NUMERICAL ANALYSIS OF HEAT TRANSFER THROUGH FINS

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Abstract :

In this paper we present Multi-dimensional heat transfer problems that can be approached in a number of ways. Analytical approach using the Laplace equation involves according the solutions of differential equations. The analysis we can get complex fin analysis depending on boundary conditions, often involving advanced mathematics using Fourier series and other special functions. A more practical approach is the use of numerical methods. The finite difference method seems to provide a good approach as using these complex problems with a variety of boundary conditions. With the help of FDM method Rectangular problem and a circular profile were examined.

Index Terms **:** Heat Transfer, Rectangular fin, Circular fin, Finite Difference Method**.**

I. INTRODUCTION

The Fin is a major component used in many systems for increasing the rate of heat transfer. In order to cool the system, fins are provided on the surface of the system to increase the rate of heat transfer. By doing thermal analysis on the fins, it is helpful to know the heat dissipation and rate of heat transfer in different types of fin. We know that, by increasing the surface area of pin configuration we can increase the heat dissipation rate of this process, so designing such a large complex systems is very difficult. Therefore, fins are provided on the surface of the system to increase heat transfer.

For this principle of conduction, convection of a fin configuration determines the amount of heat and its transfers. Increasing the temperature difference between the fin configuration and the depends on the environment, slightly increasing the convection heat transfer coefficient, or slightly increasing the surface area of the pin configuration of the object increases the heat transfer. Sometimes it is not economical or it is not feasible to change the first two options. Adding a fin configuration, however, increases the surface area of circular, square and rectangular can sometimes be economical solution to heat transfer problems. The most common materials are Aluminium and Copper. Aluminium having the thermal conductivity value of 232.56W/m-K. It is mechanically soft. Good resistance to corrosion, excellent thermal conductivity, good electrical conductivity, low density is its good properties.

II. PROBLEM DESCRIPTION:

·Surface area Quite recently, as the demand for new devices with greater performance is aroused, thermal Management becoming major area of interest to boost heat removal volumes. The means for heat removal adopted till recent past are rapidly turn out to be incompetent to match growing demands. The main challenge to be faced by the relevant experts in the field of thermal sciences is to come up with novel ideas and contemporary techniques to cope the enormous amount of heat management for present day performance necessities. For the achievement of efficient cooling by pin fin heat sinks, the discussion of elements that determine the cooling capability of any heat sink is of utmost importance

III. Objectives

Application of software in thermal analysis is not new. However, the cost of computation is very high in sophisticated software and their understanding demands greater skill for a proper solution. In view of the above and for deeper understanding of the software study of a numerical method and its application in heat transfer from fins is carried out in the project. The objectives of the project are

1. To understand Finite Difference Method and its application in heat transfer from fins.
2. To develop algorithms for heat transfer analysis of fins with different geometries.
3. To compare numerical analysis result with experimental result to validate the numerical results

IV. Methodology:

We make use both Experimental and Numerical methods in this project. The experimental work is conducted to validate the numerical analysis through the software. Once the results are comparable with these parameters, we can choose the ANSYS software for analyzing different configurations of the fins.

Experimentation Work

The experimental work has been carried out in HMT Lab for circular fin of 20mm diameter and 155mm fin length for natural convection.

Experimental Working Setup

The experimental setup environment is suitable for our Numerical analysis to carry out the project. Hence, we utilize the above setup to carry out further steps and validate the numerical analysis.

Finite Difference Modeling of Fins

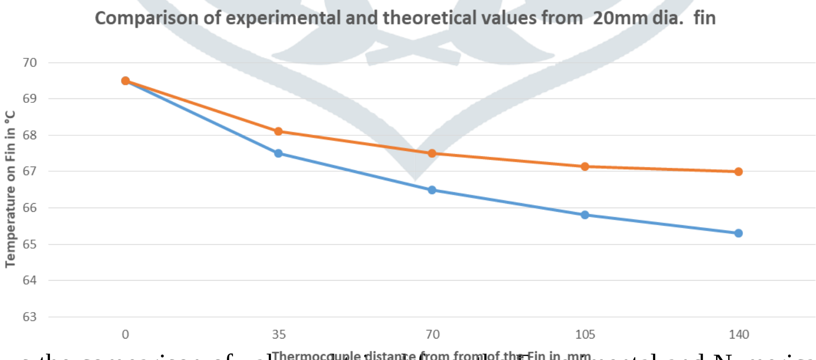
Availability of high speed computers makes it possible for today's engineer to find answers for highly complicated problems of thermodynamics and heat transfer. Though many software are available for thermal analysis, it is required to understand the calculations that is carried out by the software in the background to avoid any possible pitfall. Finite difference method is one of the methods that is used as numerical method of finding answers to some of the classical problems of heat transfer. Present section deals with the fundamental aspects of Finite Difference Method and its application in study of fins.

Finite Difference Method (FDM)

The numerical methods for solving differential equations are based on replacing the differential equations by algebraic equations. In case of finite difference method, this is achieved by replacing the derivatives by differences. This is achieved using ANSYS software.

V. Results and Discussion

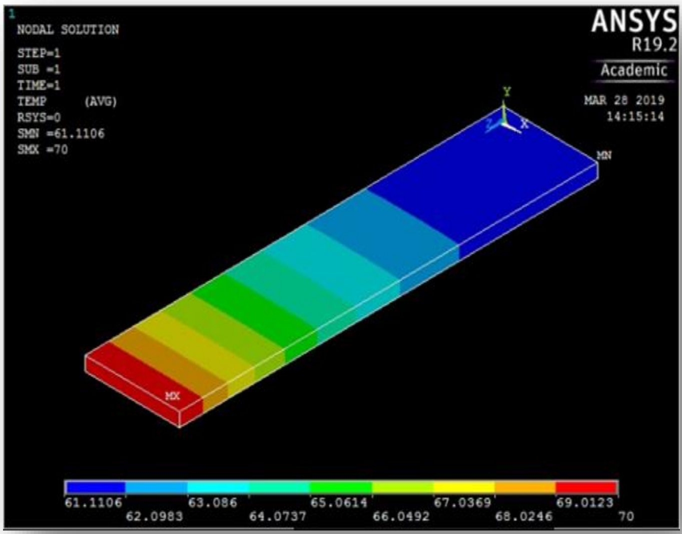
In the present study, 2 different types of fins having different dimensions namely Rectangular fin and Circular fin have been used in order to find out the most efficient type.

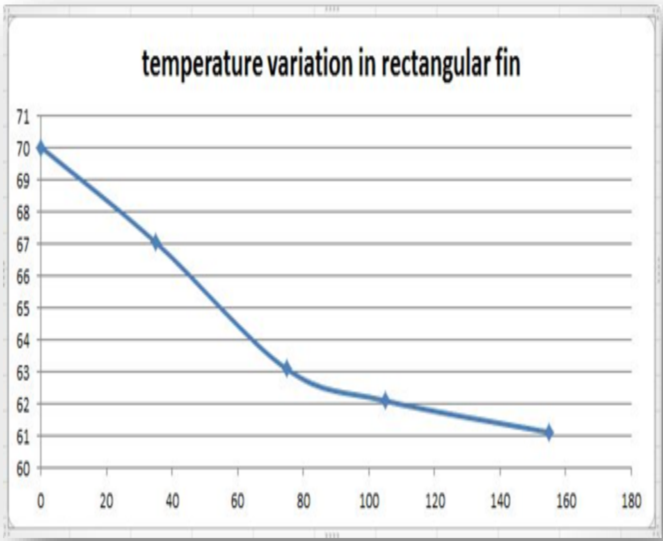


The above graph shows the comparison of values obtained from the Experimental and Numerical analysis and there is only about a slight degree of variation in the temperature i.e, about 2°C of variation. So, the result obtained from the Numerical analysis is about 90% accurate.

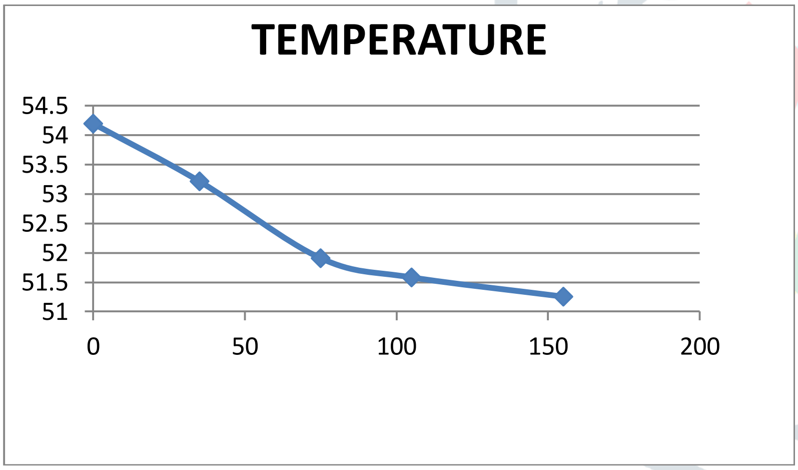
HEAT TRANSFER THROUGH A FIN OF RECTANGULAR CROSS SECTION WITH **LENGTH L=155MM, BASE THICKNESS B=5MM AND WIDTH W=35MM** AS SHOWN IN FIGURE IS CONSIDERED AND FINITE DIFFERENCE MODEL OF THE FIN IS PRESENTED.

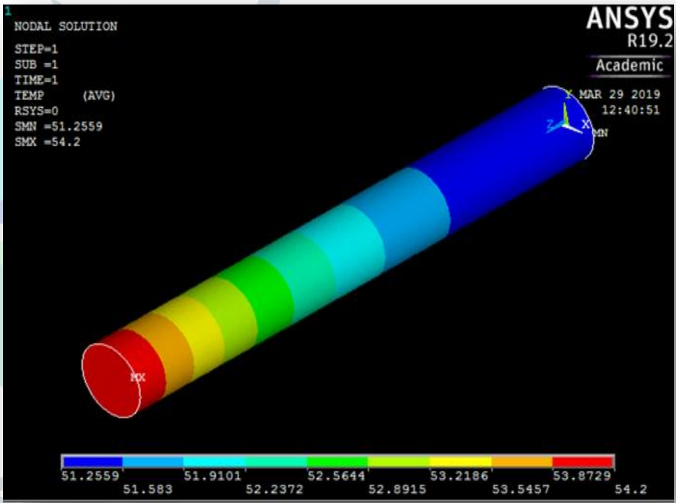
The figure below represents the temperature distribution through a Rectangular fin and how the temperature decreases over the length.





Heat transfer from a fin of cylindrical cross section with **radius r=10mm** and **depth d=155mm** as shown in figure is considered and finite difference model of the fin is:





The above figure represents the temperature distribution through a circular fin and how the temperature changes(decreases) over the length.

VI . Conclusion:

Experimental and Numerical studies have been made on fins of 2 different geometries viz. rectangular and cylindrical in free convection. Mathematical models of different geometries were developed using experimental work with suitable boundary conditions These models can be used to analyze heat transfer performance of fins having circular or rectangular sections. By analyzing these models we conclude that the fin having Rectangular geometry of dimensions **Length L=155mm, base thickness b=5mm** and **width w=35mm**, transfers heat more efficiently when compared to the other dimensions and also by comparison with other geometry.

VII. ACKNOWLEDGEMENT

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