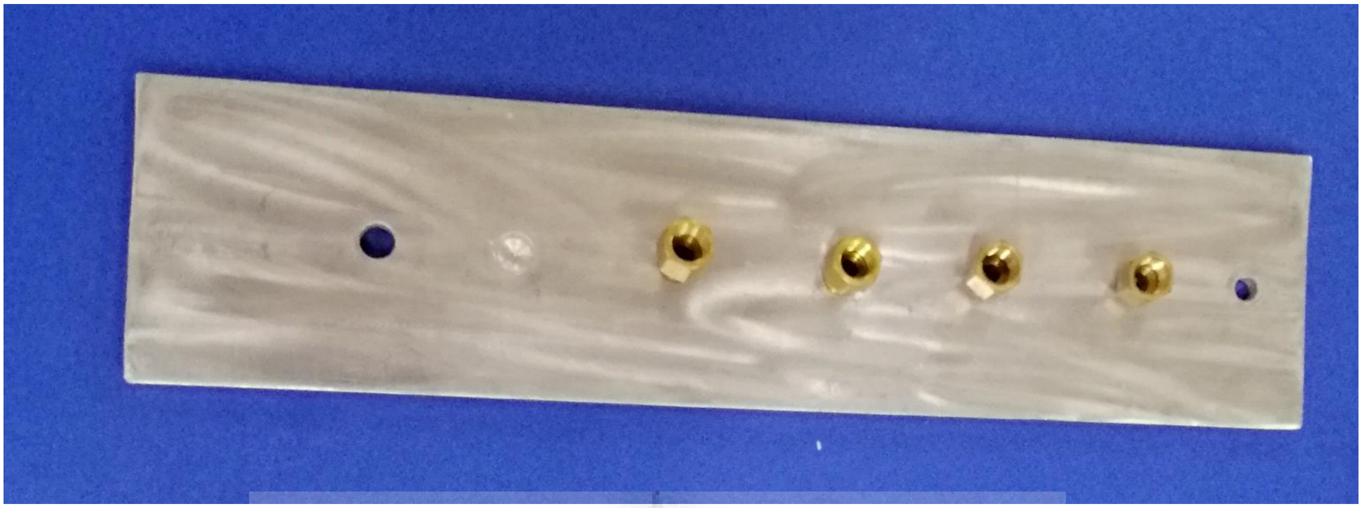


IMAGE: FROM LEFT NON-PERFORATED FIN,SQUARE FIN AND CIRCULAR FINS ABOVE 2 PLATE HEATERS 80 W

COST ESTIMATION

SR.NO.	MATERIAL / PART	QUANTITY	APPROX. COST
1	SETUP, AMMETER, VOLTMETER, SENSORS, TEMP INDICATER, BLOWER	1	APPROVED BY LAB
2	PLATE HEATER (3*3 INCH)	2	INR 1000/-
3	NUT AND BOLTS (SENSOR ATTACHMENT)	15	INR 300/-
4	MATERIAL FOR FINS (ALUMINIUM PLATE)	2	INR 500/-
5	ELECTRIC WIRE (CONNECTION) 4MM	3 METRE	INR 100/-
6	TAP TOOL , SLEEVE , LUGS (8) , POLISH WHEEL , GLASSWOOL	1	INR 230/-
7	PAPER PUBLISHING	1	INR 2100/-
8	BLACK BOOK	6	INR 2000/-
	TOTAL COST		INR 6230/-

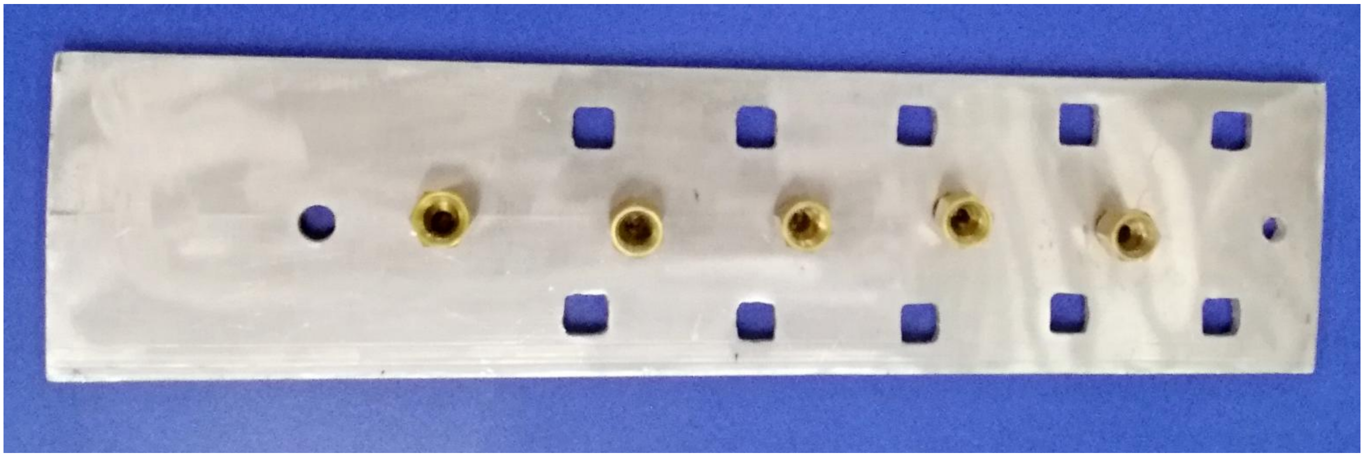


NON-PERFORATED PLATE

HEAT INPUT=52W	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	T6 (^{0}C)
(FREE CONVECTION)	140.5	121.1	107.9	109.7	107.5	37.1
(FORCED CONVECTION)	120.9	102.3	86.6	84.0	80.4	32.1

HEAT INPUT=63W	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	T6 (^{0}C)
(FREE CONVECTION)	156	136.4	120.3	121.4	118.3	36.0
(FORCED CONVECTION)	133.7	112.0	94.5	92.1	87.6	32.5

HEAT INPUT=75W	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	T6 (^{0}C)
(FREE CONVECTION)	167.7	143.5	126.8	129.5	126.3	38.3
(FORCED CONVECTION)	144.3	121.8	102.0	99.1	93.5	32.7

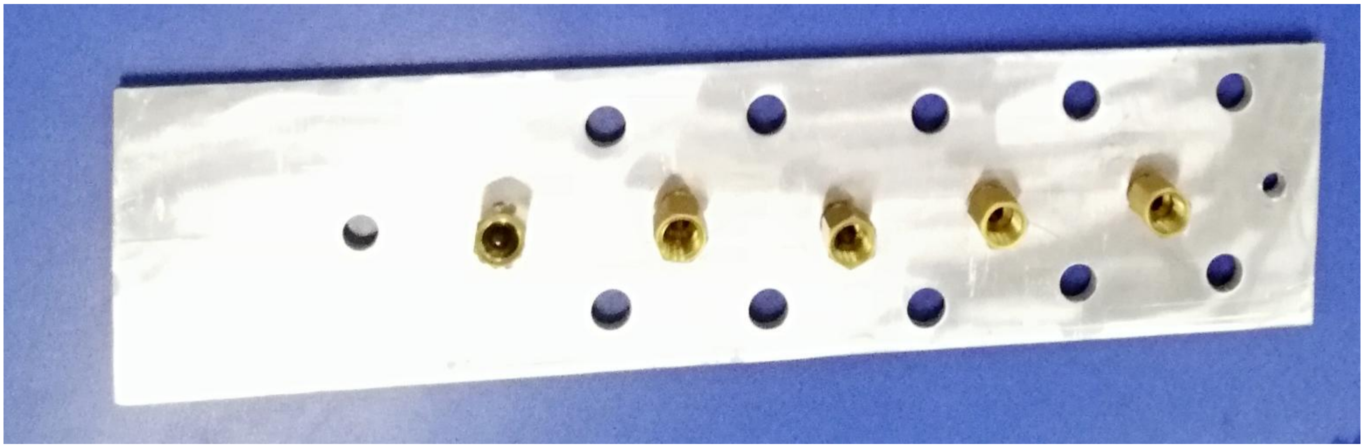


SQUARE PERFORATED PLATE

HEAT INPUT=52W	T1 (^0C)	T2 (^0C)	T3 (^0C)	T4 (^0C)	T5 (^0C)	T6 (^0C)
(FREE CONVECTION)	134.9	125.2	123.1	106.1	109.7	37.0
(FORCED CONVECTION)	107.9	95.4	90.3	73.2	72.4	33.8

HEAT INPUT=63W	T1 (^0C)	T2 (^0C)	T3 (^0C)	T4 (^0C)	T5 (^0C)	T6 (^0C)
(FREE CONVECTION)	141.9	131.2	127.8	109.7	113.1	37.1
(FORCED CONVECTION)	118.5	104.8	97.4	81.2	77.2	32.6

HEAT INPUT=67.5 W	T1 (^0C)	T2 (^0C)	T3 (^0C)	T4 (^0C)	T5 (^0C)	T6 (^0C)
(FREE CONVECTION)	158.5	147.8	143.1	127.2	127.6	37.2
(FORCED CONVECTION)	131.9	116.5	108.4	86.03	85.02	32.7



CIRCULAR PERFORATED PLATE

HEAT INPUT=52W	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	T6 (^{0}C)
(FREE CONVECTION)	143.0	120.4	117.1	103.9	99.4	37.1
(FORCED CONVECTION)	118.5	100.1	90.2	73.3	70.4	32.9

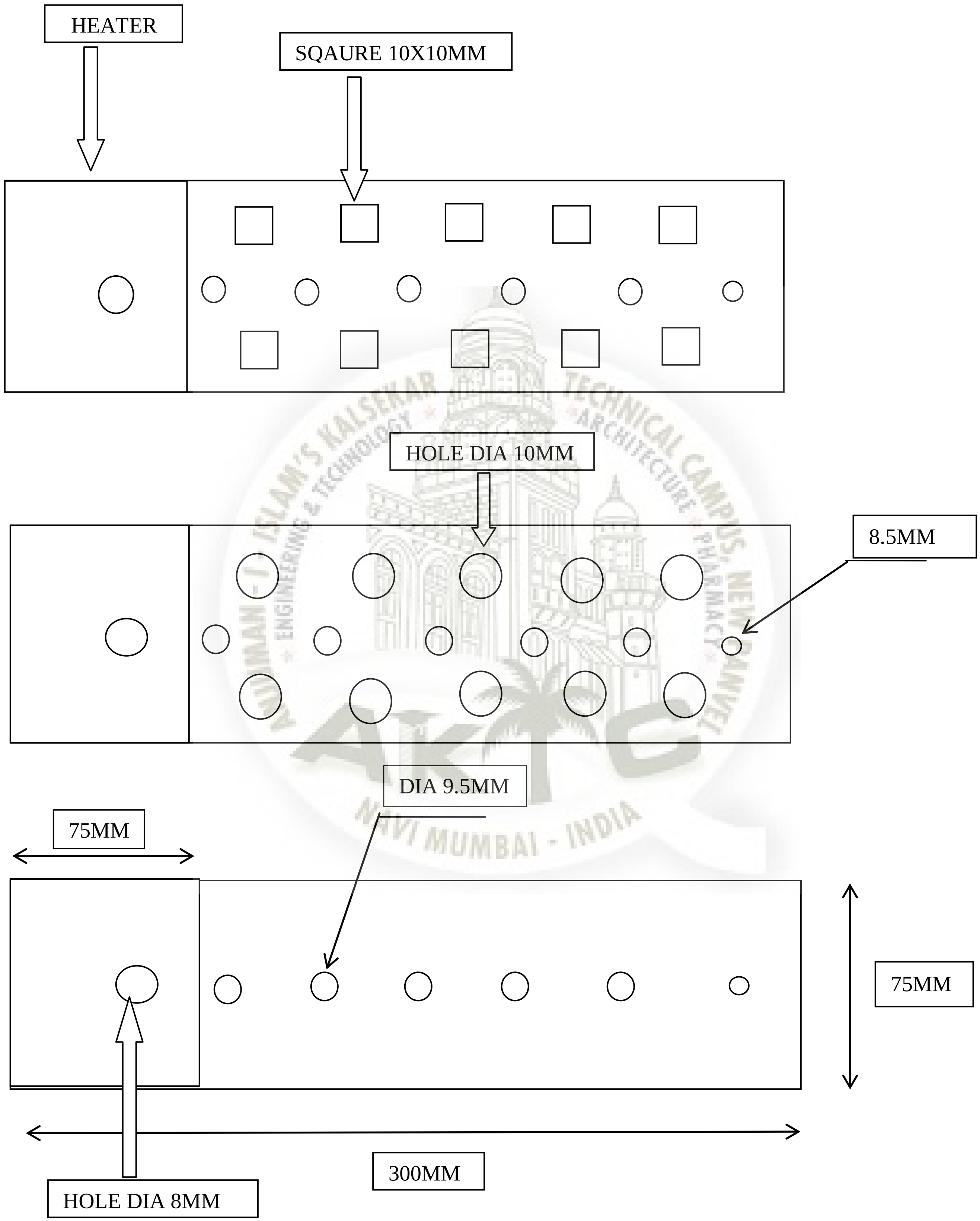
HEAT INPUT=63W	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	T6 (^{0}C)
(FREE CONVECTION)	154.8	130.3	126.5	111.7	103.2	36.8
(FORCED CONVECTION)	129.1	108.2	96.4	77.1	71.3	33.0

HEAT INPUT=67.5 W	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	T6 (^{0}C)
(FREE CONVECTION)	171.3	144.6	141.5	117.9	120.5	38.1
(FORCED CONVECTION)	139.5	109.3	102.2	77.0	74.4	32.7

CHAPTER 5

CALCULATIONS

DETAILED DIAGRAM OF DIFFERENT FINS



Calculation for non perforated fin-52W

Formula , $Q = h*A_s*\Delta t$

Where as ,
Q = heat input in watt
h = heat transfer coefficient in(W/m^oC)
A_s = surface area in m^2
Δt = temperature difference in (^oC)

Heat input,Q = V*I
Where as ,V = volts I = curent

Surface area,A_s = 2lw + 2lh + 2hw
Where as ,
L = length of the fin in (m)
W = widht of the fin in (m)
H = thickness of the fin in (m)

Sample calculation for free convection ;
Different temperature of sensors
$T_1 = 140.5\ ^oC$
$T_2 = 121.1\ ^oC$
$T_3 = 107.9\ ^oC$
$T_4 = 109.7\ ^oC$
$T_5 = 107.5\ ^oC$
$T_a = 37.1\ ^oC$

Surface temperature
$T_s = (T_1 + T_2 + T_3 + T_4 + T_5) / 5$
$T_s = 117.34\ ^oC$

Temperature difference :
$\Delta t = T_s - T_a$
= 117.34 - 37.1
= 80.24 ^oC

Surface area :$A_s = 0.03735\ m^2$
heat input : Q = 52 Watt
Calculating heat transfer coefficient :
$Q = h*A_s*\Delta t$
52 = h * 0.03735 * 80.24
h = 17.35 W/m^oC

Heat transfer coefficient rate for the free convection heat input 52 Watt is 17.35 W/m^oC

Calculation for square perforated fin-52W free convection

$T_s = 117.3\ ^oC$
$\Delta t = 80.2\ ^oC$

$A_s = 0.03295\ m^2$
$Q = h*A_s*\Delta t$

52 = h * 0.03295 * 80.2
h = 19.677 W/m^oC

Calculation for circular perforated fin-52W free convection

$T_s = 116.76\ ^oC$
$\Delta t = 79.66\ ^oC$

$A_s = 0.03389\ m^2$
$Q = h*A_s*\Delta t$

52 = h * 0.03389*79.66
h = 19.26 W/m^oC

Heat transfer coefficient rate of Non perforated plate(Using NLC)
All values are in $W/m^2\ ^oC$

Heat input	52 watt	63 watt	75 watt
Free convection	17.35	17.85	18.57
Force convection	22.19	23.59	25.27

Heat transfer coefficient of circular perforated plate(Using NLC)

Heat input	52 watt	63 watt	75 watt
Free convection	19.26	21.00	21.46
Force convection	24.62	26.24	28.12

Heat transfer coefficient of square perforated plate(Using NLC)

Heat input	52 watt	63 watt	75 watt
Free convection	19.67	22	22.65
Force convection	25.15	26.74	28.65

USING NUSSELT NUMBER (RK RAJPUT-FOR VERTICAL PLATES)

FOR NON PERFORATED PLATE-52W

Formula:

$Nu = C * (Pr)^m * (Gr)^n$

Where , $Nu = 0.59 (Gr * Pr)^{1/4}$

$hl/k = C * (\mu C_p/k)^m * (\beta g \Delta t\, l^3 / v^2)$

Calculation:

$T_f = t_s + t_a / 2 = 83.2\ ^oC$

$B = 1/ (273+T_f)$

$=2.8074*10^{-3}\ k^{-1}$

$\Delta t = t_s - t_a$

$= 94.4\ ^oC$

PROPERTIES OF AIR AT T_f

(FROM PROPERTY TABLE CHART)

$\mu = 2.096*10^{-5}$ kg/m-s

$C_p = 1008$ J/Kg K

$K_{air} = 0.02953$ W/m-K

$V = 2.097*10^{-5}\ m^2/s$

Pr = 0.7154

$Gr = \{ [2.8074*10^{-3} * 9.81 * 94.4 * (0.225)^3]/ (2.097$

$Gr = 6.7* 10^7$

$hl/k = 0.59*(0.7154)^{1/4} (6.7*10^7)^{1/4}$

$= 0.59*83.2063$

$hl/k = 49.0917$

$h =6.197\ W/m^2K$

FOR CIRCULAR PERFORATED PLATE-52W

$T_f = t_s + t_a / 2 = 76.93\ ^oC$

$B = 1/ (273+T_f)$

$=2.858*10^{-3}\ k^{-1}$

$\Delta t = t_s - t_a$

$= 79.66\ ^oC$

$hl/k = 0.59*(0.7134)^{1/4} (5.56*10^7)^{1/4}$

$= 0.59*83.2063$

$h =6.3\ W/m^2K$

FOR SQAURE PERFORATED PLATE-52W

$T_f = t_s + t_a / 2 = 78.4\ ^oC$

$B = 1/ (273+T_f)$

$=2.84*10^{-3}\ k^{-1}$

$\Delta t = t_s - t_a$

$= 82.8\ ^oC$

$hl/k = 0.59*(0.715)^{1/4} (5.97*10^7)^{1/4}$

$h =6.25\ W/m^2K$

Similarly for all other plates

USING NUSSELT NO	52W	63W	75 watt
Non perforated fin	6.197	6.35	6.45
Square perforated fin	6.3	6.49	6.56
Circular perforated fin	6.25	6.4	6.51

CHAPTER 6

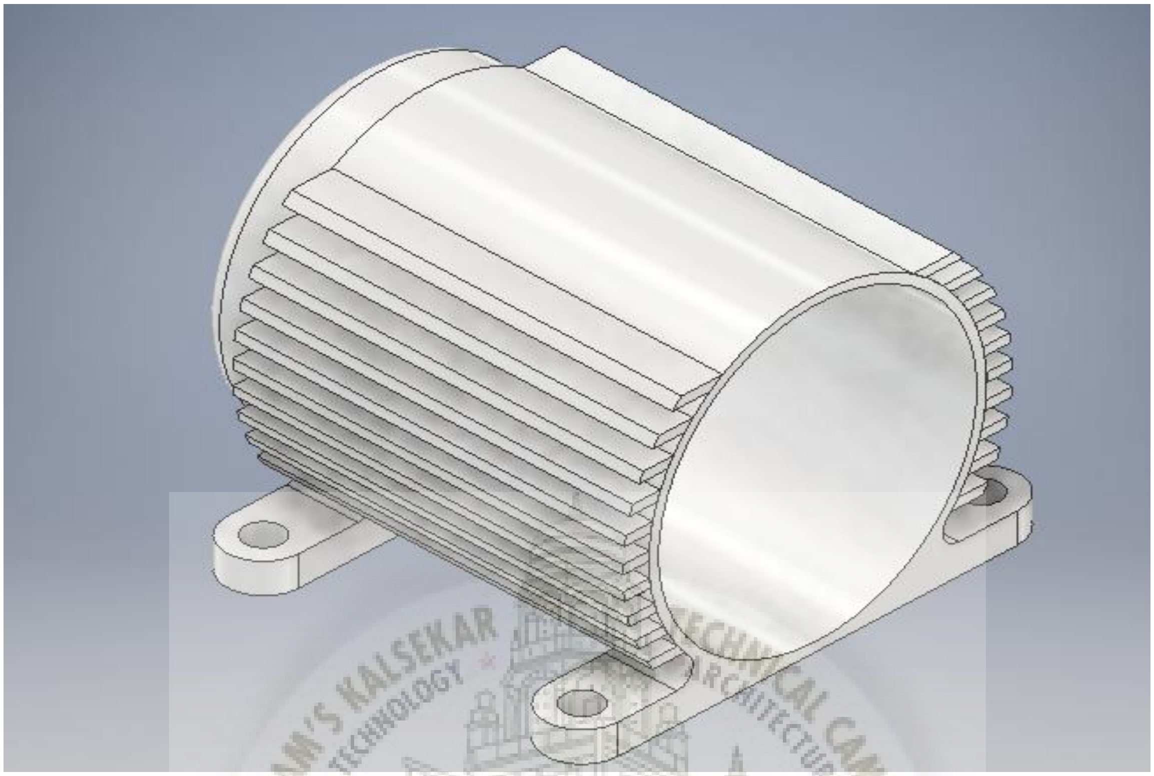
ANALYSIS

Universal IE2 7.5kW (10HP) three phase 2 pole B3 Foot mounting 132S frame AC Induction Motor for 230V or 400V 3 phase supply. Suitable for use with a Variable Frequency Inverter Drive with 3ph output. Dimensions: 265mm wide x 437mm long x 318mm high overall. Mounting: Foot mount on 12mm holes at 216mm wide x 140mm centres 89mm back from the shaft shoulder. Shaft: 38mm diameter, 80mm long with 10mm key. Construction: Aluminium Weight: 48.00kg

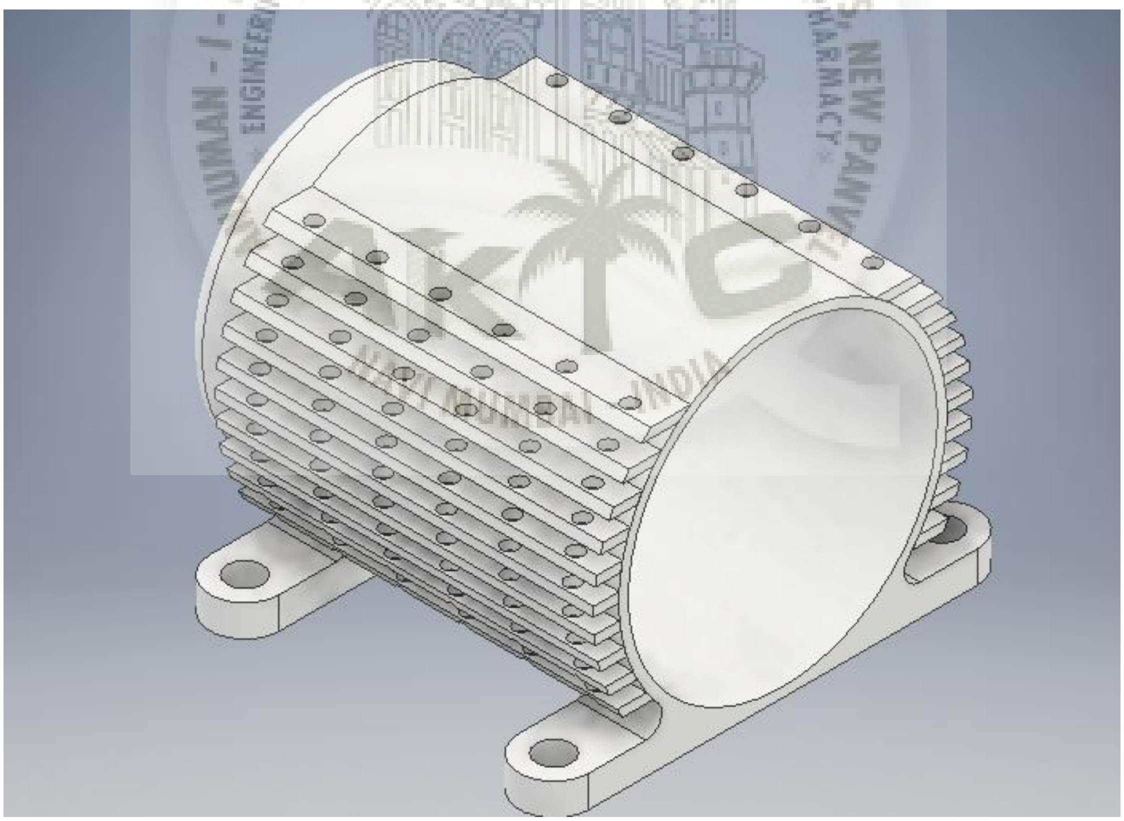
ANALYSING

▪ The heat transfer performance of fin with different geometry having various perforations and without perforation will be compared.

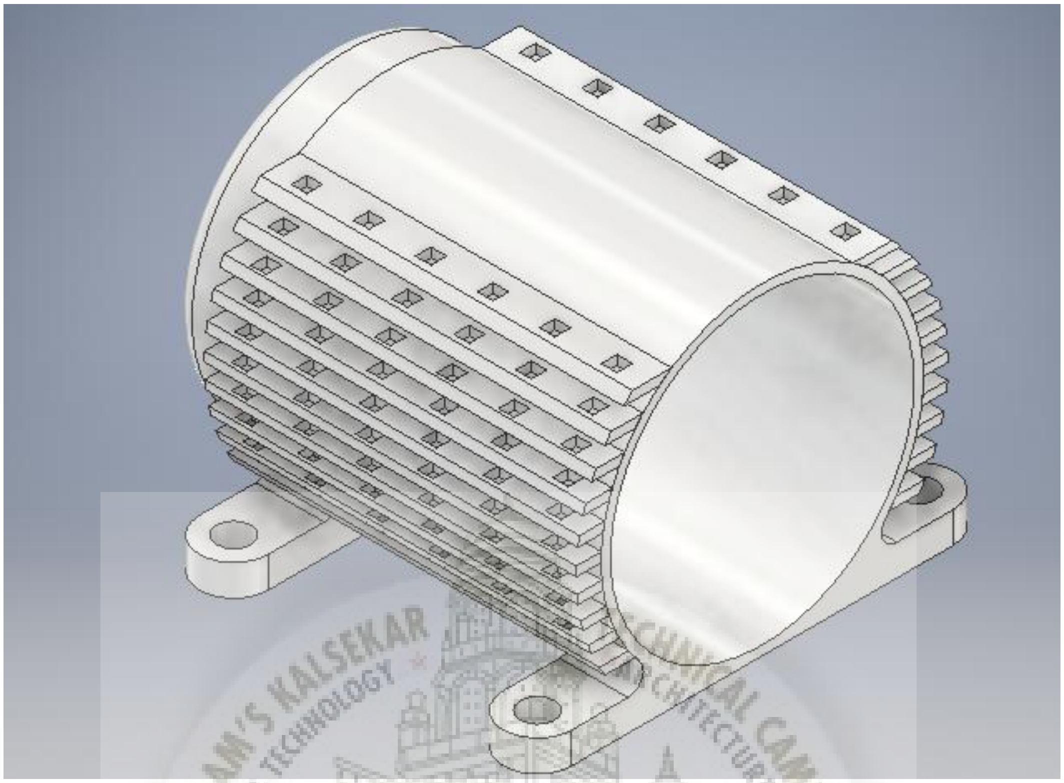
▪ Fin with various perforations design with the help of software Autodesk Inventor 2019 . Analysis of fin performance done through the software ANSYS Workbench 16.2 for obtaining results of fin performance.



3D MODELLING OF MOTOR WITH NON PERFORATED FINS (INVENTOR)



3D MODELLING OF MOTOR WITH CIRCLULAR PERFORATED FINS (INVENTOR)



3D MODELLING OF MOTOR WITH SQUARE PERFORATED FINS (INVENTOR)

STEPS FOLLOWD IN ANSYS WORKBENCH 16.2

1. The motor is designed or modelled in Inventor and converted into stp file.
2. On Ansys Workbench 16.2 Steady state Thermal Analysis is selected.
3. The .stp file is imported in the geometry selection.
4. The meshing is done using curvature ON and selecting span angle centre and smoothing as medium
5. After meshing boundary condition is given.All 20 fins as given convection of 5 W/m^2 ^oC.Heat flow given is 52W on the inner surface of the motor.
6. In solution Temperature,Total heat flux,Directional heat flux is selected.
7. User defined result is created for YT or temperature difference.
8. Heat transfer coefficient is also created in solution with the formula TFX/YT .
9. Solution is obtained.

PERFORATED SQUARE FIN ANALYSIS

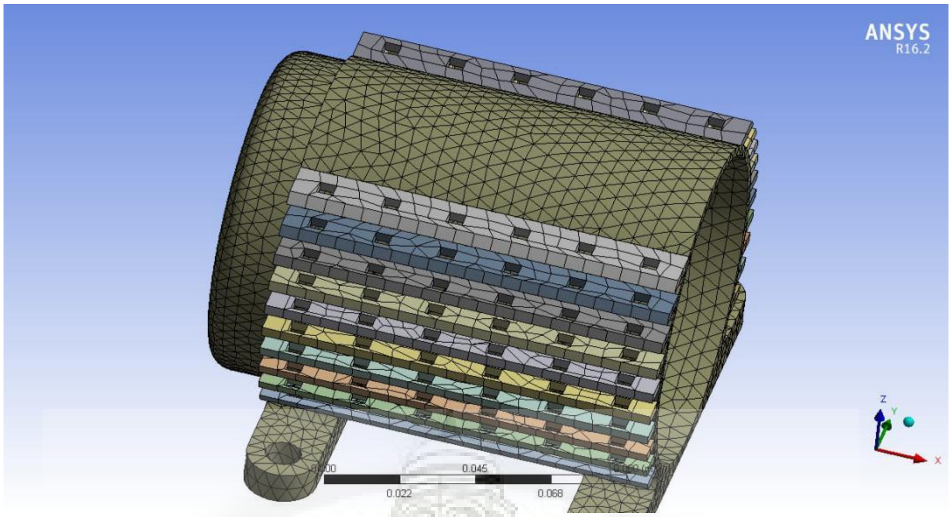


Image showing Meshing done on square perforated fins of motor

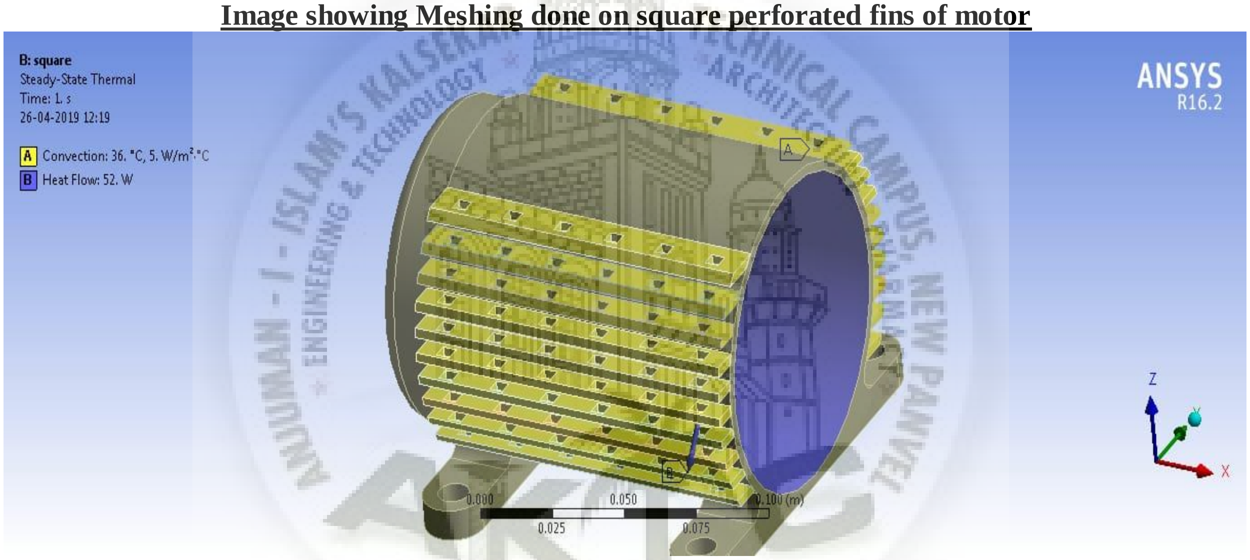


Image showing Heat flow and convection boundary conditions which are applied

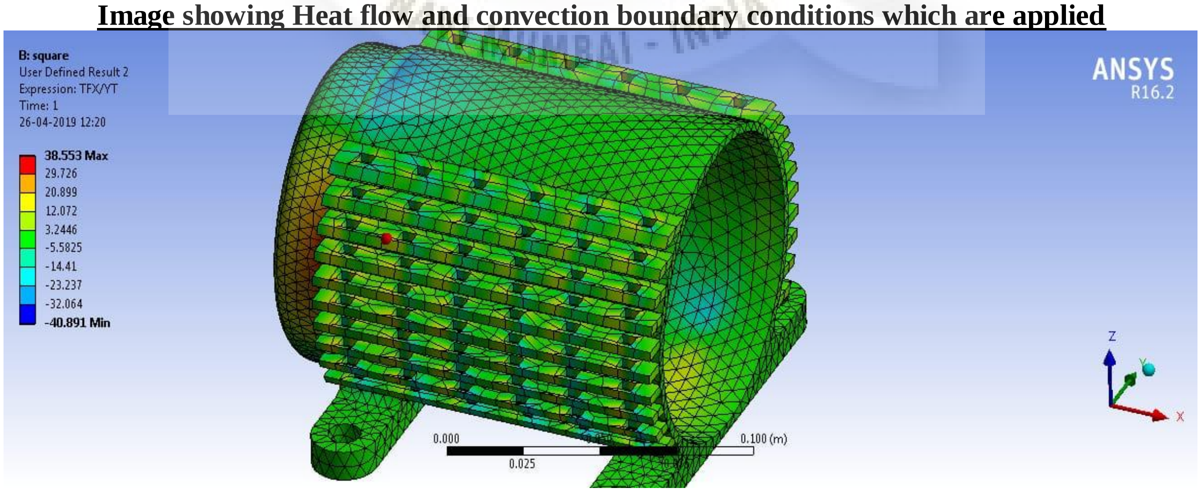


Image showing Heat transfer coefficient (38.55) of square perforated fin of motor

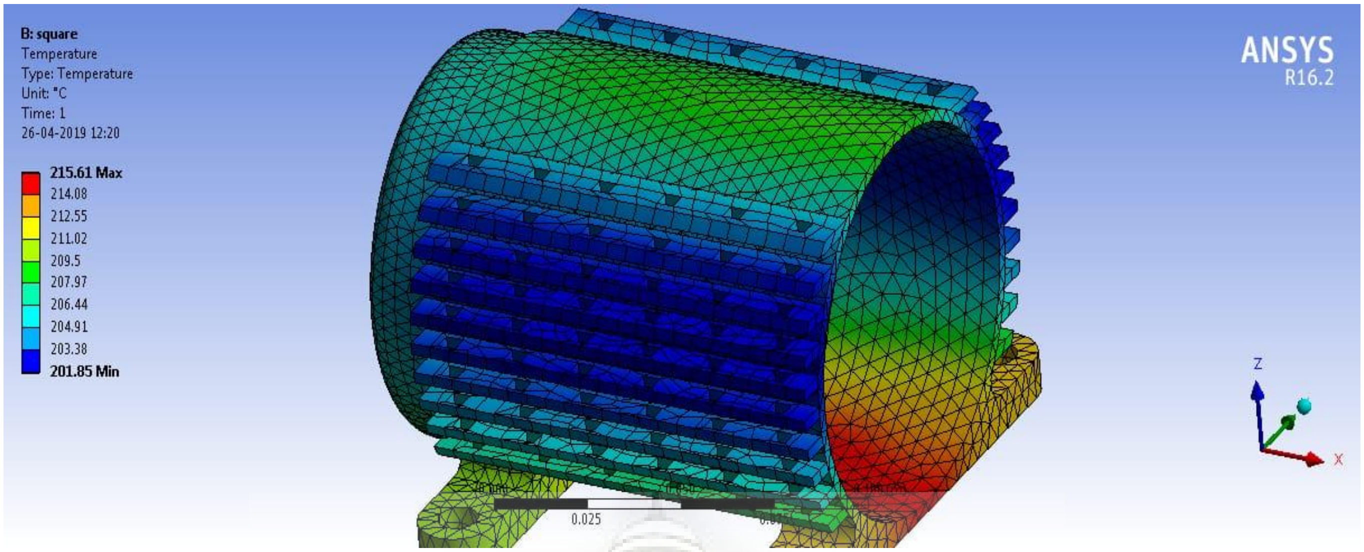


Image showing temperature distribution in square perforated fin of motor

NON PERFORATED FIN ANAYSIS

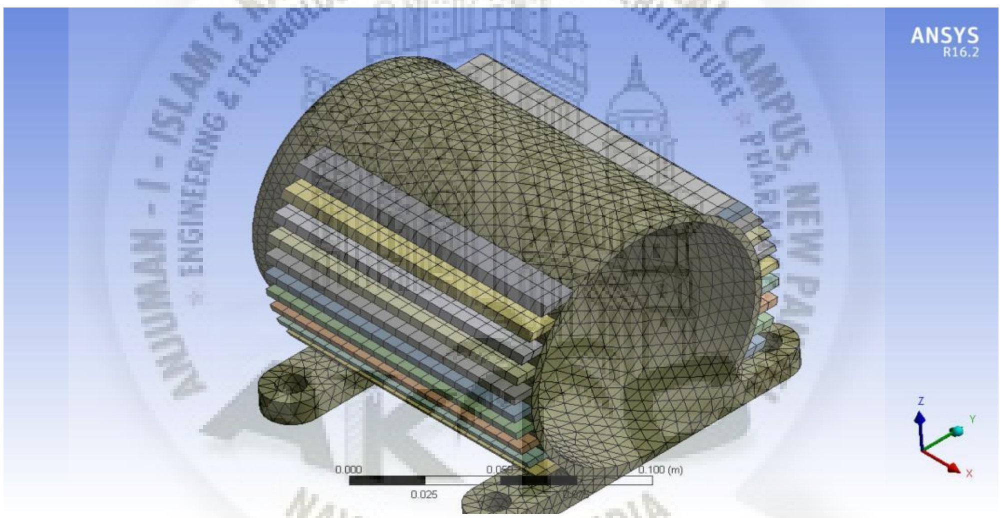


Image showing Meshing done on non perforated fins of motor

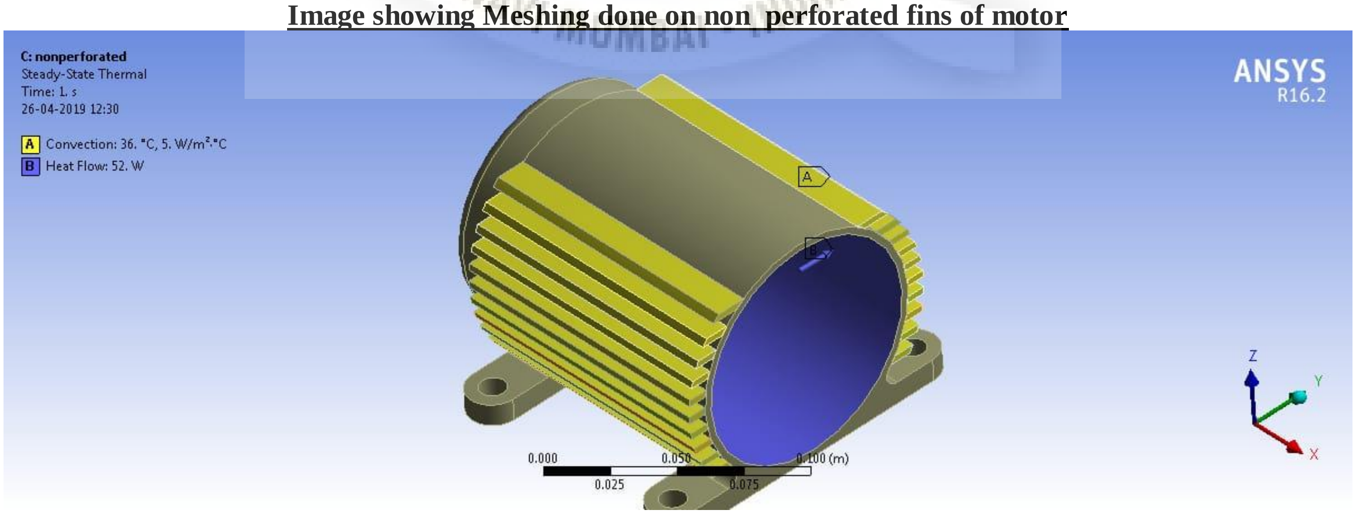


Image showing Heat flow and convection boundary conditions which are applied

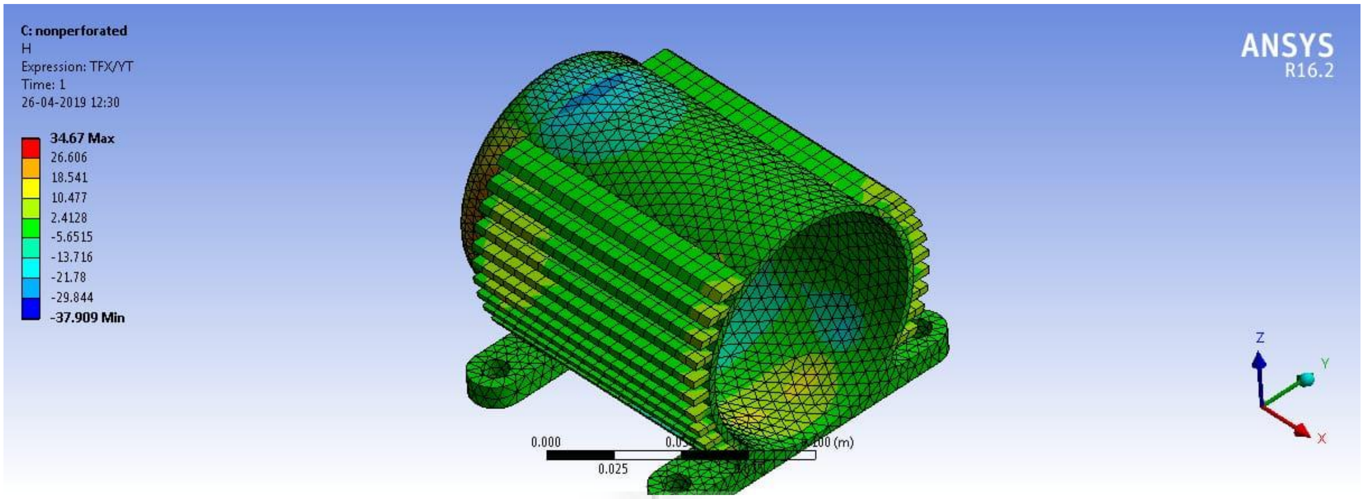


Image showing Heat transfer coefficient (34.67) of non perforated fin of motor

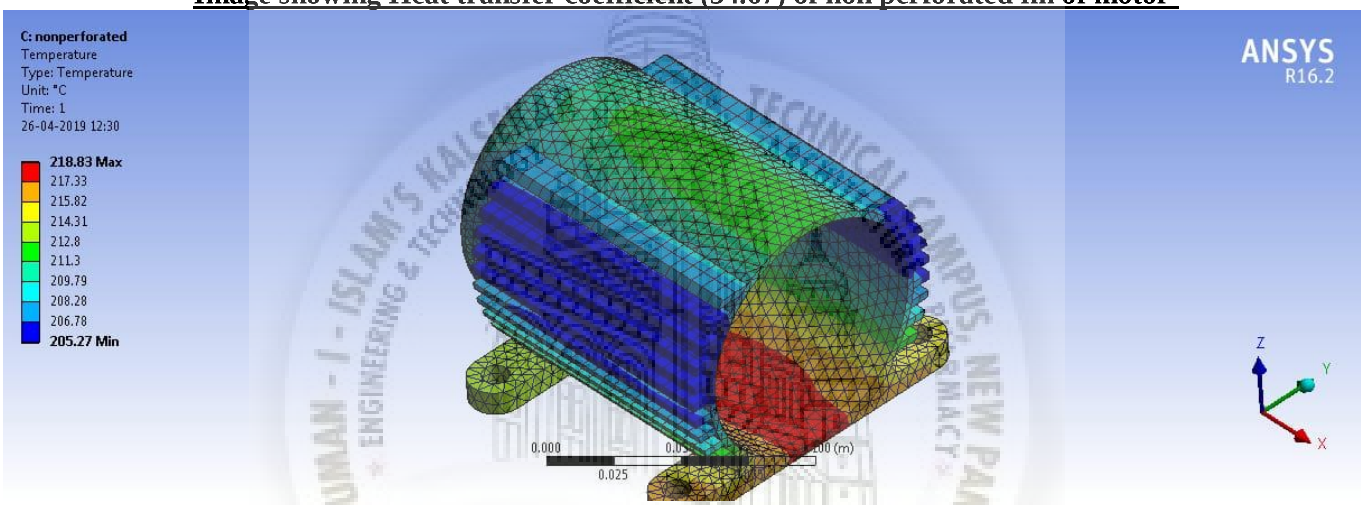


Image showing temperature distribution in square perforated fin of motor

CIRCULAR PERFORATED FINS ANALYSIS

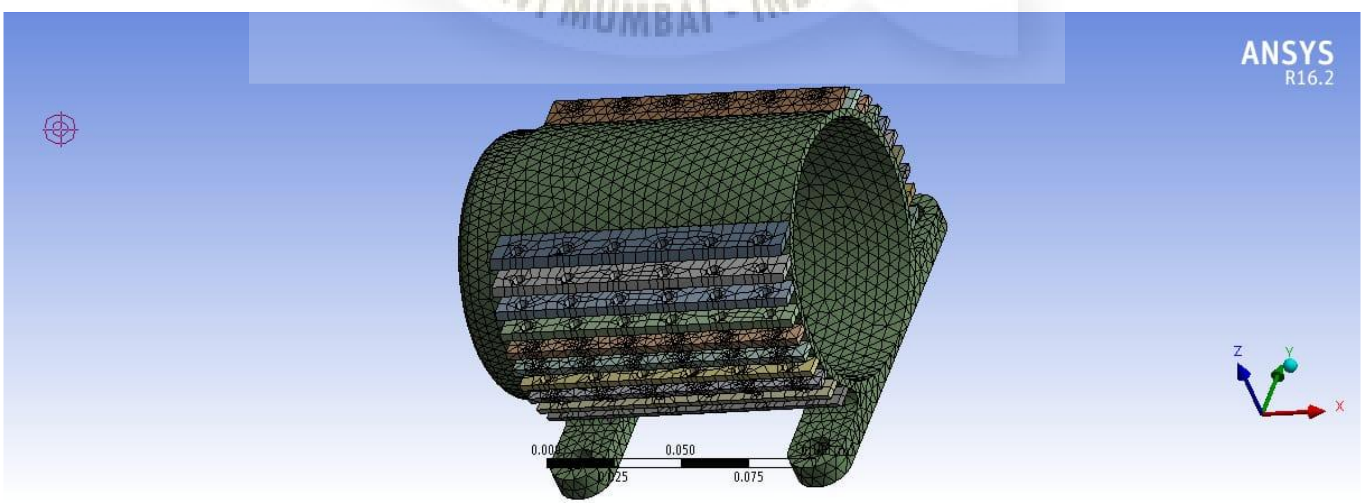


Image showing Meshing done on circular perforated fins of motor

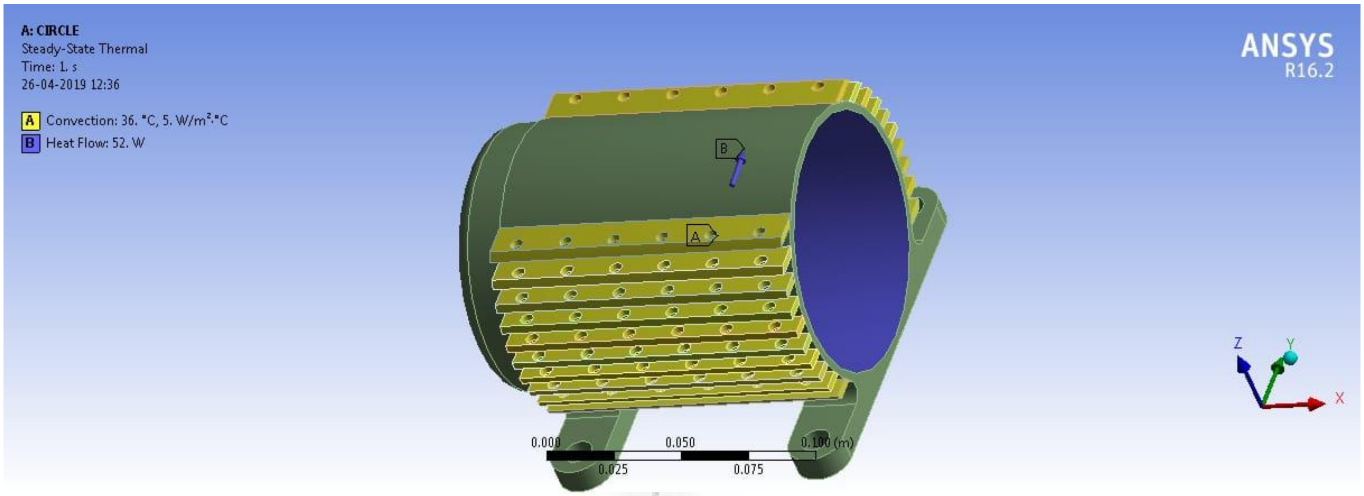


Image showing Heat flow and convection boundary conditions which are applied

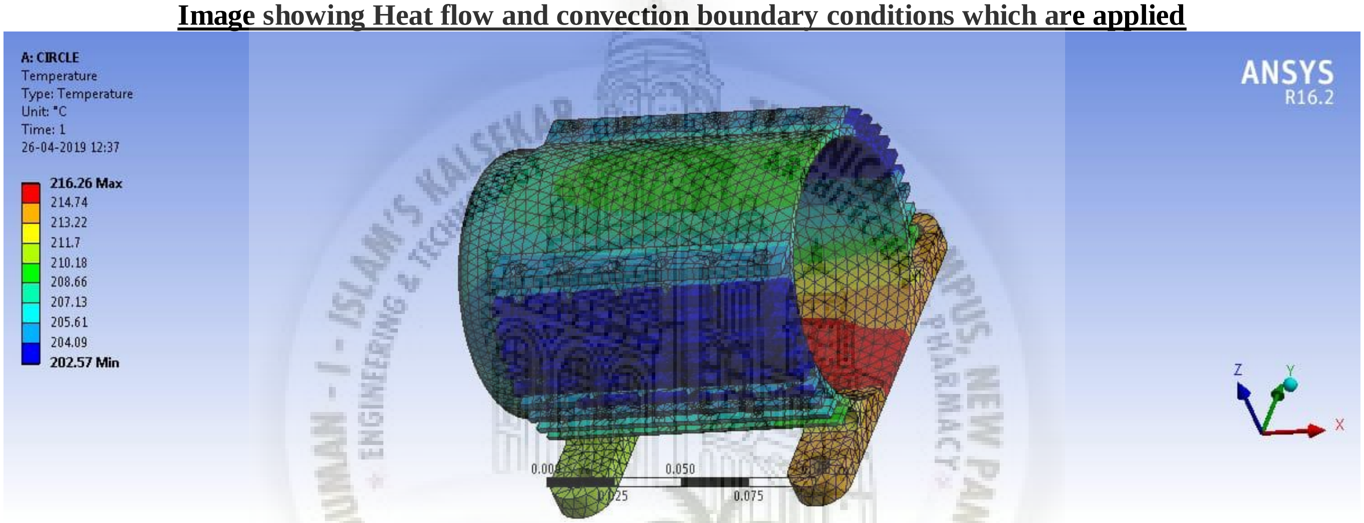


Image showing temperature distribution in square perforated fin of motor

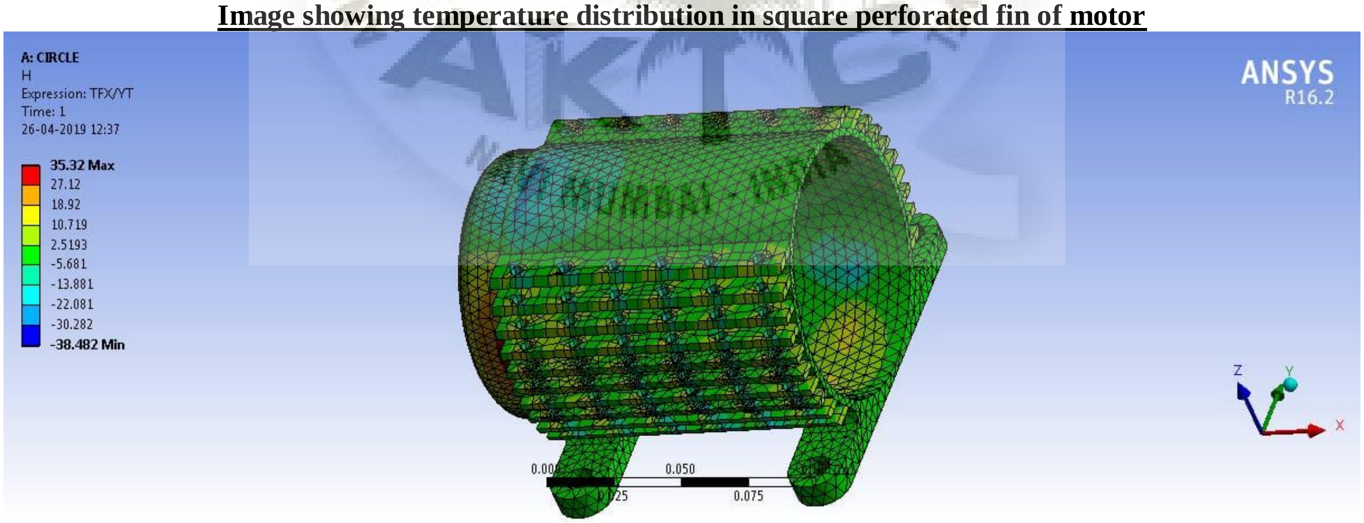
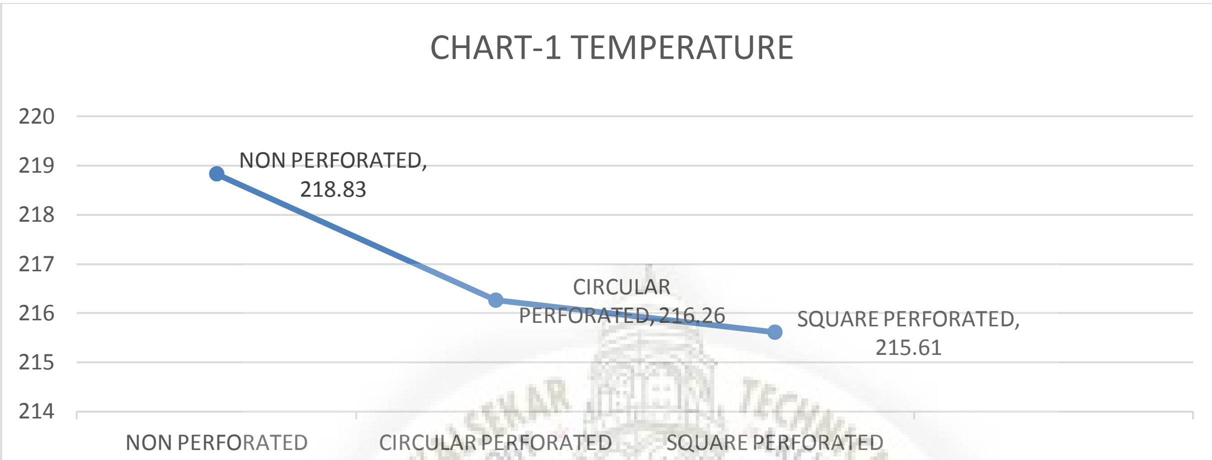


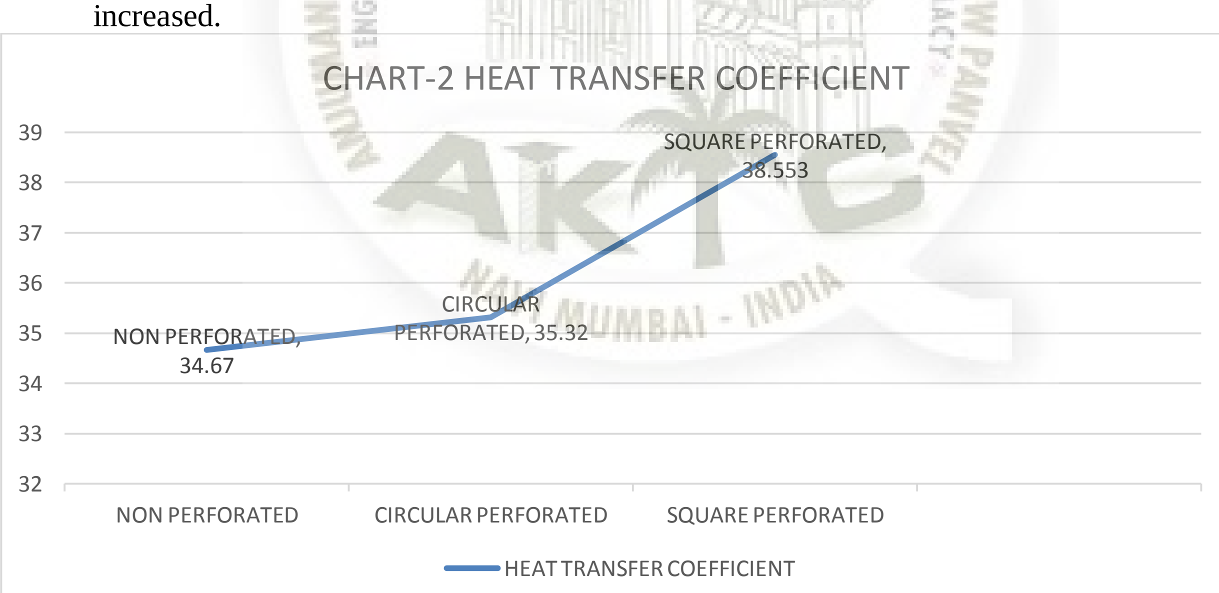
Image showing Heat transfer coefficient (35.32) of circular perforated fin of motor

EXPLANATION

1. In this research the heat transfer by natural convection was examined at steady state to show the effect of the geometrical parameters of impressions. Chart 1 below shows the temperature distribution along x-direction of the perforated fins and non-perforated fin. As shown in Figure-3, it is obvious that the temperatures along all fins decreased with the x-direction.



2. It was also found that when the perforation area increased the temperature drop between the fin base and tip increased too. This was because the increasing in the perforated area led to decrease in thermal resistance of the perforated fin. The best heat dissipation appears in the fin plate with square perforated area. Meanwhile, when the heat supplied increased the temperature drop also increased.



3. The heat transfer coefficient and fin area are the main significant parameters on the heat dissipation rate from the perforated fins. As shown in Chart-2, the heat transfer coefficient h was calculated and plotted with effect of the different perforations. It can be seen that, the heat transfer coefficient h was increased as the perforation area increased

4. Along the perforated fin length the temperature drop is higher than that for non-perforated fin. The rate of temperature drop along the perforated fin decrease with decrease of the perforation area. The perforation dimension and lateral spacing have the significant effect on the gain in the heat dissipation rate of the perforated fin.The film heat transfer coefficient of the perforated surface increased with the increase of perforation area and power supply. The increase of perforation area and power supply have significant effect on the heat transfer rate and the coefficient of heat transfer.

HEAT TRANSFER COEFFICENT	VALUES(W/m$^{2.o}$C)
HEAT INPUT=52W	
NON PERFORATED FIN	34.67
SQUARE PERFORATED FIN	38.553
CIRCULAR PERFORATED FIN	35.32

TEMPERATURE DISTRIBUTION	VALUES(^{o}C)
NON PERFORATED FIN	218.83
SQUARE PERFORATED FIN	215.61
CIRCULAR PERFORATED FIN	216.26

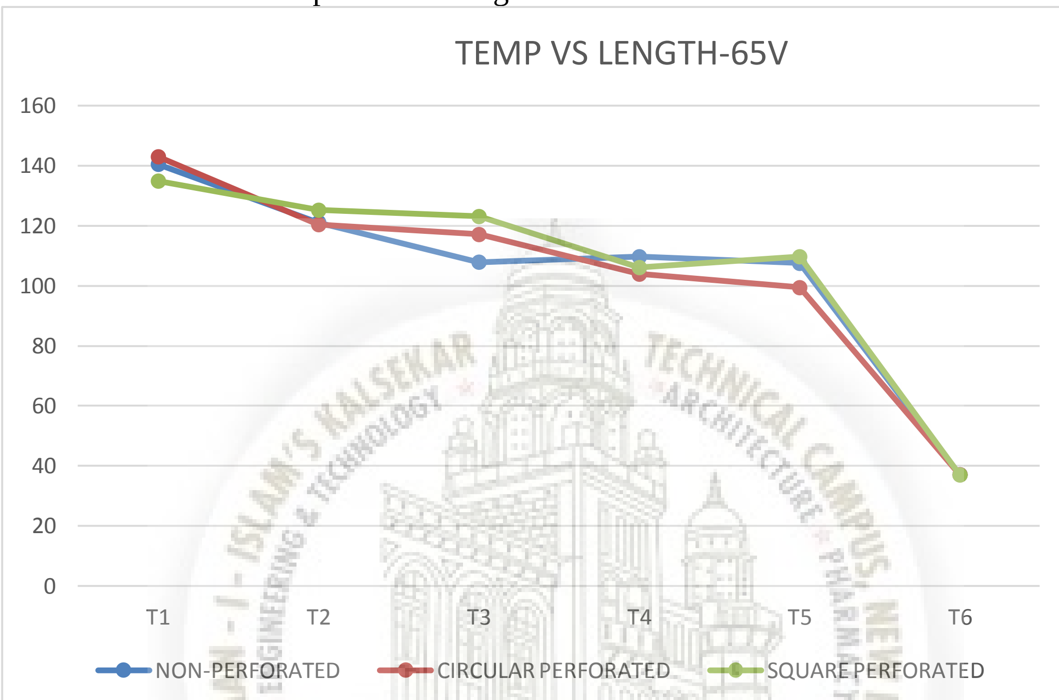
CHAPTER 7

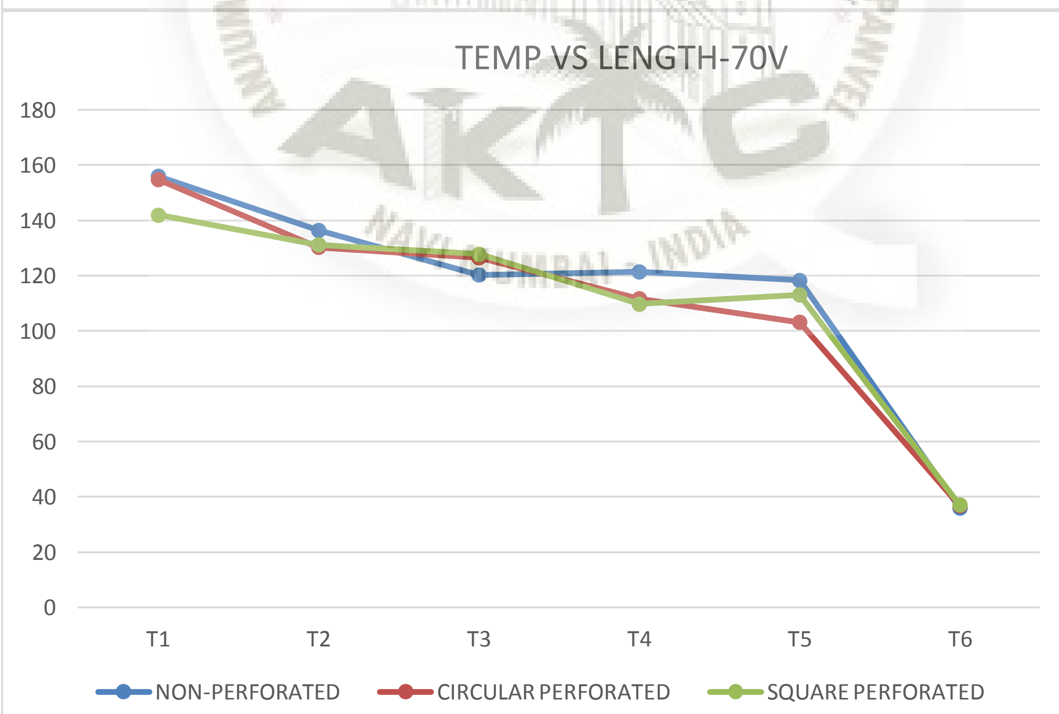
RESULTS AND VALIDATION

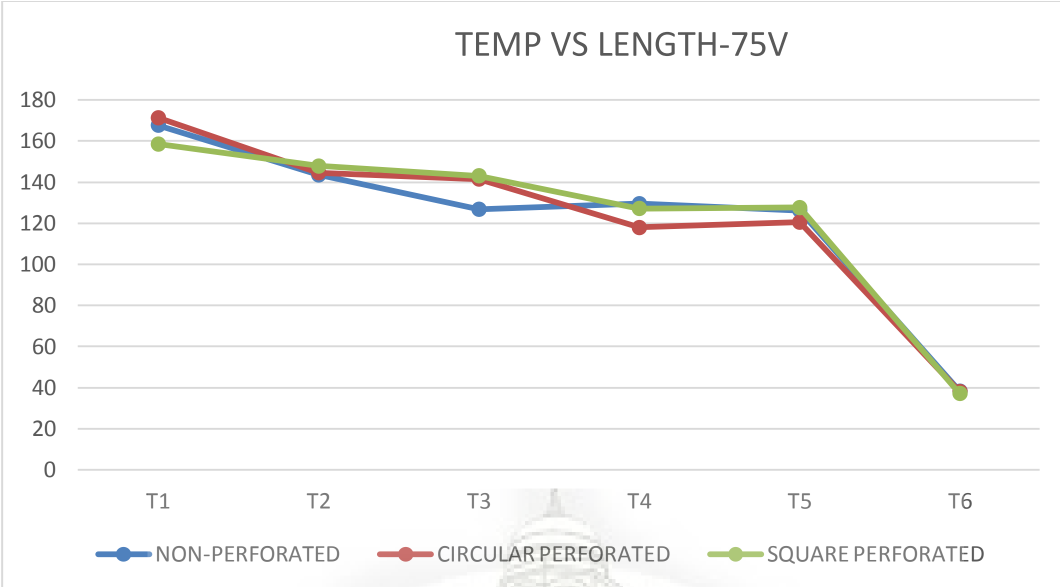
TEMP VS LENGTH VALUES USING DATA OBTAINED FOR DIFFERENT HEAT INPUTS:

EXPLANATION

1. In this research the heat transfer by natural convection was examined at steady state to show the effect of the geometrical parameters of impressions. Chart 3,4,5 below shows the temperature distribution along x-direction of the perforated fins and non-perforated fin. As shown in Figure-3, it is obvious that the temperatures along all fins decreased with the x-direction.



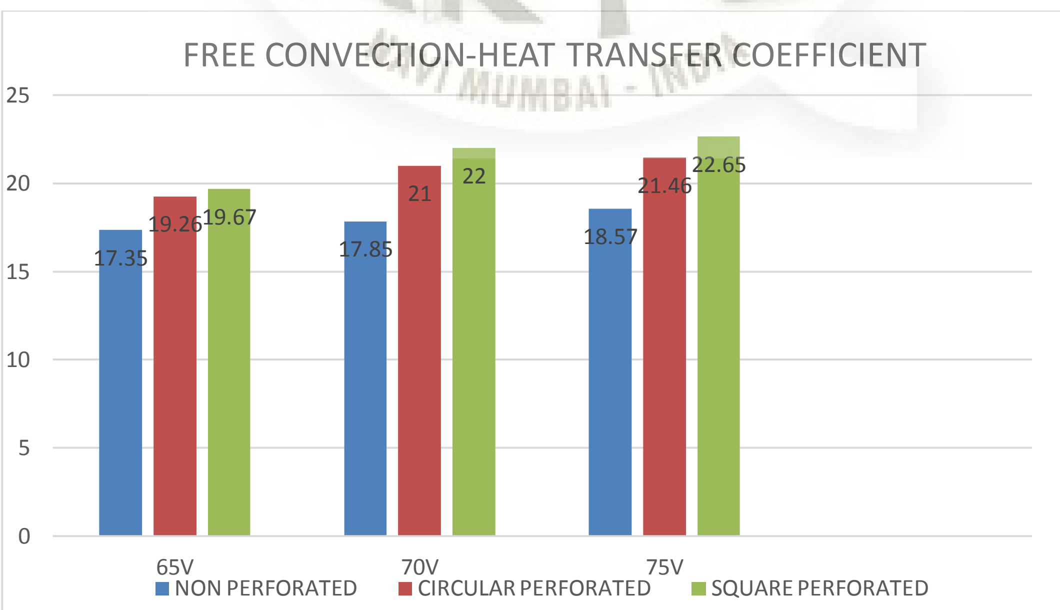


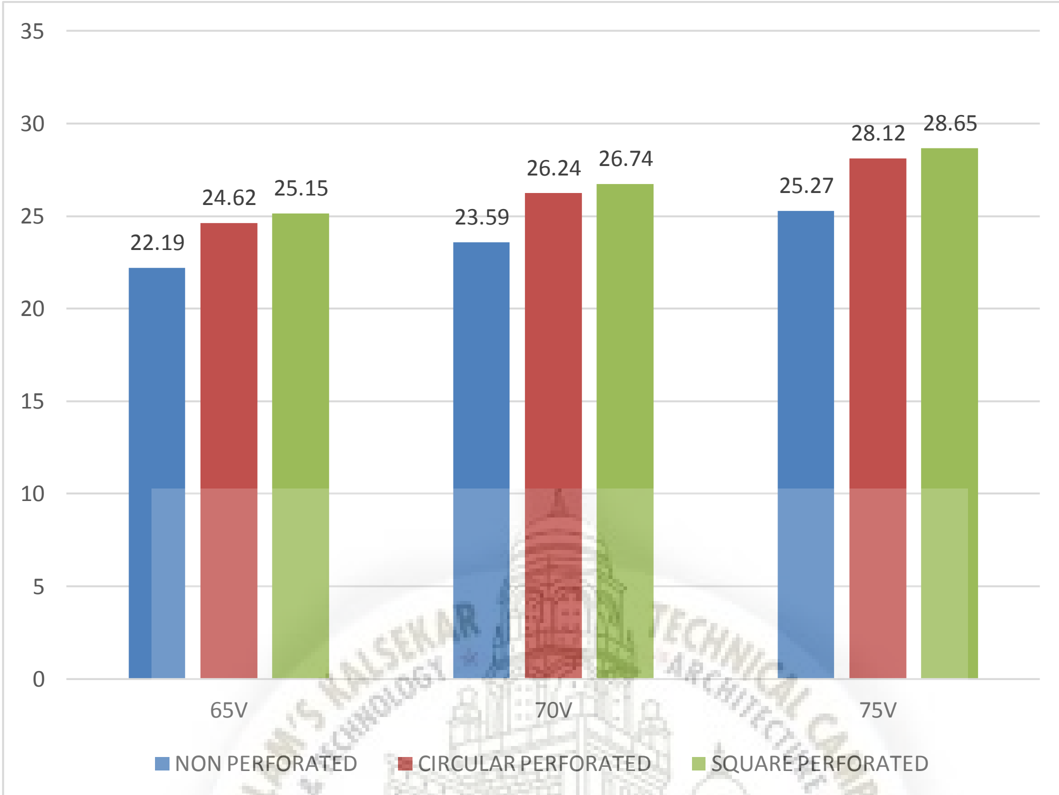


2. It was also found that when the perforation area increased the temperature drop between the fin base and tip increased too. This was because the increasing in the perforated area led to decrease in thermal resistance of the perforated fin. The best heat dissipation appears in the fin plate with square perforated area. Meanwhile, when the heat supplied increased the temperature drop also increased.

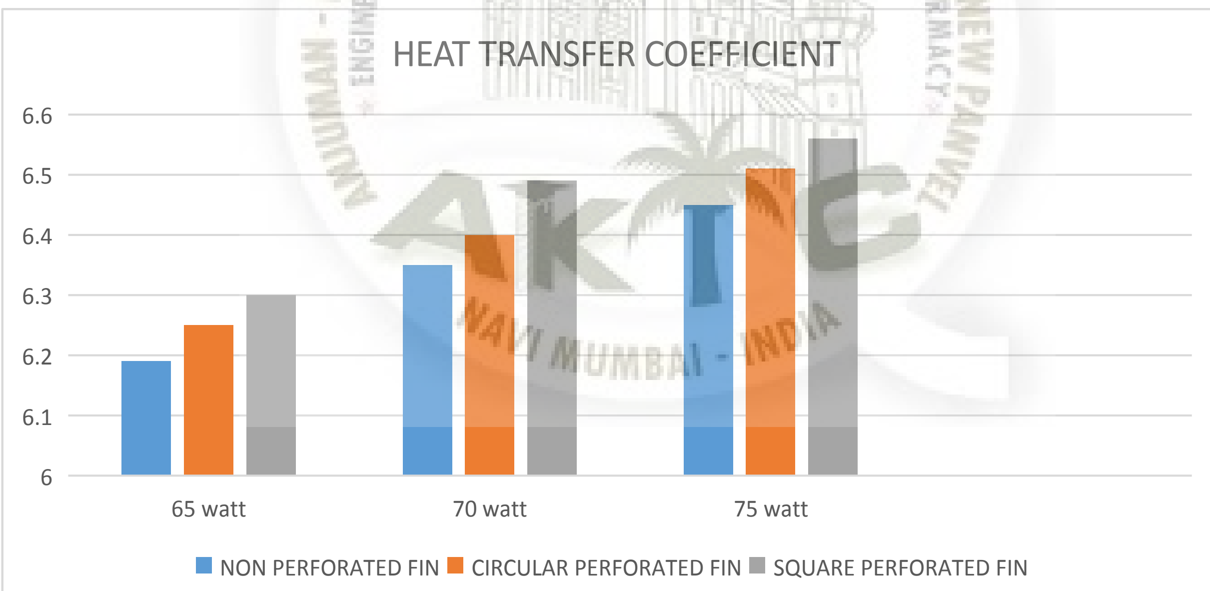
<u>HEAT TRANSFER VALUES USING NEWTONS LAW OF CONVECTION FORMULAES FOR FREE AND FORCED CONVECTION:</u>

3. The heat transfer coefficient and fin area are the main significant parameters on the heat dissipation rate from the perforated fins. As shown in Chart-6,7, the heat transfer coefficient h was calculated and plotted with effect of the different perforations. It can be seen that, the heat transfer coefficient h was increased as the perforation area increased





HEAT TRANSFER VALUES USING NUSSELT NO FOR FREE CONVECTION:



4. Along the perforated fin length the temperature drop is higher than that for non-perforated fin. The rate of temperature drop along the perforated fin decrease with decrease of the perforation area. The perforation dimension and lateral spacing have the significant effect on the gain in the heat dissipation rate of the perforated fin.The film heat transfer coefficient of the perforated surface increased with the increase of perforation area and power supply. The increase of perforation area and power supply have significant effect on the heat transfer rate and the coefficient of heat transfer.

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSIONAND FUTURE SCOPE:

[1]By giving perforation to the fin will resulting the higher temperature different compared to the non-perforated fins that will affect the temperature distribution of the heat generated at the heat source along the fins..

[2] The use of fin (extended surface) with perforations, provide efficient heat transfer: Fin with perforations provide near about 5 % to 10% more enhancement of heat transfer as compare to fin without perforations. Heat transfer through fin with rectangular perforations higher than that of fin with other types of perforation. Temperature at the end of fin with rectangular perforations is minimum as compare to fin with other types. Choosing the minimum value of ambient fluid temperature provide the greater heat transfer rate enhancement

[3] . Heat transfer through fin of rectangular perforation configuration is higher than that of other fin configurations followed by circular perforation and non perforated fins. Choosing the optimum size fin of rectangular perforation configuration will reduce the cost for heat transfer process and also increase the rate of heat transfer.

[4]The heat transfer analysis on cooling fin arrangement of motor has suggest the rectangular perforated fin has the highest total heat transfer rate compare to the others fin arrangement.

FUTURE SCOPE:

[1]The perforated fins can enhance heat transfer.The magnitude of heat transfer enhancement depends upon Angle of orientation, diameter of perforations and heater input. The optimum perforation diameter depends upon the Angle of inclination. The increase in the heat transfer coefficient can be achieved with varying different parameters which can be studied.

[2]Forced convection heat transfer can be done on perforated fins with different velocity of air input with help CFD in ANSYS.Many studies can be done in forced convection.

[3]Different material such as copper different grades of Aluminium & other materials like composite material and different types of perforation can use for further analysing.

[4] In future, the optimum fin size in term of height, width and angle will be determined using the similar method of heat transfer analysis to get a better efficiency of heat dissipation and cooling of the motor.

NOMENCLATURE

Heat liberated	Q
Convective heat transfer coefficient	h
Heat transfer area	A
temperature of the surface	Ts
ambient air temperature	T_a
free stream temperature	$T_{œ}$
temperature	T
density	ρ
acceleration due to gravity	g
characteristic length	L
velocity	V
viscosity	μ
constant	β
specific heat capacity	c_p
constant	α

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A Review Paper On Design And Analysing Of Different Types Of Fin Configurations

[1]Mubashshir Shaikh, [2]Yusuf Shaikh, [3]Fatru Shaikh,[4]Danish Shaikh, [5]Rizwan Shaikh

(Mechanical Engineering Department)

Anjuman-I-Islam Kalsekar Technical Campus,New Panvel,Maharashtra, India

Abstract : This paper investigates the work done on various types of fins effect of perforation shape or geometry on the heat transfer of perforated fins.The type of heat ex-changer used is heat sink with the perforated fins under the forced convection heat transfer to determine the performance for each perforation shape between straight, slanting, transverse,circular, rectangular, triangular,cylindrical,square and also with the non-perforated fins. The experimental result compared between the types of fins perforation shape and the heat transfer coefficient to clarify the best perforation shape for the plate heat sink. The fluid and heat transfer properties of various fins were studied which found out were using CFD,ANSYS,CATIA .The difference between experimental and numerical results was reported for temperature distributions when the power supplied are respectively.The overall conclusion shows various paper analysed and their results and tabulated and also shown in the graphical format.

Keywords:Fins analysis, Heat transfer, Perforations, shapes, Plate fins, heat ex-changers

I. Introduction

Abhishek Mote[1] Fins are the extended surfaces purposely provided at a place from where heat is to be removed. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Fins are widely used for cooling of IC engines. The different types of fin geometries that can be used for an IC engine are-

1) Rectangular fins: The cross section of fins is rectangular in shape.
2) Triangular fins: The cross section of fins is triangular in shape.
3) Trapezoidal fins: The cross section is trapezoidal in this case providing greater surface area for heat transfer.
4) Pin fins: The area for heat transfer is in the form of small pin shaped fins called as Pin fins.

Heat transfer through extended surfaces is mainly focused on convectional heat transfer. The condition of cooling medium that surrounds those surfaces is responsible for conventional heat transfer. The movement of air across the fins and its pattern of movement over the periphery of extended surfaces greatly affect the heat transfer rate. Optimum length of fins: Since we are purposely increasing the surface area for getting maximum heat transfer, but it does not mean that we can go on increasing the length (and thereby the surface area) beyond a certain limit. If the length of fins is increased too much, the convective thermal resistance would increase thus reducing the heat transfer rate, fin efficiency and also; it adds unnecessary material and costs also. Conversely, if the length of fins is too short, the heat transfer rate and fin efficiency would decrease again. Hence the length of fin needs to be optimum in value

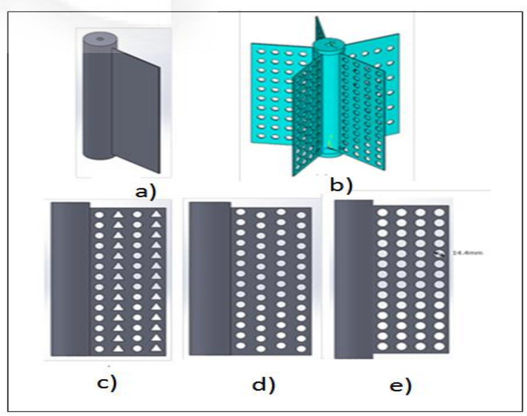


Figure 1:Different types of perforations

I. LITERATURE SURVEY

Thamir K. Ibrahim.[2] Heat sink with perforated and non-perforated fins were investigated.Perforated fins increase the heat coefficient of the heat sink by 35.82–51.29%.The difference between experimental and numerical results was about 8% and 9% for temperature distributions when the power supplied are 150 W and 100 W respectively.The fluid and heat transfer properties of heat sink were studied experimentally and numerically using CFD.Heat sink with perforated fins showed significant effect on the performance of forced convection heat transfer.

L.Prabhu[3].Heat transfer performance of fin is analysed by ANSYS workbench for the design of fin with various design configuration such as cylindrical , square and rectangular configuration. The heat transfer performance of fin with same base temperature is compared. In this thermal analysis, Aluminium was used as the base metal for the fin material. Fins are design with the help of CATIA V5R16. Analysis of fin performance done through the software ANSYS 15.0.

M. Sabri Sidik[4].An analysis was conducted to study the heat transfer of in-wheel electric motor cooling fin for light electric vehicle application. This study focuses on motor housing design and heat transfer analysis of different cooling fins arrangement for motor housing.Three types of cooling fin arrangement on the motor housing has been selected and modelled in CATIA software. There were straight fin, slanting fin and transverse fin. Then, all models were exported to ANSYS for heat transfer analysis purpose. This suggests that the straight fin arrangement has the highest efficiency of heat dissipation and distribution compare to the slanting and transverse fin arrangement.

Zan WU[5]. Natural convection heat transfer enhancement of perforated fin array with different perforation diameter 4-12mm and a different Angles of inclination (0-90) increase in the heat transfer coefficient was achieved with perforated fins of 12mm perforation diameter of the Angle of orientation 45 degree which shows about 32% enhanced heat transfer coefficient

with saving 30% material.

Pardeep Singh[6] In this research, the heat transfer performance of fin is analysed by design of fin with various extensions such as rectangular extension, trapezium extension, triangular extensions and circular segmental extensions. The heat transfer performance of fin with same geometry having various extensions and without extensions is compared. Near about ranging 5% to 13% more heat transfer can be achieved with these various extensions on fin as compare to same geometry of fin without these extensions. Fin with various extensions design with the help of software AutoCAD. Analysis of fin performance done through the software Autodesk® Simulation Multiphysics. In this thermal analysis, temperature variations w.r.t. distance at which heat flow occur through the fin is analysed. Extensions on the finned surfaces is used to increases the surface area of the fin in contact with the fluid flowing around it.So, as the surface area increase the more fluid contact to increase the rate of heat transfers from the base surface as compare to fin without the extensions provided to it. On comparison, rectangular extensions provide on fin gives the greatest heat transfer than that of other extensions having the same length and width attached to finned surface.

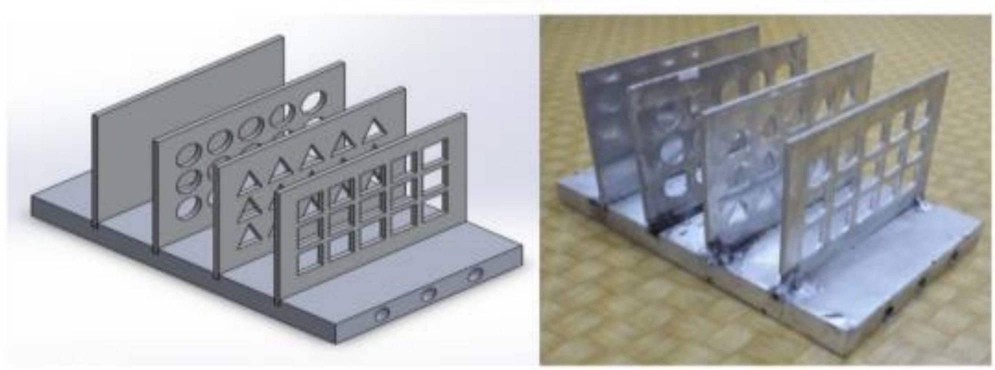


Figure 2: From left Non-perforated, Circular perforated ,Triangular perforated ,Square perforated fins.

II. ANALYSIS

[2]Thamir K. Ibrahim.The comparison between triangular perforation shapes with the rectangular show that the increment 5.099% which is a show that the triangular shape is better than rectangular in term of heat transfer coefficient. As the result, the heat transfer coefficient for triangular perforation shape is better compared to the non-perforation and also to the other perforation shape. In the same way, when comparing the circular perforation shape with the non-perforation and with the other perforation shape, the heat transfer coefficient has increased simultaneously by 5.239–7.194% compared to non-perforated and with the rectangular perforation fins. In comparison, the heat transfer coefficient of circular perforation with the triangular perforation shape has decreased significantly by 0.14%. As a result, the circular perforation shape is better in term of performance compared to non-perforated and rectangular shape but it not as good as the triangular perforation shape. Also, when comparing the rectangular shape with the non-perforated and another perforation shape, the rectangular perforation shape has increment of 2.25% compared to the non perforated but when doing comparison between rectangular perforations with the circular perforation the heat transfer coefficient of rectangular shape has decrement about 5.099% which is can be stated that the circular perforation shape is better than the rectangular perforation shape. This trend also can be seen when comparing the rectangular shape with the triangular shape which has decrement about 5.239%. This result will be stated that the rectangular perforation shape is the on the third place when comparing the rectangular perforation shape with non-perforation and also with the other perforation shape.

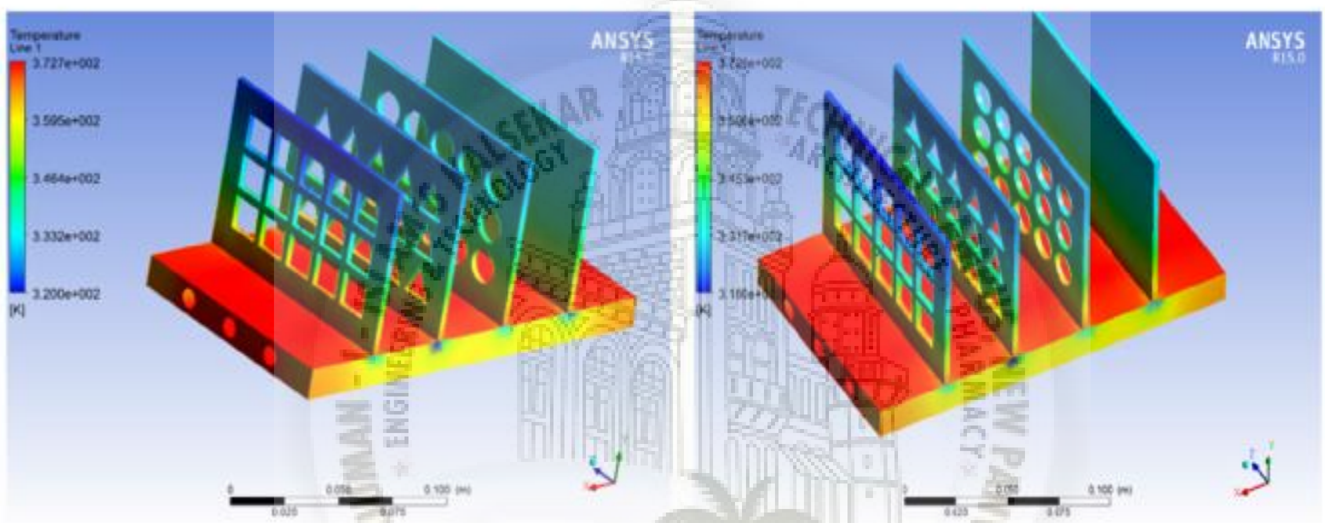


Figure 3. Analysis on software (ANSYS)

Table 1

Calculated data for *h* with 150 W.

Shape	1.8 ms^{-1}	2.0 ms^{-1}	2.3 ms^{-1}	2.5 ms^{-1}	2.8 ms^{-1}
Triangular	809.641	811.787	812.707	813.988	816.693
Circular	808.768	809.297	811.260	811.872	812.208
Non-Perforated	802.962	805.586	806.011	807.391	808.649
Rectangular	804.792	805.359	806.820	807.555	807.837

Table 2

Calculated data for *h* with 100 W.

Shape	1.8 ms^{-1}	2.0 ms^{-1}	2.3 ms^{-1}	2.5 ms^{-1}	2.8 ms^{-1}
Triangular	813.9321	814.8369	815.6178	819.6847	818.1489
Circular	813.5966	813.4903	812.9027	813.3169	811.8548
Non-Perforated	782.7495	791.9992	787.4329	787.5146	787.2344
Rectangular	805.9596	806.6728	806.7859	806.9838	807.1534

L.Prabhu[3].All the 3D models of the different fin configurations (circular, rectangular, square) are imported to ANSYS WORKBENCH 15.0 for meshing and steady state thermal analysis. ANSYS Mechanical is a Workbench application that can perform a variety of engineering simulations, including stress, thermal, vibration, thermoelectric, and magneto static simulations. A typical simulation consists of setting up the model and the loads applied to it, solving for the model's responses to the loads, then examining the details of the response with a variety of tools. The Mechanical application has "objects" arranged in a tree structure that guide you through the different steps of a simulation. By expanding the objects, you expose the details associated with the object, and you can use the corresponding tools and specification tables to perform that part of the simulation.

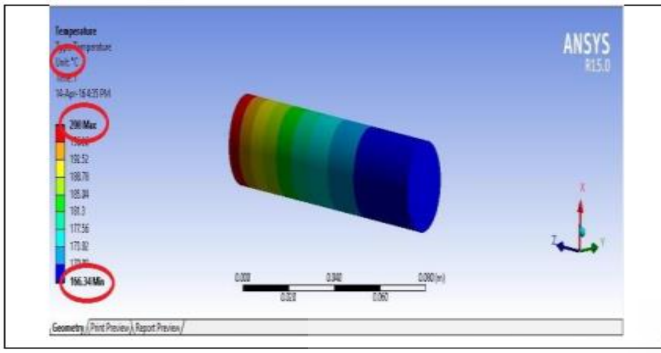


Fig 4.Steady State Thermal Analysis of Circular

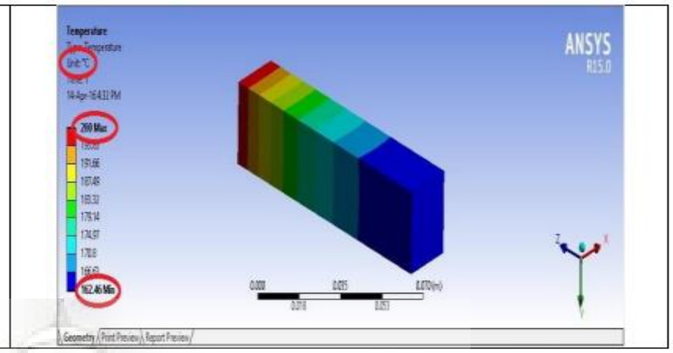


Fig 5. Steady State Thermal Analysis of Square

Table 3 Maximum and Minimum temperatures

FIN CONFIGURATION	MAXIMUM TEMPRATURE	MINIMUM TEMPRATURE
CIRCULAR	200	166.34
SQUARE	200	162.46
RECTANGULAR	200	155.62

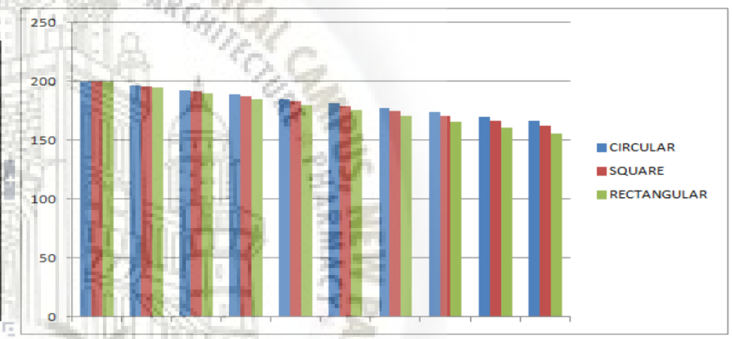


Fig 6: Graph showing temperature variations

M. Sabri Sidik[4]Total Heat Transfer Rate and Maximum Temperature. Fig. 8 shows bar graph of the total heat transfer rate and maximum temperature for all the three fin arrangement. It shows the lowest total heat transfer rate and the lowest maximum temperature achieved was the straight fin with value of 2056.91 W and 407.71 K. These results reflect due to the efficiency of the temperature distribution and the velocity fluid flow through this fin. The highest total heat transfer rate and highest maximum temperature is the transverse fin suggests that this fin has the lowest efficiency of cooling fin arrangement as shown in Fig 7.

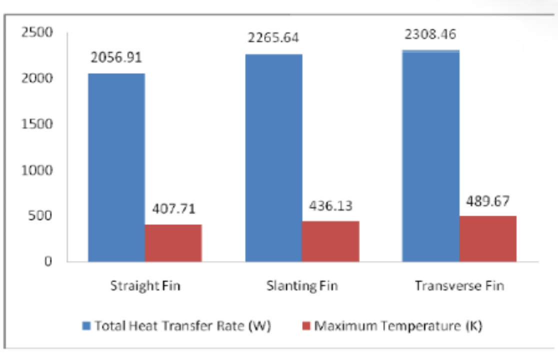
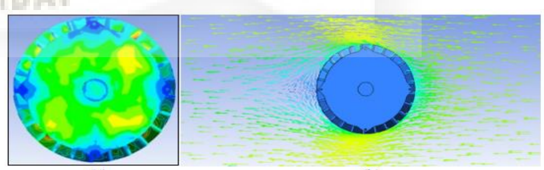
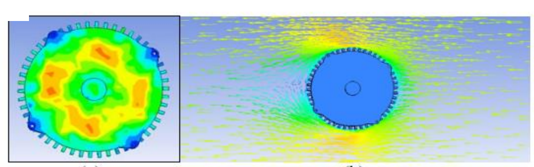


Figure 8: Total heat transfer rate and maximum temperature for the straight, slanting and tranverse fin arrangement



(a) (b)
: Slanting fin arrangement; (a) Temperature distribution, (b) Velocity vector



(a) (b)
Figure 7: Transverse fin arrangement; (a) Temperature distribution, (b) Velocity vector

Zan WU[5] The present study examined the extent of heat transfer enhancement from isolated isothermal perforated plates with staggered patterns, vertical parallel Isothermal perforated plates, and vertical Fig. 10 Vertical rectangular isothermal perforated fins on vertical surfaces s W H qh/qs Fig. 9 Ratio of heat transfer rate of high (a) and low (b) H/s ratios perforated to non-perforated vertical parallel plates with the same weight vs wall-to-wall spacing for different ratios of open area, t=0.002 rectangular isothermal perforated fins compared with their non-perforated counterparts with the same weight by using existing correlations, under natural convection conditions. Most of the correlations were adopted for calculating hs under different conditions. However, the qh/qs ratio is almost unaffected by the uncertainties of these correlations, because the hs value is also present in qh term and accounts for a large amount of qh. The qh/qs ratio has a similar level of uncertainty with Eq. (2) resulting from the term (1+0.75ε), the heat transfer augmentation ratio of the interrupted surface which should be experimentally and numerically investigated comprehensively in the future.

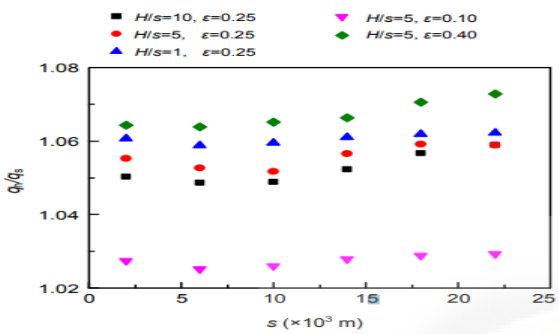


Fig 9. Ratio of heat transfer rate of perforated to non-perforated vertical rectangular isothermal fins with the same weight vs wall-to-wall spacing at various H/s and ratios of open area, t=0.002m

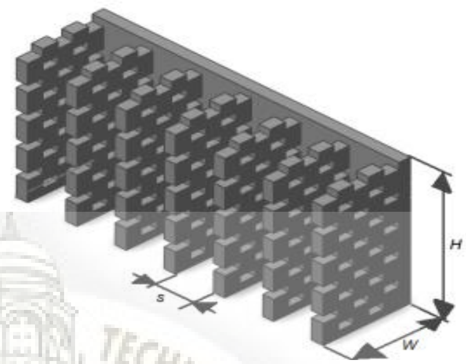


Fig 10. Vertical rectangular isothermal perforated fins on vertical surfaces.

Pardeep Singh[6]Heat transfer calculated by using the heat transfer governing differential equation for the fin of finite length and loses heat by convection ,

$$Q_{fin} = \sqrt{hPkA_{cs}}(t_o - t_a)\left[\frac{\tanh[ml] + \frac{h}{km}}{\left(1 + \frac{h}{km}\tanh(ml)\right)}\right]$$

for which the given length of fin (l in m), thickness of fin (y in m), width of fin (b in m),thermal conductivity of fin (k in W/m °C), coefficient of convective heat transfer (h in W/m2 °C) , temperature at base of fin (to in °C),temperature of the ambient fluid (ta in °C). After the calculations of heat transfer rate of various fin geometry now it is the time to compare the increase in heat transfer rate for the given geometry of fin which is shown in Table-4. The fin without extensions having 21.7665 W heat transfer

TABLE-4
PERCENTAGE INCREASE IN HEAT TRANSFER FIN WITH EXTENSIONS

Type of extensions	Percentage increase in heat transfer fin with extensions					
	28 °C	26 °C	24 °C	22 °C	20 °C	18 °C
Rectangular	12.796	12.797	12.793	12.794	12.798	12.795
Trapezium	5.232	5.232	5.232	5.231	5.231	5.227
Triangular	3.139	3.137	3.134	3.139	3.137	3.135
Circular segmental	4.373	4.380	4.372	4.371	4.374	4.371

Table-5 shows that the effectiveness of fin with rectangular extensions, trapezium extensions, triangular extensions and circular segmental extensions.

TABLE-5
EFFECTIVENESS OF FIN WITH EXTENSIONS

Type of extensions	Effectiveness					
	28 °C	26 °C	24 °C	22 °C	20 °C	18 °C
Rectangular	5.846	5.846	5.846	5.846	5.846	5.846
Trapezium	5.656	5.656	5.656	5.656	5.656	5.655
Triangular	5.756	5.756	5.756	5.756	5.756	5.756
Circular segmental	5.408	5.408	5.408	5.408	5.408	5.408

III. CONCLUSION

By giving perforation to the fin will resulting the higher temperature different compared to the non-perforated fins that will affect the temperature distribution of the heat generated at the heat source along the fins. By giving perforation to the fins will increase the heat coefficient of the heat sink by 35.82–51.29% regarding to the perforation shape or geometry.Data collected from the experiment can be used for analysing the heat transfer coefficient and also the temperature distribution for each of the perforation shape or geometry conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.[2]

The use of fin (extended surface), provide efficient heat transfer. Heat transfer through fin of rectangular configuration is higher than that of other fin configurations. Temperature at the end of fin with rectangular configuration is minimum, as compare to fin with other types of configurations. The effectiveness of fin with rectangular configuration is greater than other configurations. Choosing the optimum size fin of rectangular configuration will reduce the cost for heat transfer process and also increase the rate of heat transfer.[3]

The heat transfer analysis on cooling fin arrangement of in-wheel electric motor housing has suggest the straight fin has the highest efficiency in temperature distribution and the lowest total heat transfer rate compare to the others fin arrangement. In future, the optimum fin size in term of height, width and spacing will be determined using the similar method of heat transfer analysis to get a better efficiency of heat dissipation and cooling of the motor.[4]

The perforated fins can enhance heat transfer the magnitude of heat transfer enhancement depends upon Angle of orientation, diameter of perforations and heater input. The optimum perforation diameter depends upon the Angle of inclination. The increase in the heat transfer coefficient was achieved with perforated fins of 12mm perforation diameter[5]

The use of fin (extended surface) with extensions, provide efficient heat transfer: Fin with extensions provide near about 5 % to 13% more enhancement of heat transfer as compare to fin without extensions.Heat transfer through fin with rectangular extensions higher than that of fin with other types of extensions. Temperature at the end of fin with rectangular extensions is minimum as compare to fin with other types of extensions. The effectiveness of fin with rectangular extensions is greater than other extensions. Choosing the minimum value of ambient fluid temperature provide the greater heat transfer rate enhancement. [6]

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