HEAT TRANSFER ANALYSIS THROUGH POROUS FIN

PROJECT REPORT

Submitted by

S. HARRISH PETHUNASH (953016114036)
P. KISHORE KUMAR (953016114041)
S. MANOJ KUMAR (953016114047)
P. MARIAPPAN (953016114048)

In partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

MECHANICAL ENGINEERING

ST. MOTHER THERESA ENGINEERING COLLEGE

ANNA UNIVERSITY: CHENNAI 600 025

APRIL 2020

BONAFIDE CERTIFICATE

Certified that this project report **"HEAT TRANSFER ANALYSIS THROUGH POROUS FIN"** is the bonafide work of **"S. HARRISH PETHUNASH (953016114036), P. KISHORE KUMAR(953016114041), S.MANOJ KUMAR (953016114047), P. MARIAPPAN(953016114048),"** who carried out the project work under my supervision.

SIGNATURE

Mr.M. MuthuKrishnan.,M.E.

MK Sir

Head of the Department

Department of Mechanical Engineering,

St. Mother Theresa Engineering College,

Vagaikulam.

SIGNATURE

Dr.S. Ramaswamy, M.E.,Ph.D,

Associate Professor

Department of Mechanical Engineering,

St. Mother Theresa Engineering College,

Vagaikulam.

CERTIFICATE OF EVALUATION

COLLEGE CODE/NAME: 9530/ St. Mother Theresa Engineering College

DEPARTMENT : Mechanical Engineering
SEM / YEAR : VIIIth /
SUB CODE / NAME : ME6811-PROJECT WORK

S. NO	NAME OF THE STUDENTS	TITLE OF THE PROJECT	NAME OF THE INTERNAL GUIDE
1	S.HARRISH PETHUNASH (953016114036)	**HEAT TRANSFER ANALYSIS THROUGH POROUS FIN**	Dr.S.Ramaswamy.,M.E,Ph.D, Associate Professor DEPARTMENT OF MECHANICAL ENGINEERING
2	P. KISHORE KUMAR (953016114041)		
3	S.MANOJKUMAR (953016114047)		
4	P. MARIAPPAN (953016114048)		

This is to certify that the project entitled **"HEAT TRANSFER ANALYSIS THROUGH POROUS FIN"** is the bonafide record of work done by the above students who carried out the project work under our guidance during the year 2019 - 2020 in partial fulfillment of the award of Bachelor of Engineering degree in Mechanical Engineering of Anna University Chennai.

Submitted for the Viva-voce held on …………22.09.2020……………..at St. Mother Theresa Engineering College, Vagaikulam.

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

First of we would like to thank God Almighty for giving us sound health throughtout our project work. We would like to express our thanks to our beloved parents for their constantsupport and advice during the course of the project work.

For this great opportunity given to us we express our profound sense of thanks to our Head of the Department **Mr.M.MUTHU KRISHNAN, M.E**., who guided us with his precious ideas, valuable suggestions.

Department of Mechanical Engineering and our project supervisor **Dr.S.RAMASWAMY, M.E.,Ph.D,** for their moral support by taking keen interest on our project work and guided us all along, till the completion of our project work.

We would like that to convey our heartily thanks to our project coordinator **Mr. R.SAMUEL SANJAY RAJA, ME., (Ph.D).** for the consistence guidance and valuable suggestion for successful completion of work project work

We also express our sincere thanks to **Mr.G. KRISHNA MOORTHY, M.E.,** Assistant professor, St. Mother Theresa Engineering College, Vagaikulam for his Support to complete this project successfully. Other faculty members of our department guided through the whole process, never accepting less than our best effects. We thank them all. Finally we would like to thank our friends and the non-teaching or indirectly contributed to the successful complrtion of this project.

ABSTRACT

According to increasing human needs for energy and to avoid energy waste, researchers are struggling to increase the efficiency of energy production and energy conversion. One of these methods is increasing heat transfer and reducing heat dissipation in heat exchangers. Using porous materials in the fluid flow is one of the passive methods to increase heat transfer in heat exchangers. The existence of porous media in the flow path, improve the matrix of thermal conductivity and effective flow thermal capacity and also matrix of poroussolid increase radiation heat transfer, especially in two phase flow (gas-water) systems. In this paper, recent studies on the effect of using porous media on enhancement the amount of heat transfer in heat exchangers has been investigated via using porous media with difference porosity percentage, material and geometric structure in the flow path in numerical simulations and laboratory studies., Such methods lead to lower energy consumption and less costly and less expensive equipment, with higher thermal efficiency . As increasing efficiency and improving energy consumption in the industry have always been a concern of the researchers, improving heat transfer in heating and cooling systems is no exception. aluminium heat sinks are often capable of dissipating the heat. If better performance is required, copper heat sink may be used for higher heat sink performance, but aluminium is used because of its lower weight and lower cost than copper. This numerical simulation is accomplished by 3D modeling and analysis using ANSYS, 19.0. This will help in finding out the new fin topologies with heat transfer characteristics that will do better than conventional plane fin. The main goal is to increase the heat transfer rate through the fin surface and to decrease material cost**.** The effect of forms of Porous fins on the overall performance of the heat sink studied in this paper.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUTION

Energy consumption is one of the most important issues that man has faced over the past decades. Providing clean and environmentally friendly energy is of great importance to developed countries. Among the various types of energy used today, more than 70% of it is exchanged as heat energy. In many industrial systems and processes, the heat must be given as input to the system or, ultimately, the energy must be exhaust from the system. By increasing the need for energy in the world, strengthening the process of heat transfer and reducing energy losses is of great importance . Better design of heat exchangers and their wider application to retrieval of the far-off heat industry can have a significant effect on the preservation of fuel resources and the prevention of environmental pollution. The key to increasing heat transfer is to reduce thermal resistance. This results in smaller heat transfer systems with lower cost and better efficiency. Heat transfer and control are a very important issue in high-flux systems,

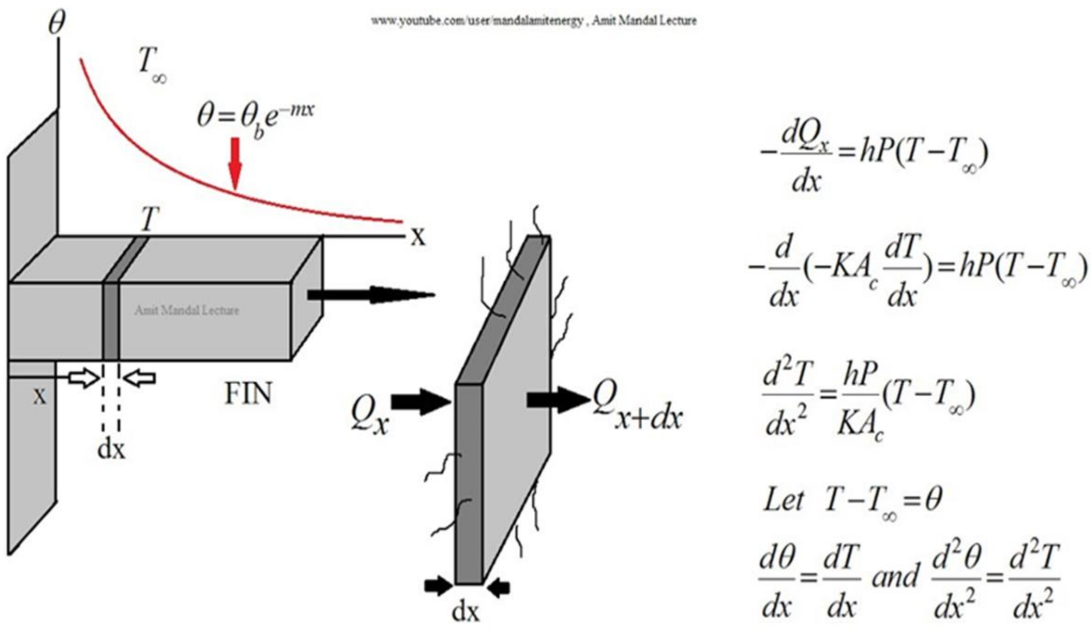


Fig 1 **Heat Transfer in Fin**

including reactors and nuclear reactors, microelectronic systems and micro-chemical reactors, and many other applications. Today, porous materials are used in many industrial applications to control the heat transfer and insulating of the systems. The most important application of porous materials is the insulating of furnaces and boilers and the transfer of energy in the geothermal and oil industries.

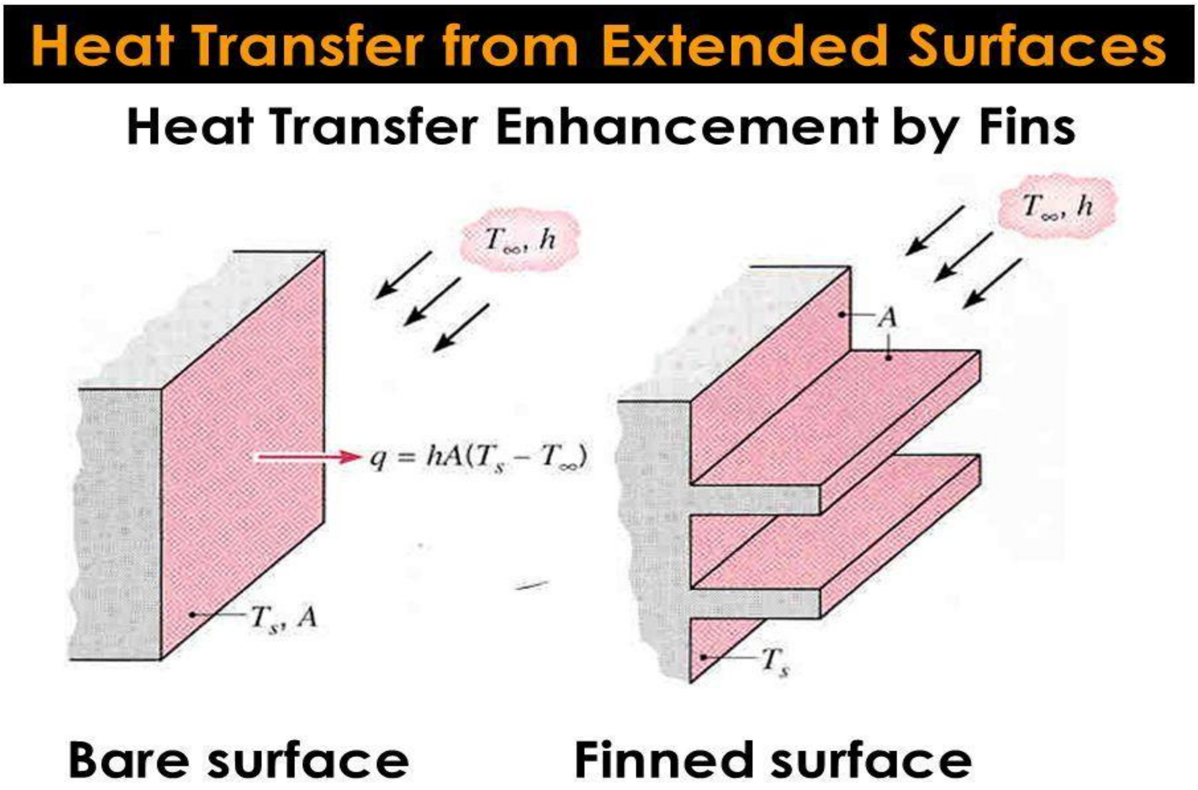


Fig 2 **Bare Surface vs Finned Surface**

In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. 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. Sometimes it is not feasible or economical to change the first two options. Thus, adding a fin to an object, increases the surface area and can sometimes be an economical solution to heat transfer problems. Heat transfer devices have been used for conversion and recovery of heat in many industrial and domestic applications. Heat transfer enhancement techniques generally reduce the thermal resistance either by increasing the effective heat transfer surface area or by generating turbulence. Sometimes these changes are accompanied by an increase in the required pumping power which results in higher cost.

A fin is a surface that extends from an object to increase the rate of heat transfer to or from the environment by increasing convection. 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 transfer from the base surface as compare to fin without the extensions provided to it.

1.1 HEAT TRANSFER ENHANCEMENT METHODS

In recent decades, many studies have been conducted to enhance heat transfer, focusing on finding methods that, in addition to increasing heat transfer, have more efficiency. Such methods lead to lower energy consumption and less costly and less expensive equipment, with higher thermal efficiency. As increasing efficiency and improving energy consumption in the industry have always been a concern of the researchers, improving heat transfer in heating and cooling systems is no exception. Therefore, extensive research to enhance the transmission methods Heat is used to reduce heat dissipation in these systems. Bergles, In his book , introduced fourteen ways to increase heat transfer in heat exchangers. These methods can be divided into two active and passive categories. Passive methods do not require any external power source to increase heat transfer. One of the non-active methods that has been considered in recent decades to increase heat transfer in heat exchangers is the use of porous media. Porous media play an important role in the industry due to their unique properties. In the following, the porous environment and its application are discussed. The material used for coating should be high melting point and boiling point, more heat resistive, economic, low thermal conductivity. Ceramic materials can be able to meet the required characteristics. It is light weight, smooth, scratch resistance and also has advance features when it is mixed or reinforced with some metals or non-metals.

1.2 POROUS MEDIUM

A Porous medium or a porous material is a material containing pores (voids). The skeletal portion of the material is often called the "matrix" or "frame".A porous medium is most often characterised by its porosity. Other properties of the medium (e.g. permeability, tensile strength, electrical conductivity, tortuosity) can sometimes be derived from the respective properties of its constituents (solid matrix and fluid) and the media porosity and pores structure, but such a derivation is usually complex.

Fig 3 Porous Aluminium Foam

Even the concept of porosity is only straightforward for a poroelastic medium. Often both the solid matrix and the pore network (also known as the pore space) are continuous

Weight of Porous Aluminium g/cm3.	1-1.4 g/cm3
Pour Size μm	100-5000 μm
Heat expansion coefficient, 1/К	23.6e6 1/К
Heat conductivity, W(m·K)	35 alloy 50 pure Al
Compressive strength, MPa	35-109 Mpa
Tensile strength, MPa	10-30 Mpa

Table 1 Property of Porous Aluminium Foam

so as to form two interpenetrating continua such as in a sponge. However, there is also a concept of closed porosity and effective porosity.

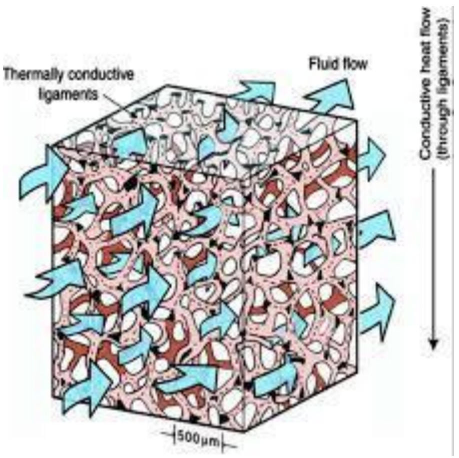
1.3 POROUS MEDIUM CHARACTERISTICS

- ✓ Porosity
- ✓ Infiltration Coefficient
- ✓ Permeability

1.4 THE ROLE OF POROUS MEDIA IN INCREASING HEAT TRANSFER

Porous media have a large contact surface with fluids, which can enhance the heat transfer effect. The porous medium not only changes the flow field conditions and causes the frontal layer to thinner, but also the conduction heat transfer coefficient is usually higher than that of the fluid studied. As a result, the introduction of a porous medium into a fluid channel effectively improves the thermal transfer properties . Also, for open cellular porous media, the presence of multiple paths that are intense heat conductors can increase heat transfer; another reason is the increase in heat transfer, the flow of the porous matrix and its high mixing.

Applying the porous medium, depending on the permeability of the environment, forces the fluid to escape from the central region to the outer regions, which reduces the thickness of the boundary layer and increases the heat transfer rate. The porous medium also corrects effective thermal conductivity and effective heat capacity and fluid heat capacity, and, in a system that has a gas flow, the solid matrix also enhances the heat transfer rate. Heat transfer reinforcement occurs through three mechanisms: redistribution of current, thermal conduction modification, and correction of environmental radiation Properties.



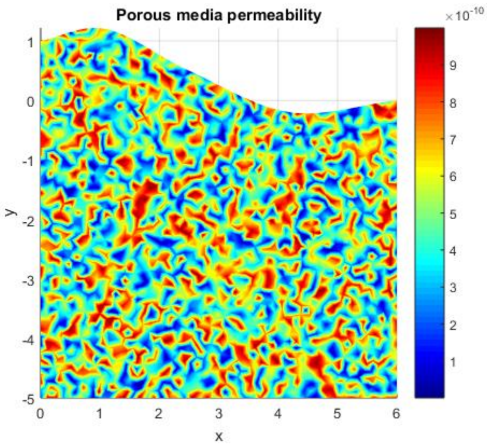


Fig 4 Heat Transfer Through Porous Media

The study of the hydraulic properties of porous media is important because the transfer of heat can be considerably increased by adding a porous medium to a heat exchanger. But, on the other hand, the fluid passes through the porous matrix, with greatly reduced pressure. In order to achieve the maximum heat transfer in a heat exchanger, the porous medium parameters must be optimized during the design stage, due to the fluid pressure drop. Improvement of heat transfer in thermal systems (such as heat exchangers) using a porous medium results in a significant increase in the loss of fluid pressure and fluid pumping power.

CHAPTER 2

LITERATURE REVIEW

Abdullah, H. Alessa et. al. [1] had studied the natural convection heat transfer enhancement from a horizontal rectangular fin embedded with equilateral triangular perforations. The heat dissipation rate from the perforated fin is compared to that of the equivalent solid one. The effect of geometrical dimensions of the perforated fin and thermal properties of the fin was studied in detail. They concluded that, For certain values of triangular dimensions, the perforated fin can result in heat transfer enhancement. The magnitude of enhancement is proportional to the fin thickness and its thermal conductivity. The perforation of fins enhances heat dissipation rates and at the same time decreases the expenditure of the fin material.

B. Ramdas Pradip et. al. [2] had studied the many industries are utilizing thermal systems wherein overheating can damage the system components and lead to failure of the system. In order to overcome this problem, thermal systems with effective emitters such as ribs, fins, baffles etc. are desirable. The need to increase the thermal performance of the systems, thereby affecting energy, material and cost savings has led to development and use of many techniques termed as “Heat transfer Augmentation”. This technique is also termed as “Heat transfer Enhancement” or “Intensification”. Augmentation techniques increase convective heat transfer by reducing the thermal resistance in a heat exchanger. Many heat augmentation techniques has been reviewed, these are (a) surface roughness, (b) plate baffle and wave baffle, (c) perforated baffle, (d) inclined baffle, (e) porous baffle, (f) corrugated channel, (g) twisted tape inserts, (h) discontinuous Crossed Ribs and Grooves. Most of these enhancement techniques are based on the baffle arrangement. Use of Heat transfer enhancement techniques lead to increase in heat transfer coefficient but at the cost of increase in pressure drop.

Golnoosh Mostafavi [3] had investigated the steady-state external natural convection heat transfer from verticallymounted rectangular interrupted finned heatsinks. After regenerating and validating the existing analytical results for continuous fins, a systematic numerical, experimental, and analytical study is conducted on the effect of the fin array and single wall interruption. FLUENT and COMSOL Multiphysics software are used in order to develop a twodimensional numerical model for investigation of fin interruption effects. Results show that adding interruptions to vertical rectangular fins enhances the thermal performance of fins and reduces the weight of the fin arrays, which in turn, can lead to lower manufacturing costs.

Sable, M.J. et. al. [4] had investigated for natural convection adjacent to a vertical heated plate with a multiple v- type partition plates (fins) in ambient air surrounding. As compared to conventional vertical fins, this v-type partition plate's works not only as extended surface but also as flow turbulator. In order to enhance the heat transfer, V-shaped partition plates (fins) with edges faced upstream were attached to the two identical vertical plates. They observed that among the three different fin array configurations on vertical heated plate, V-type fin array design performs better than rectangular vertical fin array and V-fin array with bottom spacing design. The performance was observed to improve further, with increase in the height of the V-plates (fin height).

Pradeep singh[5] Most studies that have demonstrated the beneficial effects of perforations on the rate of heat transfer in pin fin arrays have used only a single perforation per pin. The logical extremis of this parameter is the metallic foam-like porous pins. Indeed, numerical simulations that the rectangular shaped extended surfaces shows the high rate of heat transfer when compared to other extensions at same length.

Kang Hiechan[6], has made many experiments to find the fin efficiency and concluded that the efficiency of fin is useful when the value of NTU is zero otherwise the fin efficiency is high when the NTU is high and is used in air conditioning systems.

Shivdas S Kharche[7], explained that the when a notch is provided on the surface of fin with a rectangular shape the fin supports for much heat transfer and compared the heat transfer rate of fins by changing the material from Aluminum to copper and found that copper shows much heat transfer value than aluminum.

Sandhya Mirapalli[8], had made a conclusion that for a triangular fin when the length is increased the heatflow percentage also increases at constant base temperature compared to rectangular fin.

I.Lakshmi Anusha[9], concluded that total weight of the system made of splayed pin fins can be reduced to the minimum level by using the advanced composite materials like polyphenylene sulphide (PPS), carbon foam, graphite epoxy at the same thermal inputs.

Zhang, H.S[10], resulted that a fabric heat sink temperature distribution is so nearer to common pin fin heat sink but the temperature decreases in axial direction by increasing the fin length.

Sampath S S[11], compared the temperature distribution of a cylindrical element at various points is carried out by providing the thermal conductivity and heat transfer coefficient and with prescribed boundary conditions and analyzed with the help of simulation software and DOT NET software[12] and the results are almost equal expect at the middle of the specimen it is just deviated.

Amol B. Dhumne[12], resulted that to achieve high thermal performance the cylindrical perforated fins are used they leads to high heat transfer than the Porous fins.

CHAPTER 3

ANSYS

ANSYS stands for Analysis System. ANSYS Mechanical is a finite element analysis tool for structural analysis, including linear, nonlinear and dynamic studies. This computer simulation product provides finite elements to model behaviour, and supports material models and equation solvers for a wide range of mechanical design problems.

CHAPTER 4

WORKBENCH

4.1 TOOLBOX

The ansys workbench toolbox presents the types of data that you can add to your project. The toolbox in content sensitive, as you select different items in the project schematic or the other workspaces, the contents of the toolbox may change to reflect the components and actions available to you.

When working in other workspaces, such as engineering data or parameters, you can return to the project workspace by clicking the return to project button on the toolbar.

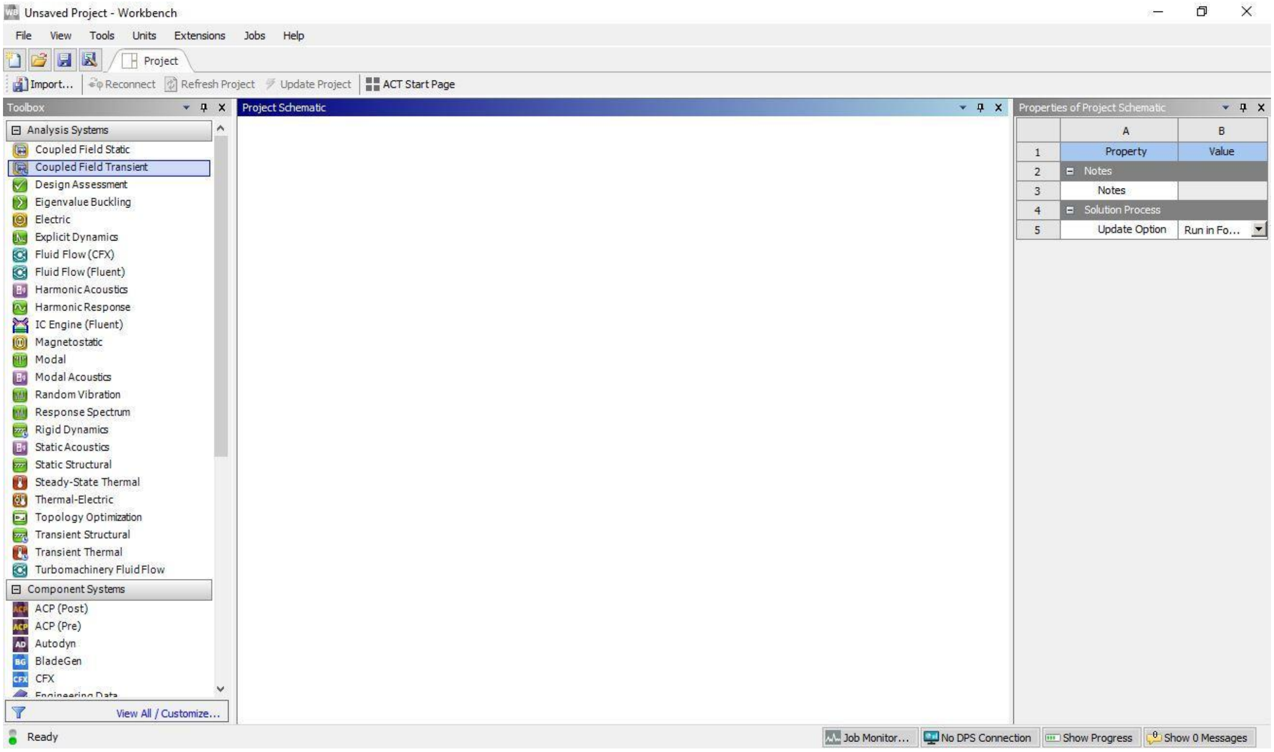


Fig 6 ToolBox

4.2 PROJECT SCHEMATIC

The project schematic captures the project and workflow of your project, providing a visual representation of the objects in the project and their relationship to each other. Analyses are shown as systems, which are comprised of different individual cell**s.**

4.3 TYPES OF CELLS

1. Engineering data
2. Geometry
3. Model/Mesh
4. Setup
5. Solution

4.3.1 ENGINEERING DATA

Use the Engineering data cell with Mechanical systems or the Engineering data component system to define or access material models for use in an analysis. Double click the engineering data cell, or right mouse click and choose EDIT from the context menu to display the engineering data workspace to define material data. For more information see engineering data.

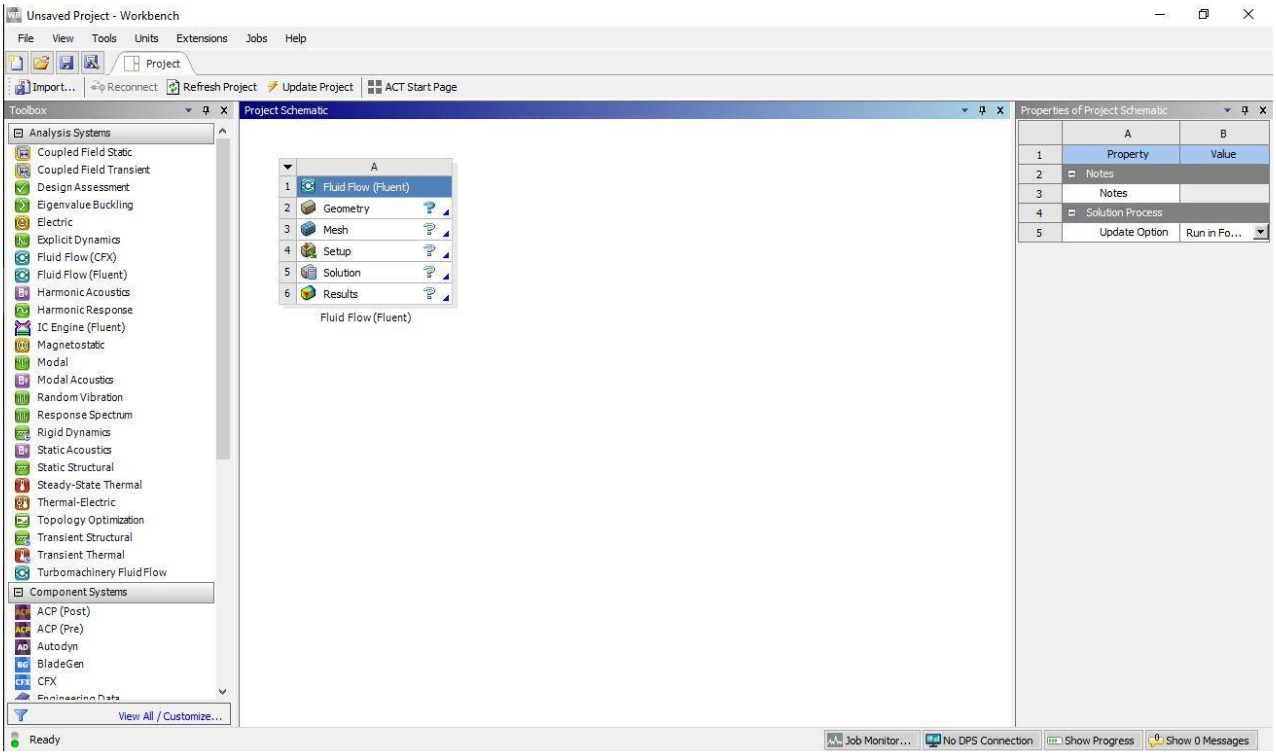


Fig 7 FLUID FLUENT Insert

The required material for the analysis is selected from the options provided in the engineering data sources. There are different categories of materials available in the engineering data sources for this steady state thermal analysis we are going to consider the material as Aluminium. This material is available in the general materials.

4.3.2 GEOMETRY

Select browse to open a dialog box that allows you to navigate to an existing geometry file, or select a file from the list of recently viewed files to replace the currently specified file.

Displays a properties pane where you can select basic and advanced geometry properties. For a detailed description of the options available from the properties pane, see geometry preferences in the Mechanical application help.

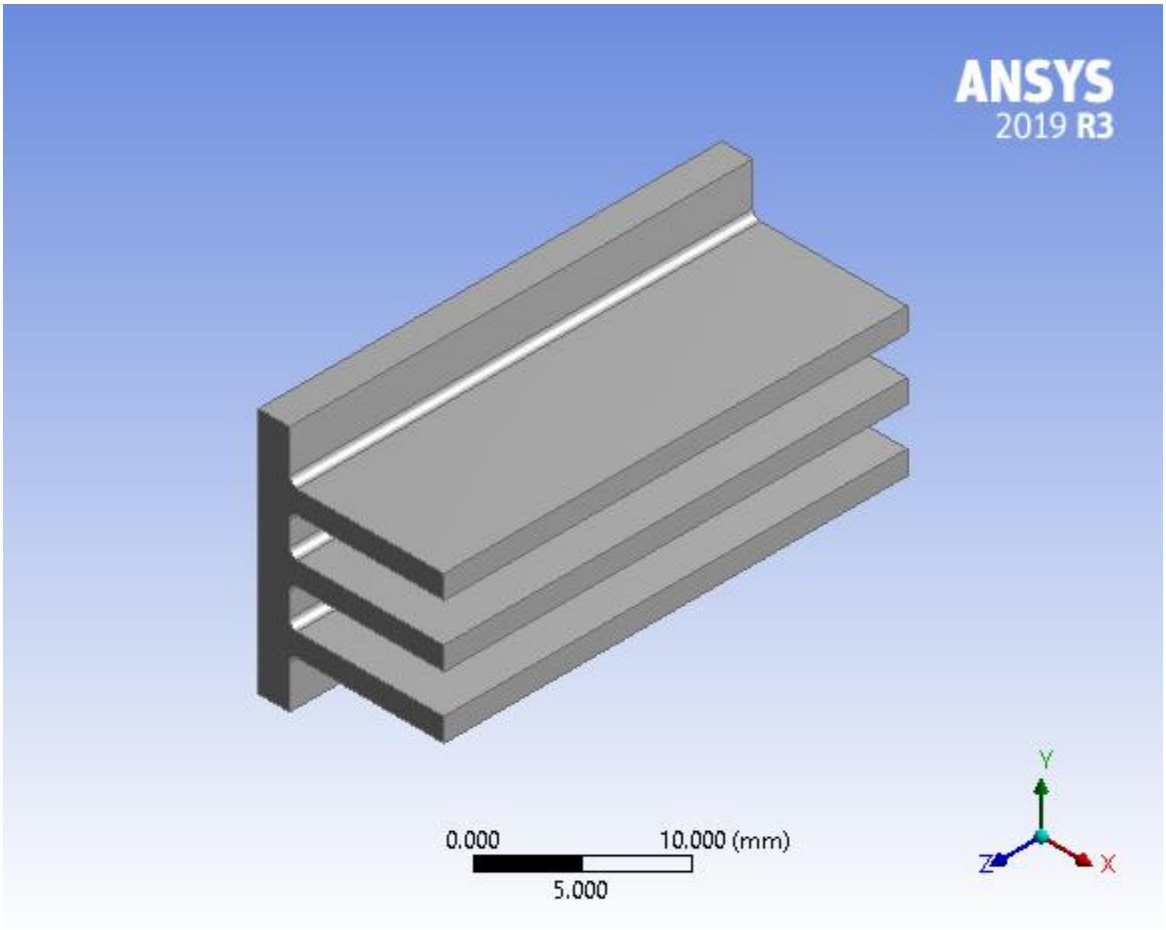


Fig 8 Geometry of Fin

The design modeller will be generated in a new window where the geometric model can be imported according to our requirement. Click on the import option so that the design modeller imports the geometric created CAD model. The geometric model can be imported by right mouse click on the import and then click on generate. This will generate the created CAD model into the design modeller window. The imported geometric model has to be converted or formed into a single solid component Hence all the small parts of the generated CAD model are selected and converted into a solid part. To form a single solid part, right mouse click on the selected solids and click on form new part The required CAD model can be generated as a single solid part. The created model can be used for further modelling or meshing based on the requirement for the FLUID FLUENT analysis.

4.3.3 MODEL/MESH

The Model cell in the Mechanical application analysis systems or the Mechanical model component system is associated with the Model branch in the Mechanical application and affects the definition of the geometry, coordinate systems, connections and mesh branches of the model definition. The Mesh cell in the Steady State Thermal analysis systems or the Mesh component system is used to create a mesh using the Meshing application. It can also be used to import an existing mesh file.

EDIT: Launches the appropriate Model or Mesh application (the mechanical application, meshing etc).

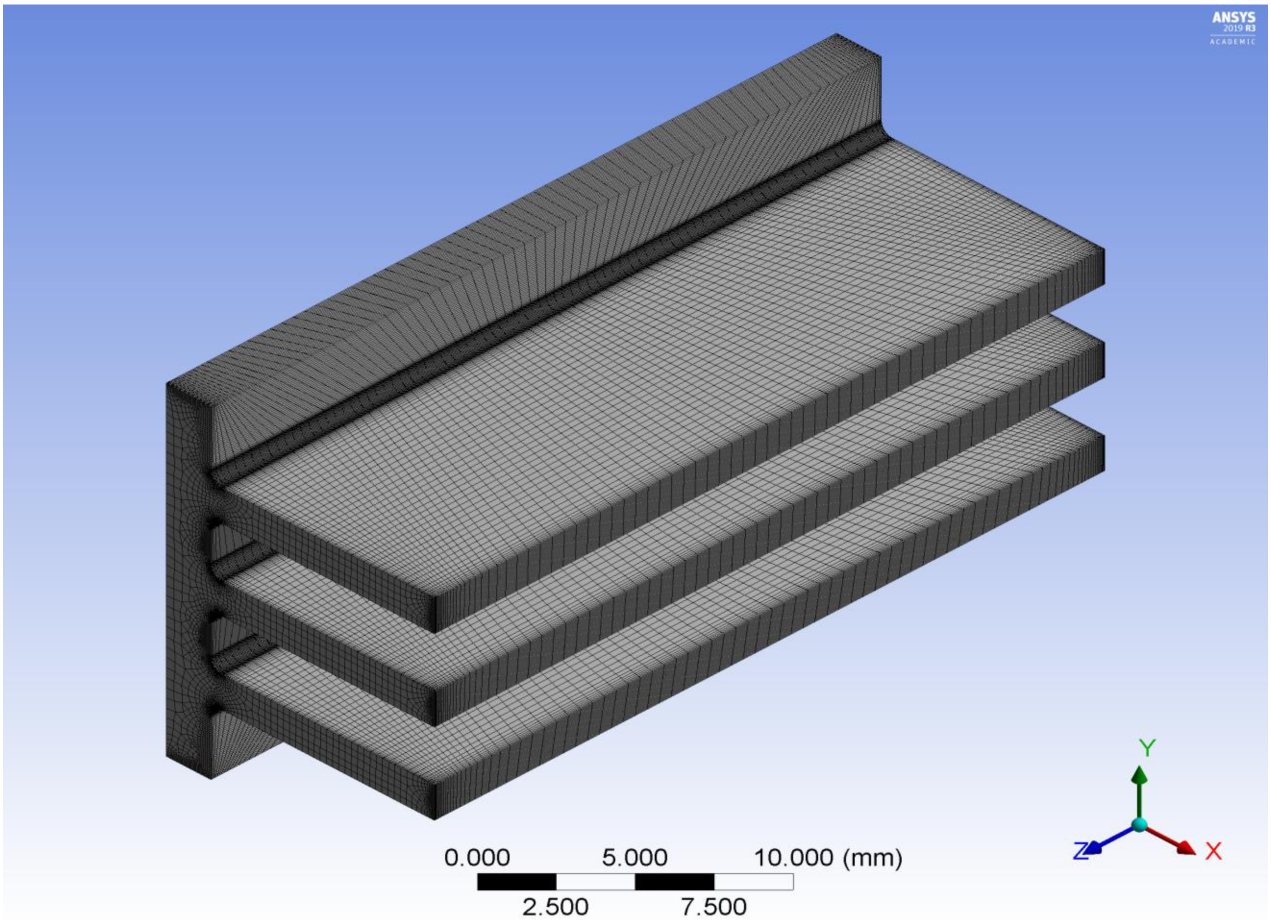


Fig 9 Mesh Model of the Fin

Now the generated model has to be meshed in order to get appropriate results. The left side box outline is having options mainly geometry, mesh, steady state thermal etc. The material can be again selected at the geometry option. The aluminium material will be available at the geometry. The boundary conditions can be given according to the required analysis. Now right click on the geometry to get an option called part. Now click on the part so that the required material can be selected as shown in the bottom left side box. The properties of the material and the solid can be changed based on the results that are to be attained. The meshing can be generated by right mouse click on the mesh option in the left side toolbox Click on the generate mesh option. The system takes a few seconds to generate the required mesh.

Domain	Nodes	Elements
design1_solid	54400	45441
solid	55724	277555
All Domains	110124	322996

Table 2 Mesh Information

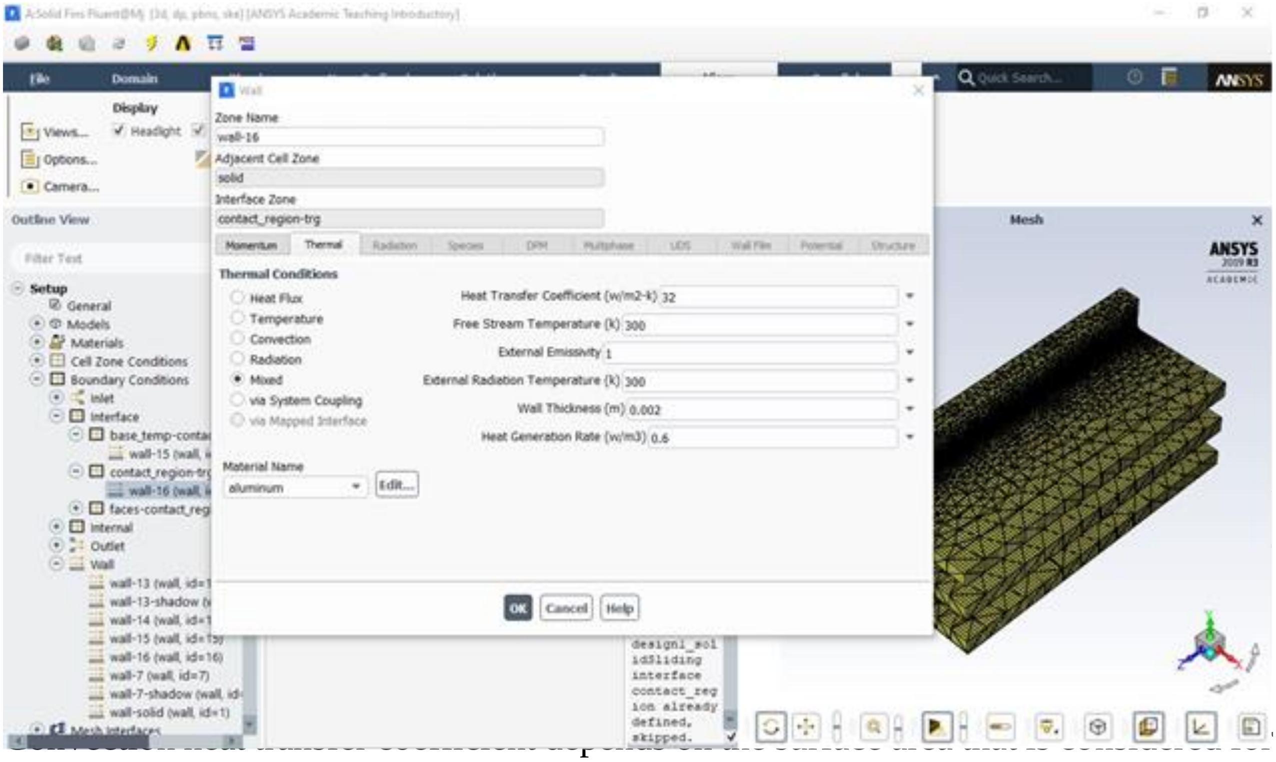
Domain	Maximum Edge Length Ratio
design1_solid	6.82961
solid	2.6526
All Domains	6.82961

Table 3 Mesh Statistics

The meshing of the created CAD model can be made by giving the element size. There is a sizing option in the left side bottom toolbox. Click on the sizing option, the element size is to be defined. The smaller the element size the greater is the accuracy in the results.

4.3.4 SETUP

Use the Setup cell to launch the appropriate application for that system. You will define your loads, boundary conditions, and otherwise configure your analysis in the application. The data from the application will then be incorporated in the project in ansys workbench, including connections between systems. For the mechanical application systems, you will see the following setup options, in addition to the common options.



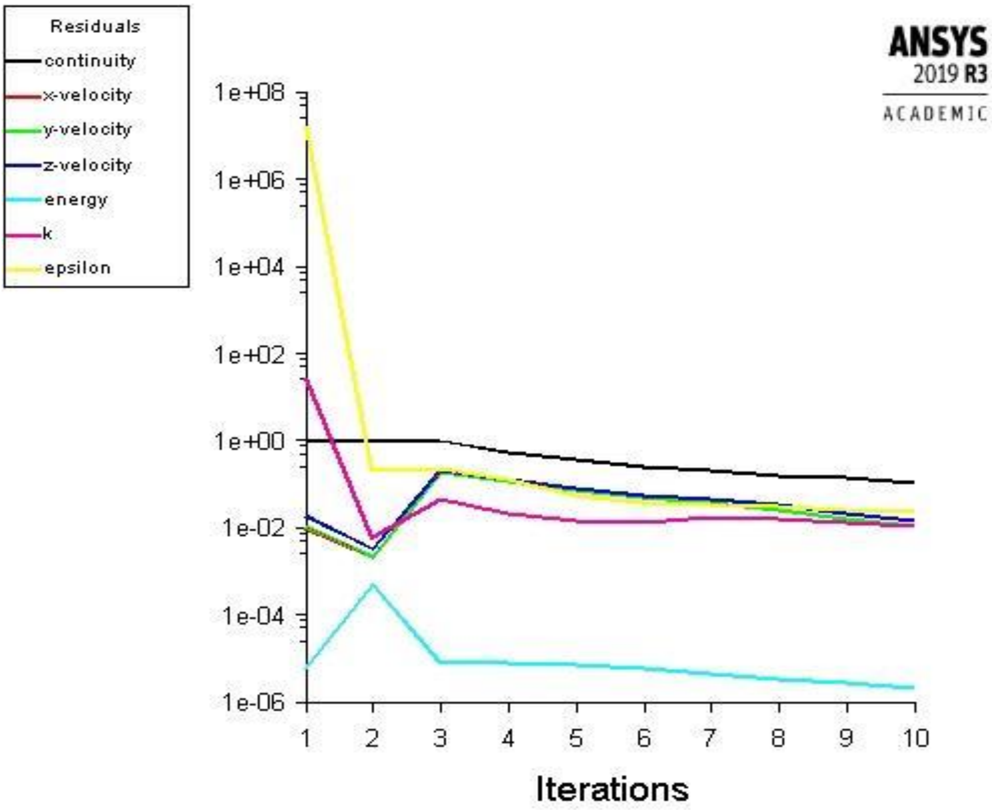
the calculation. Now right mouse click on the Boundary conditions option which is available in the left side toolbox. Click on insert and then select thetemperature

Domain	Boundaries	
design1_solid	Boundary - base_temp contact_region src	
	Type	INTERFACE
	Boundary - faces contact_region src	
	Type	INTERFACE
solid	Boundary - contact_region trg	
	Type	INTERFACE
	Boundary - inlet	
	Type	VELOCITY-INLET
	Boundary - outlet	
	Type	PRESSURE-OUTLET
	Boundary - wall solid	
	Type	WALL

Table 4 Boundry Condition

Now the initial boundary condition is given as above fig.10. In this thermal analysis, the initial condition is given at the heater i.e., the maximum temperature at which the conduction of the fin starts. The required temperature value can be given beside the magnitude option. After giving the temperature value, select all the faces of the solid body where the temperature is to be applied Here the temperature is given to the source as an input i.e., the initial boundary condition.

A graph is shown in the below graphic window which indicates the temperature variation along the fin. The second boundary condition is the convection along the fin. Now in the graphic window, right mouse click on the steady state thermal and then click on insert, then click convection. Here the value of heat transfer coefficient is given according to the calculations.



Graph 1 FFF Setup output Scaled Residual

The convection is applied only to the fin surface. Hence the value of heat transfer is to be calculated earlier based on the attained temperature values. Now give the value of heat transfer coefficient in the toolbox beside the film coefficient in the left side bottom box. Select all the surfaces on the fin and then click apply so that the convection is applied on the fin. The ambient temperature can be defined based on the requirement. Generally the ambient temperature refers to the temperature inside the duct where the air flow takes place. In this case the ambient temperature can be considered as the atmospheric temperature as 25°C. The convection is applied on the surface of the fin. A tick mark is displayed on the left side of the convection option. Convection heat transfer coefficient depends on the surface area that is considered for the calculation. A graph is shown below the solid part which is straight along the length of the fin i.e., the convection takes place linearly along the length of the fin. The value of heat transfer coefficient changes based on the surface area considered and the initial boundary conditions of temperature.

4.3.5 SOLUTION

From the solution cell, you can access the solution branch of your application, and you can share solution data with other downstream systems (for instance, you can specify the solution from one analysis as input conditions to another analysis). If you have an analysis running as a remote process, you will see the solution cell in a pending state until the remote process completes. Displays the open dialog, where you can specify the solver results file to load. When the results file is loaded, the system will display only the solution cell and the results cell.

The solution in the ansys workbench gives the temperature distribution along the considered surface or fin. To get the temperature distribution, right mouse click on the solution and click on insert and then select thermalThe minimum temperature at the end indicates the heat transfer rate that has been taken place. The temperature of the fin decreases if the heat transfer increases.

The temperature distribution can be determined by using ansys workbench. The maximum temperature will be at the source and the minimum temperature will be at the end of the fin. The temperature gradually decreases from one end to other end based on the given heat transfer coefficient.

CHAPTER 5

RESULTS

After the evaluation of temperature distribution along the length of the fin, a path can be defined to analyze the variation in the temperature from source to the free end of the fin. Hence to define the path, construction geometry is to be considered. Now right mouse click on the model and then click insert. There select the construction geometry option. Now in this graphic window, the required path can be defined based on the given boundary conditions. Click on construction geometry, then select the path option. Here we require a path from the source to the free end of the fin. After the selection of path, the graphic window shows options where the required path can be defined.

5.1 TEMPERATURE DISTRIBUTION OF THE SOLID FIN WITH FORCED CONVECTION

We need to define the path based on two points i.e., the source and the end of the fin. Now select the first point at the source and then click apply. Again select second point at the free end of the fin and then click apply. then select the path option. Here we require a path from the source to the free end of the fin. the required path can be defined based on the given boundary conditions. Click on construction geometry, then select the path option. Here we require a path from the source to the free end of the fin. After the selection of path, the graphic window shows options where the required path can be defined. After the selection of path, the graphic window shows options where the required path can be defined. To generate the required path, we have to insert temperature in the solution option. After defining the path, insert temperature from the solution option available in the left side toolbox. Right mouse click on the temperature and then select evaluate all results. The required path will be generated as shown in the graphic window below.

The Temperature is Distributed from the base to the tip of the fins is Shown in the Contour image of the solid aluminium fin.

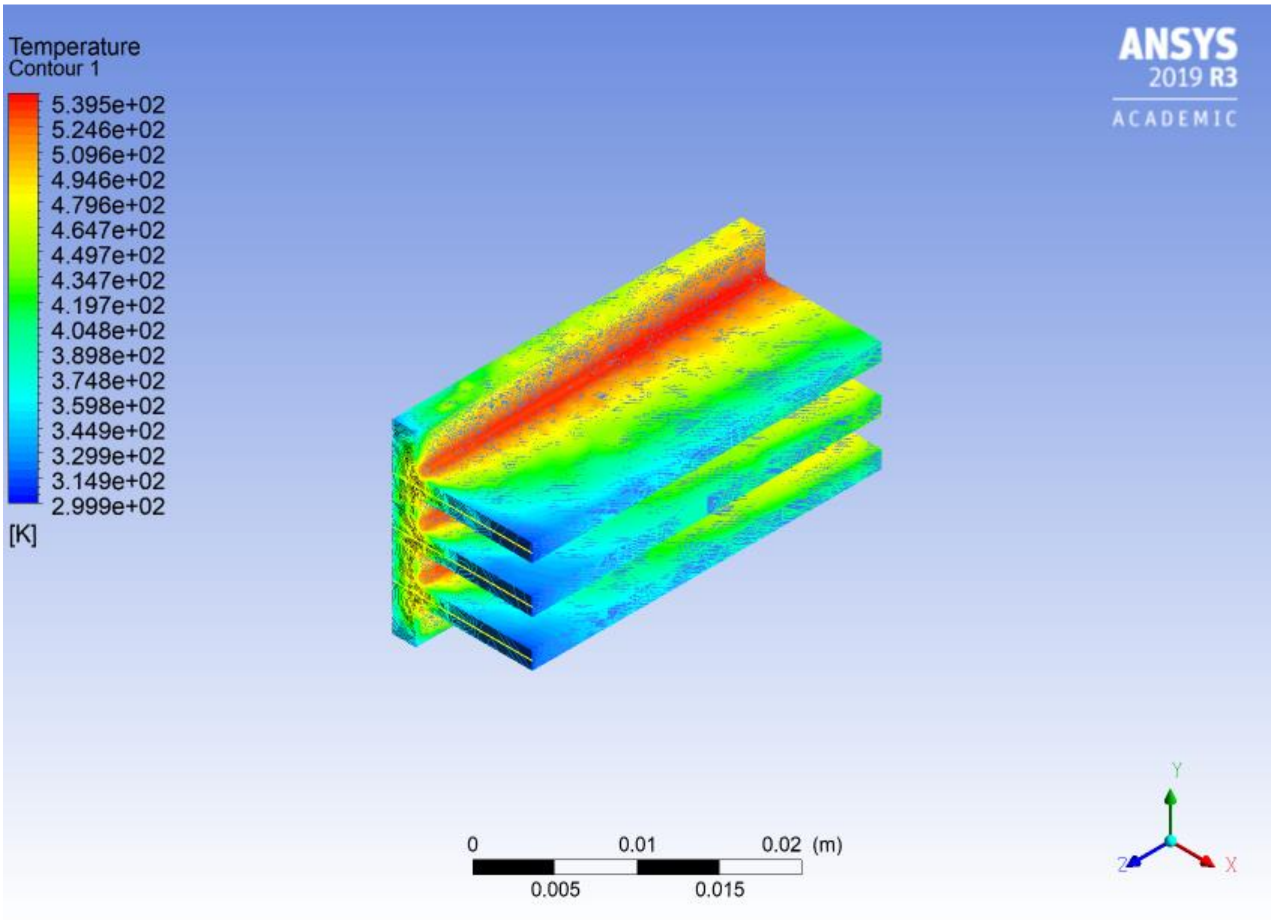


Fig 12 Temperature Distribution is the Solid Aluminium Fin

This shows how the Heat is Transfered Through the fins The maximum and minimum temperatures are defined based on the steady state thermal analysis. Now select the first point at the source and then click apply. Again select second point at the free end of the pin fin and then click apply. To generate the required path, we have to insert temperature in the solution option. The variation of temperature can be determined from point 1 to point 2. Here the path can be generated based on the given boundary conditions. The maximum and minimum temperatures are defined based on the Fluid Fluent analysis.

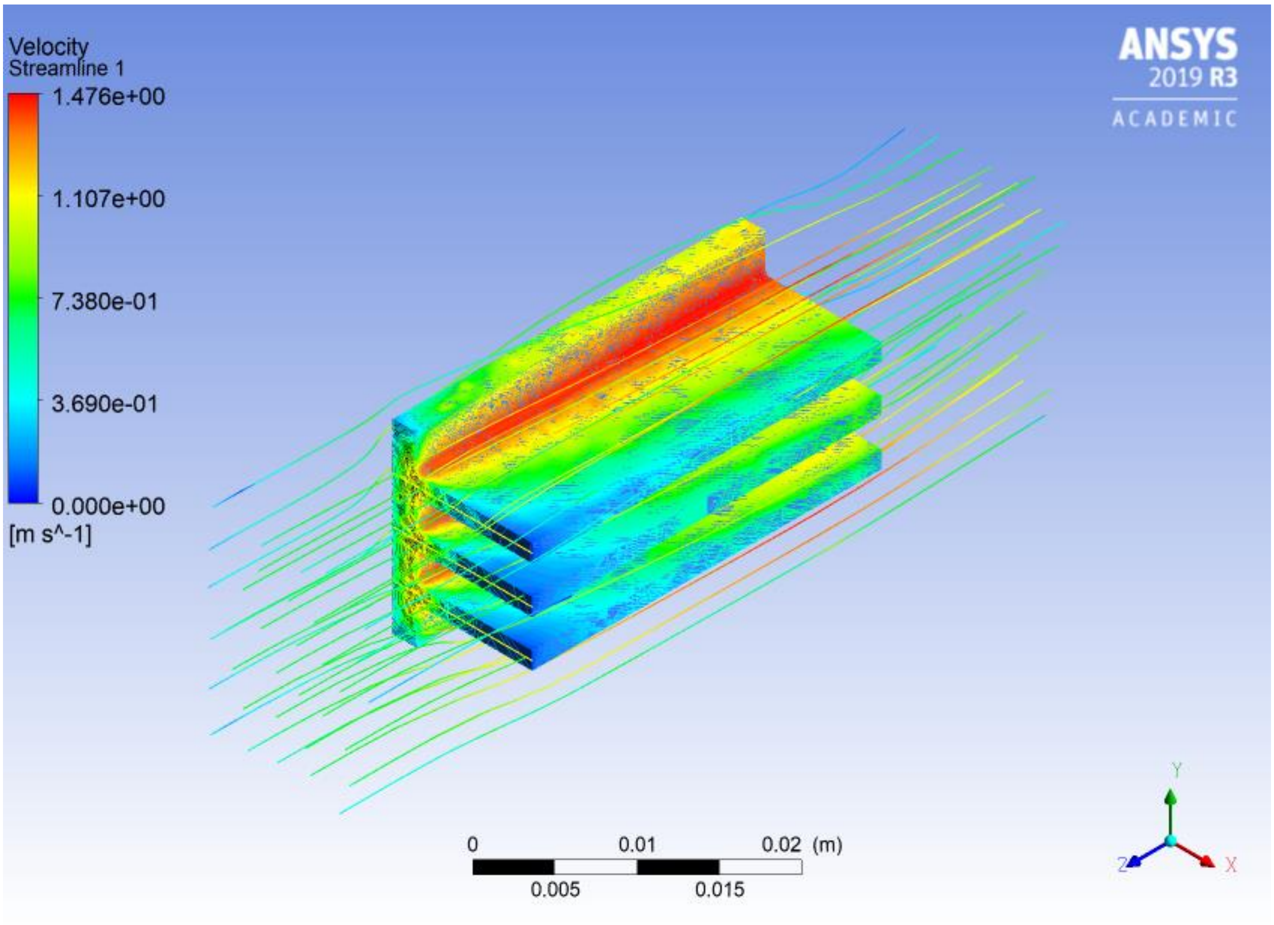
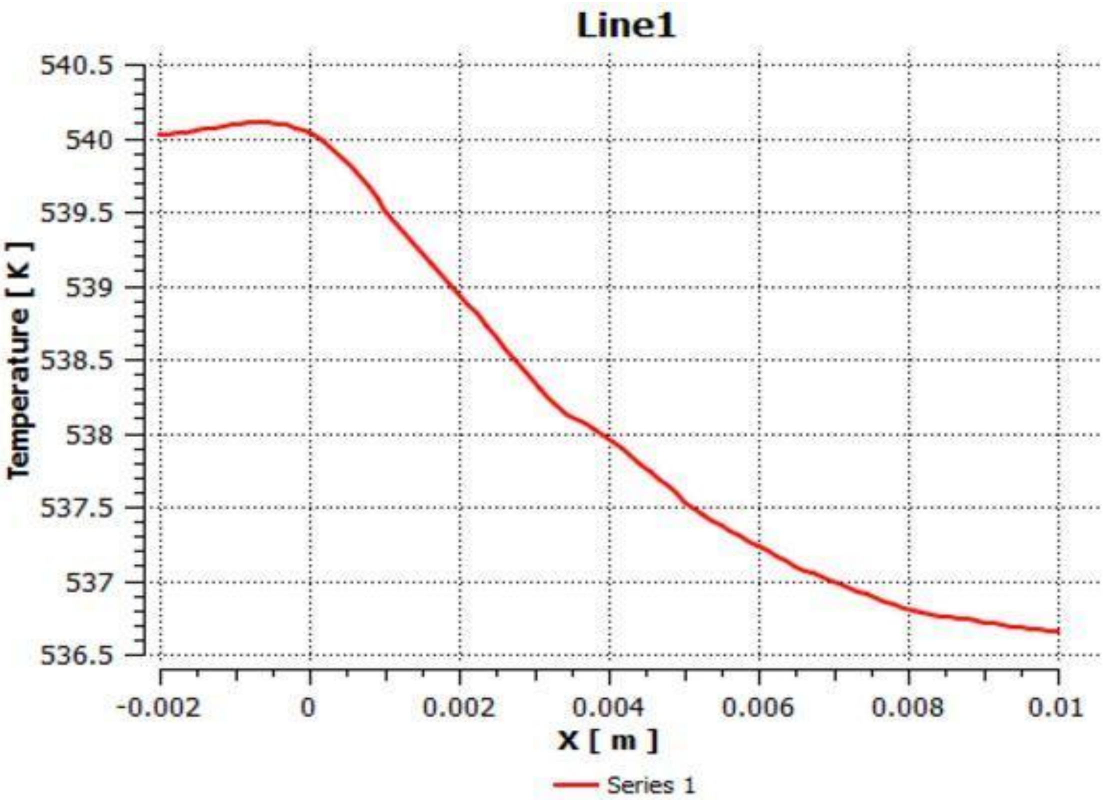
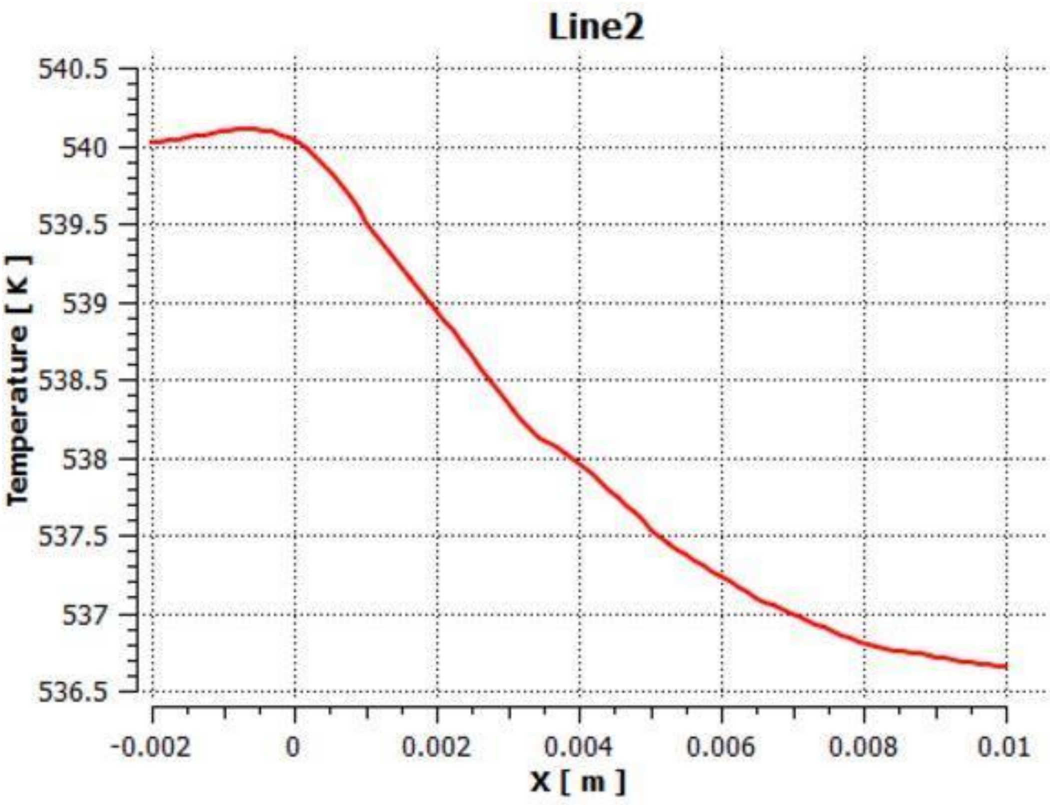


Fig 13 Temperature Distribution with Forced Convection

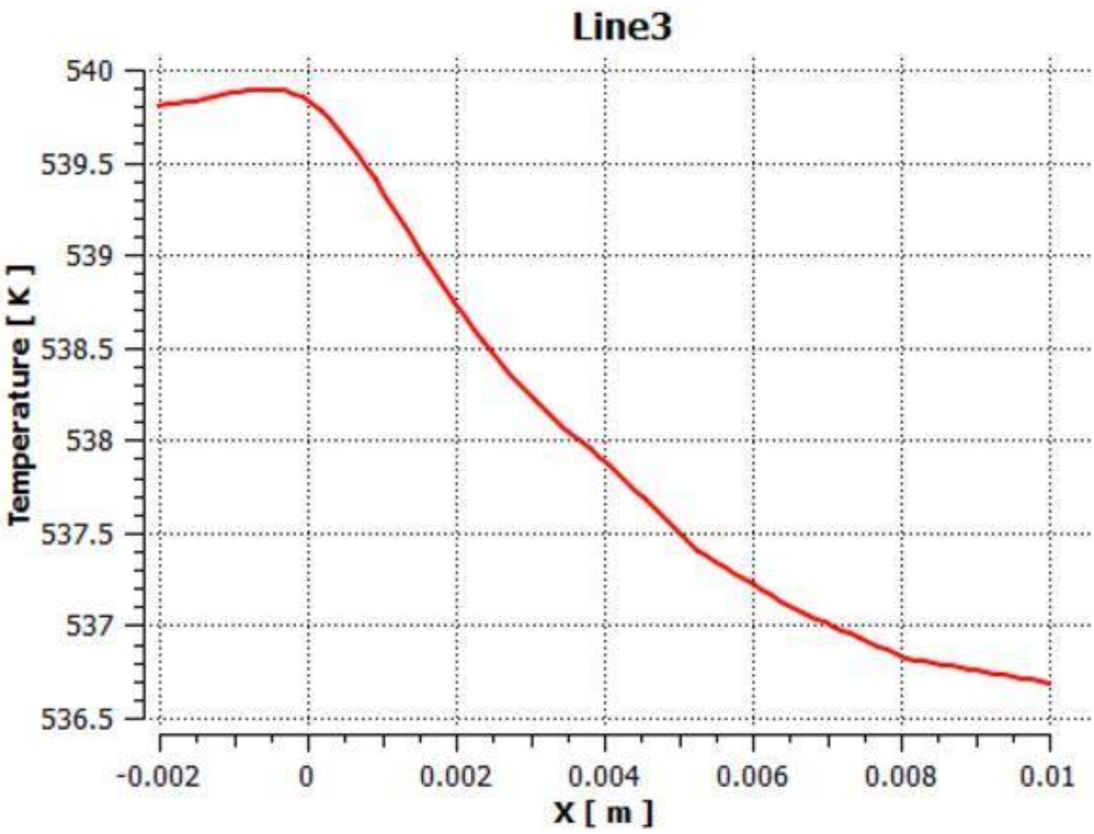
This analysis has been supplied to assist in the evaluation of tonal noise levels generated by low speed fans (Mach Number less than 0.4). The equations were obtained from available literature, however some equations may have alternate definitions. It is **your responsibility** to verify the accuracy of these definitions.



Graph 2 The Temperature Drop at the First Extended Surface



Graph 3 The Temperature Drop at the Second Extended Surface



Graph 4 The Temperature Drop in Third Extended Surface

The above graphs are represent that the temperature is droped on the various extended surfaces

The Outlet Temperature of the Air :

The Random Points are selected in the Outlet Plane and the Average of the Temperature is calculated

Pt1 = 309.89k	Pt2 = 307K	Pt3 = 333K
Pt4 = 381K	Pt5 = 400K	Pt6 = 387.9K
Pt7 = 408.1K	Pt8 = 431.3K	Pt9 = 427.38K
Pt10 = 426.98K	Pt11 = 316K	Pt12 = 318 K

Table5 The Outlet Air Temperature of the Solid fin

Average Outlet Temperature = ∑Pts ÷ No.of Points

Average Outlet Temperature = (309.8 + 307 + 333+ 381.3 + 400 + 389.8 + 408.8 + 431.3 + 427.4 + 426.87 + 316 + 318) ÷ 12

Average Outlet Temperature of the Solid Aluminium Fin with Forced Convection = 348.71 K

5.2 TEMPERATURE DISTRIBUTION OF THE ALUMINIUM POROUS FIN WITH FORCED CONVECTION

The porous medium not only changes the flow field conditions and causes the frontal layer to thinner, but also the conduction heat transfer coefficient is usually higher than that of the fluid studied. As a result, the introduction of a porous medium into a fluid channel effectively improves the thermal transfer properties . Also, for open cellular porous media, the presence of multiple paths that are intense heat conductors can increase heat transfer; another reason is the increase in heat transfer, the flow of the porous matrix and its high mixing.

For the Porous Aluminium fin analysis the material should be changed as a Frozon to setup the Porosity of the Material.

5.2.1 SETUP OF POROUS ZONE

In the setup the porosity of the material is to be given for the accurate ananlysis of the porous fin. In the Fluid Fluent From the Left side of the option the Cell zone conditions are placed at there the property of the fluid is selected and edit that it flow through the porous media and give the porosity value of the aluminium porous which give in the above table 1 Property of aluminium porous foam.

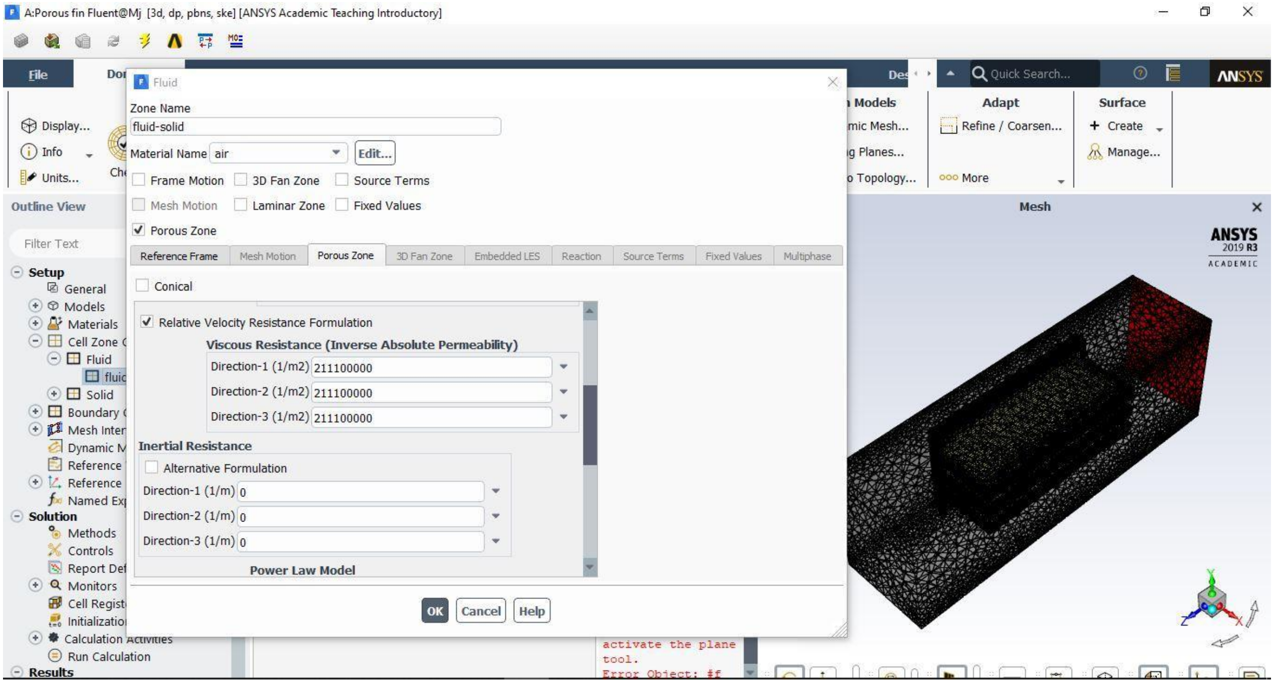
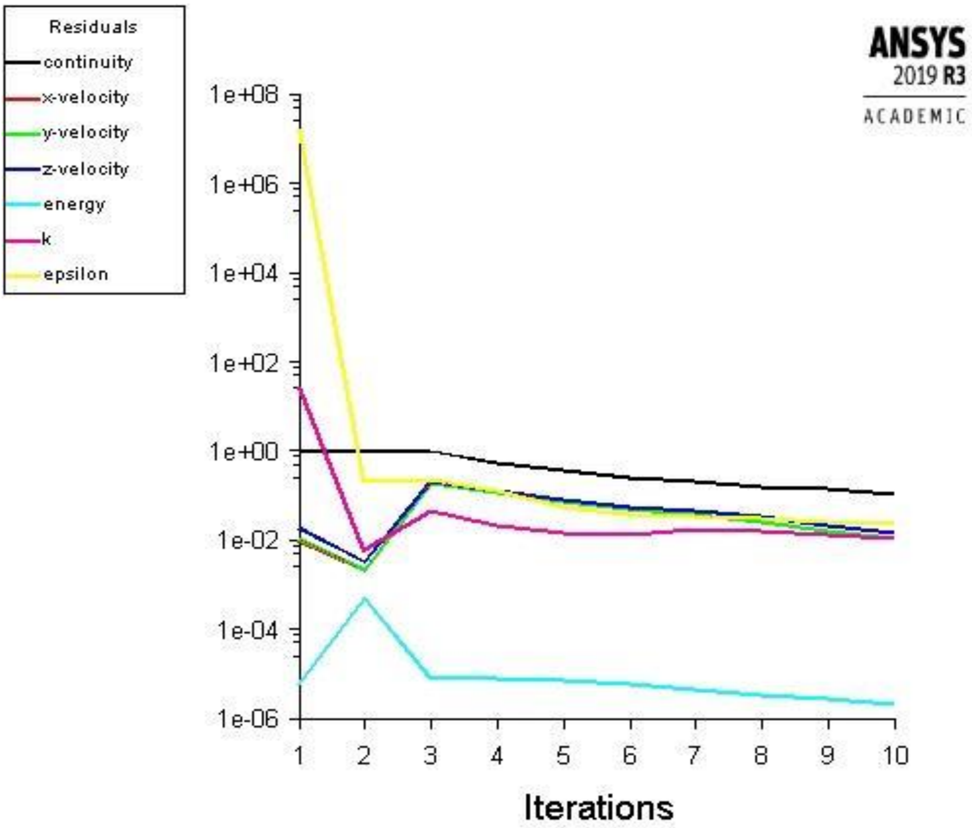


Fig 14 Porous Zone setup



Graph 4 FFF Setup Output of Porous Fin Residual

5.2.2 RESULT OF THE HEAT TRANSFER ANALYSIS OF POROUS ALUMINIUM FIN

The results of this study show that the use of porous material in the heat exchanger increases the total heat transfer coefficient of porous material and, in the best case, results in an improvement of about 7 times. Reducing porosity in the range of 0.95-0.8 increases the porosity of the porous material and the thermal conductivity coefficient, thus improving the heat transfer in the heat exchanger, although a reduction in porosity results in a significant drop in pressure**.**

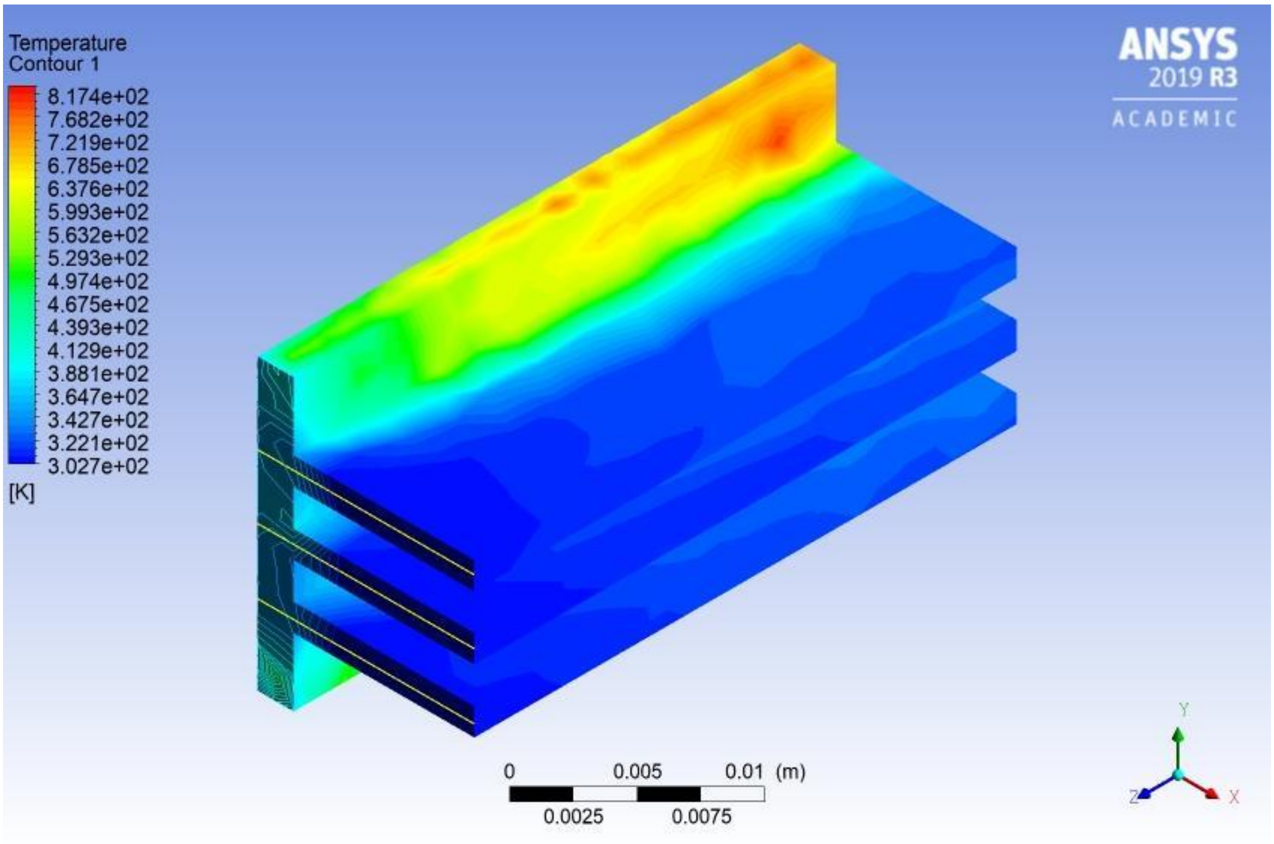


Fig 15 Temperature Drop in the Porous Aluminium Fin

The changes in the diameter of the porous material cavity in the range of 1 to 6 mm shows that increasing the diameter of the cavity increases the permeability and dimensions of the turbulent flow vortices in the porous medium, thereby increasing the turbulence of the flow and heat transfer And the pressure drop also decreases.

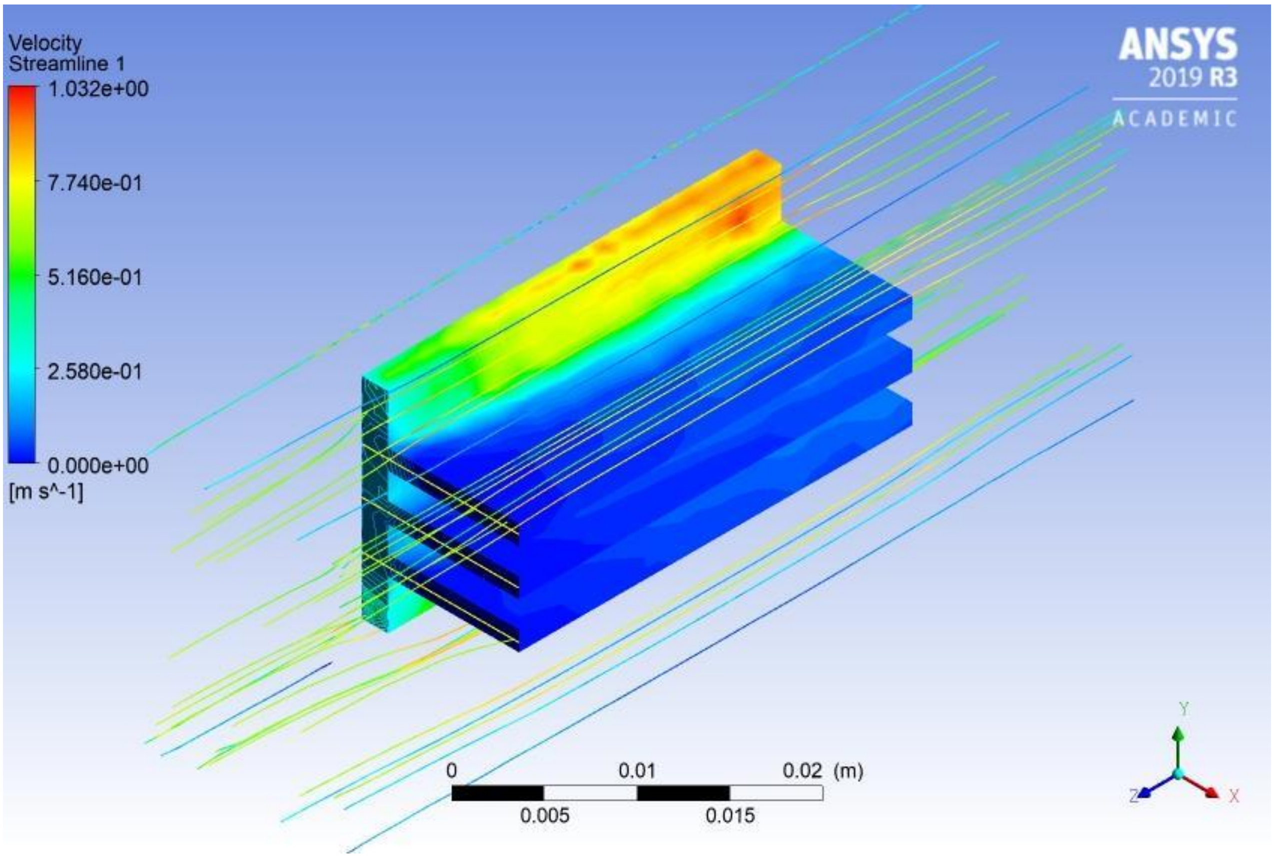
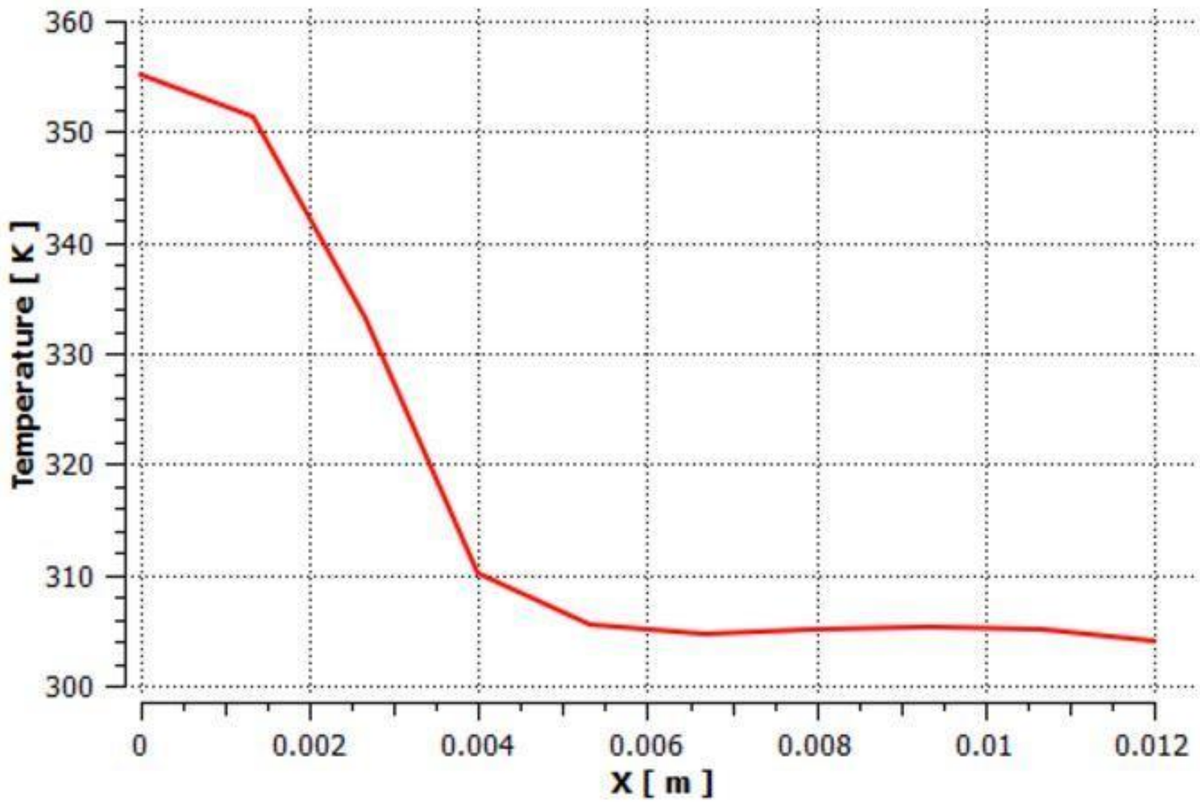
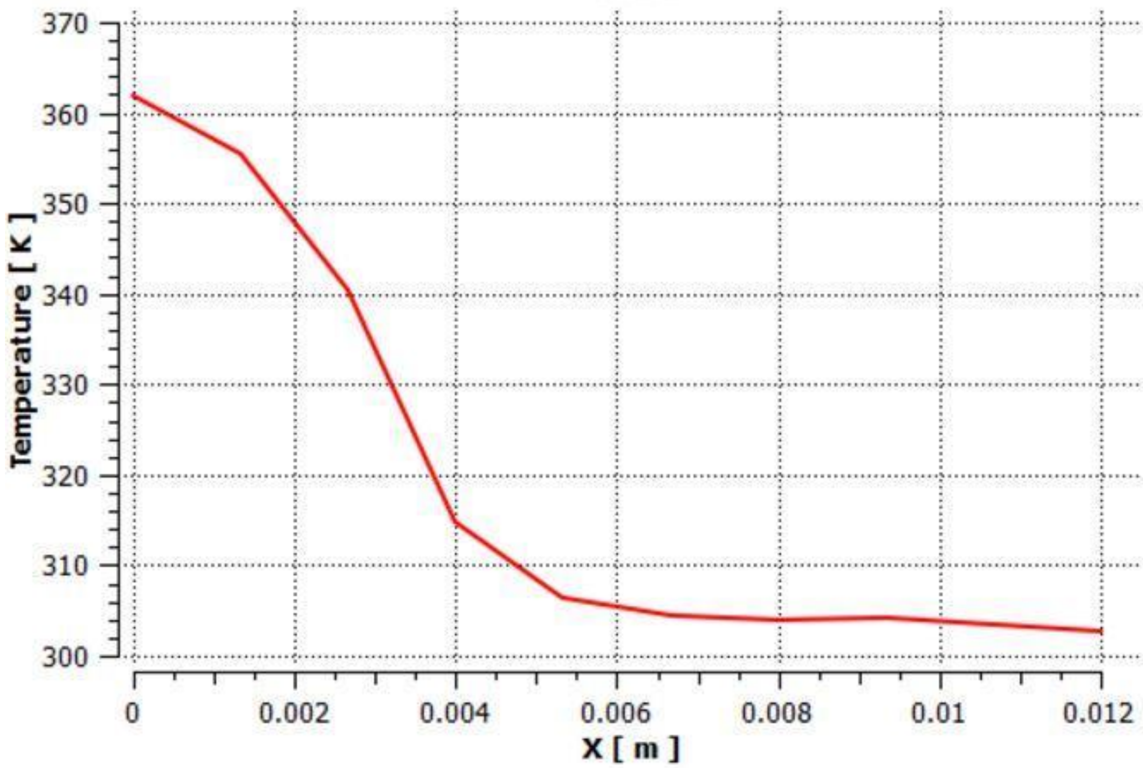


Fig 16 Temperature Drop in the Porous Aluminium Fin with Forced Convection

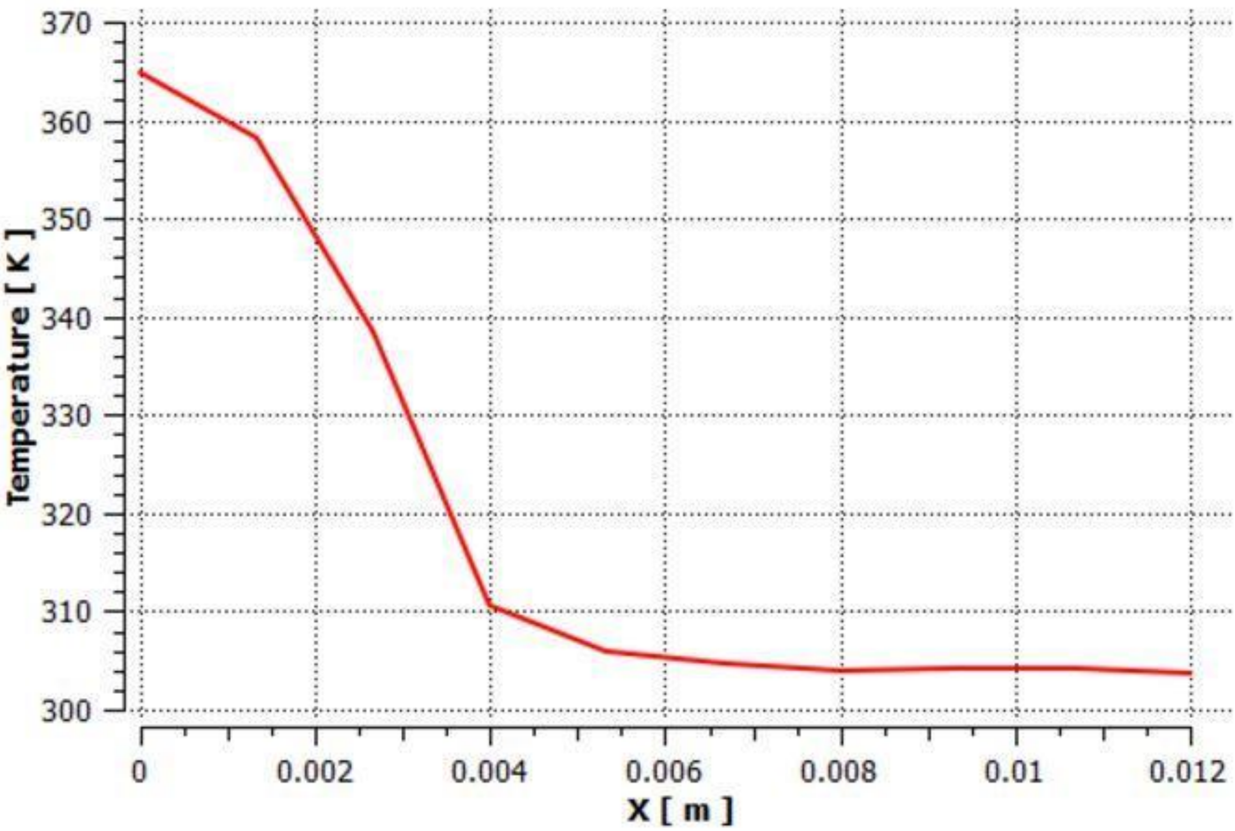
As the amount of this ratio increases, the total heat transfer coefficient of the heat exchanger increases and reaches the highest value for the porous material of copper. Another result was that changing the Reynolds number of the turbulent flow from 10,000 to 80,000 does not change the heat transfer efficiency. However, the results show that the ratio of improved heat transfer in the flow is more than confluent flow. Evaluation of the performance evaluation criterion shows that with increasing the diameter of the cavity and the thermal conductivity of the porous material, the system performance can be improved, while the porosity increase of the porous material does not have much effect on this parameter.



Graph 6 Temperature Drop at First Porous Fin



Graph 7 Temperature Drop at Second Porous Fin



Graph 8 Temperature Drop at Third Porous Fin

The above graphs are represent that the temperature is droped on the various extended surfaces

The Outlet Temperature of the Air :

The Random Points are selected in the Outlet Plane and the Average of the Temperature is calculated

Pt1 = 300.27K	Pt2 = 300.1K	Pt3 = 308.6K	Pt4 = 423.65K
Pt5 = 489.6K	Pt6 = 316.6K	Pt7 = 324.6 K	Pt8 = 346.6K
Pt9 = 464.56K	Pt10 = 542.4K	Pt11 = 300.12K	Pt12 = 300.65K

Table 6 The Outlet Air Temperature Of the Porous Fin

Average Outlet Temperature = ∑Pts ÷ No.of Points

Average Outlet Temperature = (300.27+300.1+308.7+423.65+489.87+316.6+324.6+346.6+4665.56+542+300.12+ 300.65) ÷ 12

Average Outlet Temperature of the Porous Aluminium Fin with Forced Convection = 372.481 K

The results of the second definition of Nusselt number show the increase of heat transfer in the tube with the porous porcelain boundary arrangement. This is completely compatible with the physics of the problem, and as such, the use of this definition is appropriate for calculating the Nusselt number in the boundary arrangement of the porous material. In another study, the numerical study of the effect of aluminum-oxide nanowire on the heat transfer in a tube containing porous material was investigated with a mixed flow of fluid [28]. Thermal tubes have been studied in four different structures without porous material, filled ith porous material, boundary and central makeup of porous material. The results show that the use of nanofluidis improves the thermal conductivity of the entire nanofluid and porous material in the tube section. As the porous material is located in the central arrangement, the total conductivity coefficient at the adjacent wall of the pipe shows the most improvement, and thus the heat of entering the fluid in this case has the highest increase. As the porous material is placed adjacent to the wall of the pipe, ie the border arrangement and the state of the porous material, due to the thermal

conductivity of the porous material, the effect of nanoparticles on the total thermal conductivity is lower and, as a result of heat transfer Moving is a better place for improvement.

CHAPTER 6

CONCLUSION

From the investigation the following conclusion were made:

- ❖ It is found that the temperature drop along the Solid fins is consistently Lower than that for the Porous aluminium fins.
- ❖ It is found that the heat transfer rate is more for the Porous Aluminium Fin when compared to the Solid Fin.
- ❖ Average Outlet Temperature of the Solid Aluminium Fin with Forced Convection = **348.871 K**
- ❖ Average Outlet Temperature of the Porous Aluminium Fin with Forced Convection = **372.481 K**
- ❖ By Comparing both the outlet Temperature the Porous Fins Outlet Temperature is Higher than the Solid Fin Which Means the Convection Rate is Higher than the Solid Fin
- ❖ Therefore The Conclusion is That By using The Porous Medium Material the Rate of Heat Transfer of Convection is Increased
- ❖ The Efficiency of the Machine is increased by the increase of Heat Transfer rate

CHAPTER 7

REFERENCES

[1]. R. Sam Sukumar, G.Sriharsha, S.Bala Arun, P.Dilip kumar, Ch.Sanyasi Naidu,Modelling and Analysis of Heat Sink With Rectangular Fins Having Through Holes”,Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 2, March – April 2013, pp.1557-1561.

[2]. Deepak Gupta, Vignesh Venkataraman, Rakesh Nimje, “Thermal Analysis of Heat Sink and its application in CPU”, International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 8, August 2014).

[3]. Mr. N. Phani Raja Rao, Mr. T. Vishnu Vardhan, “Thermal Analysis of Engine Cylinder Fins By Varying Its Geometry and Material”, International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 8, August – 2013

[4]. S.S. Sane, N. K. Sane, G.V.Parishwad, “Computational Analysis of Horizontal Rectangular Notched Fin Arrays Dissipating Heat by Natural Convection”, 5th Thermal-Sciences Conference, The Netherlands, 2008

[5]. Nocedal J & Wright S. (1999), Numerical Optimization. New York: Springer.

[6]. Pudiri Madhu, N. Sateesh, “Modeling and Simulation of Fins for 150cc Engine”, Volume - 5 | Issue - 1 | Jan Special Issue - 2015 | ISSN - 2249-555X

[7]. Qusay R. Al-Hagag, Bassil M. Hadi, Mohammed Y. Al-Janabi, “Optimum Design of Rectangular Plate Heat Sink”, International Journal of Engineering Science and

Technology, Vol. 2(9), 2010, 4051- International Journal For Technological Research In Engineering Volume 3, Issue 3, November-2015 ISSN (Online): 2347 – 4718

[8]. Hussam Jouhara, "Modelling and Simulation Techniques for Forced Convection Heat Transfer in Heat Sinks with Rectangular FinsSchool of Engineering and Design, Brunel University, Uxbridge.

[9]. Salila Ranjan Dixit, DrTarinicharana Panda, "Numerical Analysis of Inverted Notched Fin Array Using Natural Convection", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 6, Issue 4 (May. Jun. 2013), PP 47-56

[10]. Pratul Biswas, "Analytical Model for Performance Analysis of a Two dimensional Fin Assembly under Dehumidification Process: A Comparison of One and Two Dimensional Investigation", Jadavpur University.

[11]. Y. Chung and K. Luo,‖ Unsteady heat transfer analysis of an impinging jet‖, J. Heat Transfer, 124 (2002) 1039-48.

[12]. B.Sri Aravindh, "Heat Sink Performance Analysis through Numerical Technique", IEEE Symposium (NSSP08), Bangalore, 2008.

[13]. Saitoh, T., Sajik, T., and Maruhara, K., 1993, "Benchmark Solutions to Natural Convection Heat Transfer Problem Around a Horizontal Circular Cylinder," Int. J. Heat Mass Transfer, 36 pp. 1251-1259.

[14] D. A. De Vries, The theory of heat and moisture transfer in porous media revisited, International Journal of Heat and Mass Transfer, vol. 30, Issue 7, pp. 1343-1350, 1987.

[15] C. L. Tien, K. Vafai, Convective and radiative heat transfer in porous media, Advances in Applied Mechanics, vol. 27, pp. 225-281, 1989.

[16] R. Webb, Performance evaluation criteria for use of enhanced heat transfer surfaces in heat exchanger design, International Journal of Heat and Mass Transfer, Vol. 24, No. 4, pp. 715-726, 1981.

[17] R. Webb, E. Eckert, Application of rough surfaces to heat exchanger design, International Journal of Heat and Mass Transfer, Vol. 15, No. 9, pp. 1647- 1658, 1972.

[18] Whitaker, S. "Flow in porous media I: A theoretical derivation of Darcy's law, Transport in porous media, vol. 1, Issue 1, pp. 3-25, 1986.

[19] S. Ergun, Fluid flow through packed columns, Chem. Eng. Prog, Vol. 48, No. 2, pp. 89-94, 1952.

[20] R. L. Webb, Principle of Enhanced Heat Transfer, second Edition, New York: CRC Press, 2005.

[21] G. Lauriat, G. Riad, Forced convective heat transfer in porous media, New York: Dekker, 2000.

[22] A. A. Mohamad, Heat transfer enhancements in heat exchangers fitted with porous media. Part 1: Constant wall temperature, International journal of Thermal Sciences, vol. 42, Issue 4, pp. 385-395,2003.

[23] M. Siavashi, H. R. Talesh-Bahrami, H. Saffari, Numerical investigation of flow characteristics, heat transfer and entropy generation of nano-fluid flow inside an annular pipe partially or completely filled with porous media using two phases mixture model, Energy, vol. 93, Part 2, pp. 2451-2466, 2015.

[24] H. Shokouhmand, F. Jam, M. R. Salimpour, Simulation of laminar flow and convective heat transfer in conduits filled with porous media using Lattice Boltzmann Method, International Communications in Heat and Mass Transfer, vol. 36, Issue 4, pp. 378-384, 2009.

[25] M. Nazari, M. M. Shahmardan, S. Mosayebidorcheh, Analytical Solution of Steady Heat Transfer in a Multi-Layer Porous Media under Local Thermal Non-Equilibrium Condition, Modares Mechanical Engineering, vol. 12, Issue 4, pp. 1-8, 2012. (in Persian)

[26] M. Maerefat, A. Jamarani, M. Eshagh-Nimvari, Numerical study of heat transfer in double-tube heat exchanger filled with porous material in a turbulent fluid flow, Modares Mechanical Engineering, vol. 16, Issue 3, pp. 173-184, 2016. (in Persian)

[27] M. Maerefat, A. Jamarani, M. Eshagh-Nimvari, Introducing proper definition of the Nusselt number for fluid flow in pipe partially filled with porous media, Modares Mechanical Engineering, vol. 15, Issue 6, pp. 278-286, 2015. (in Persian)

[28] M. Maerefat, A. Jamarani, M. Eshagh-Nimvari, Numerical investigation of nanofluid's effect on heat transfer in a pipe partially filled with porous material in a turbulent fluid flow, Modares Mechanical Engineering, vol. 16, Issue 6, pp. 255-258, 2016. (in Persian)

[29] H. Hamidi-Moghadam, M. Daie, H, Amiri, H. Erfan-Niya, Investigating the effects of viscous dissipation on compulsory displacement inside the porous cylindrical channel and solving the governing equations, Accessed on 17 April 2014;

[30] H. Shokouhmand, A. Ejlali, Study of heat transfer in an array of two-dimensional porous fins, Journal of the College of Engineering, vol. 39, Issue 1, pp. 31-40, 2005. (in Persian)

[31] M. R. Rezaie, M. J. Maghrebi, Numerical investigation of conjugate natural convection heat transfer in porous enclosure with lattice Boltzmannnmethod, Journal of Solid and Fluid Mechanics, vol. 5, Issue 2, pp. 217-231, 2015. (in Persian)