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THERMAL ANALYSIS AND PERFOMANCE COMPARISION OF VARIOUS CROSS SECTIONAL FINS USING FEM

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ABSTRACT

The heat transfer performance of fin is analyzed by several cross sectional design of fin i.e. Rectangular, trapezium, triangular and circular segmental. The heat transfer performance of fin with unchanged geometry which have various extensions and without extensions is compared. Approximate ranging 4% to 14% greater heat transfer can be reached with different extensions on fin as compare to unchanged geometry of fin without these extensions. Fin with various extensions are designed with the help of software Pro-E.

Analysis of fin performance done through the software ANSYS. In this thermal analysis, temperature variations of the fin is analyzed. Extensions on the finned surfaces is set while designing 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 yields the superior heat transfer than that of other extensions having the same length and width attached to finned surface. The effectiveness of fin with rectangular extensions greater as compare to other extensions on fin.

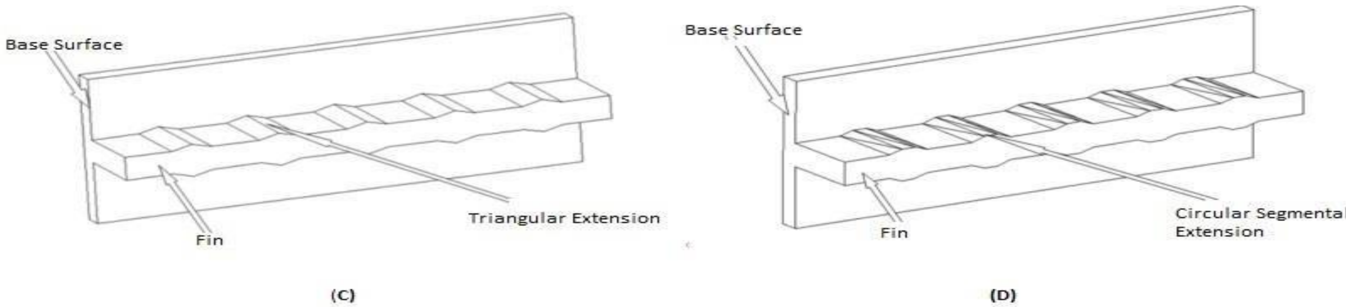
Keywords: Software Pro-E, ANSYS,

1. INTRODUCTION

For research problem the only way of increasing heat transfer rates in a heat-exchanger is to increase the surface area. One way of attaining this is through the use of extended or finned surfaces.

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 transfers from the base surface as compare to fin without the extensions provided to it.

Fig: 1.1 Types of extension provided on fin such as (a) Rectangular extensions, (b) Trapezium extensions, (c) Triangular extension, and



(d) Circular Segmental extension

There are two ways to increase the rate of heat transfer:

1. To increase the convection heat transfer coefficient h.

2. To increase the surface area As It is noted that: Increasing h may required the installation of a pump or fan, or replacing the existing one with a large one. The alternative is to increase the surface area by attaching to the surface extended surfaces called fins made of highly conductive material such as aluminum.

$$\dot{Q}_{conv} = hA_s(T_s - T_\infty)$$

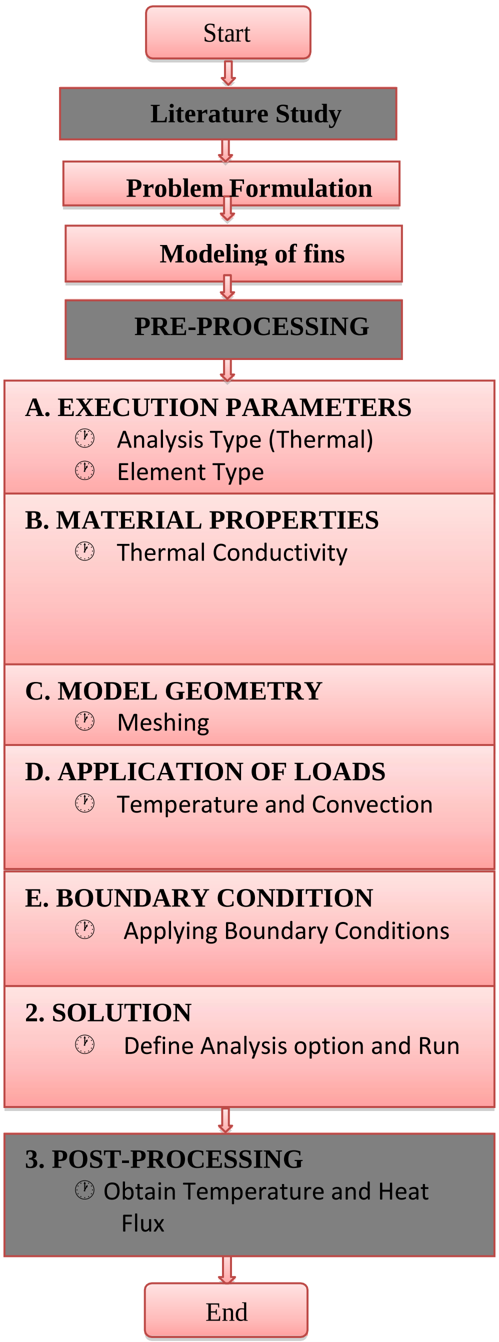
2. Literature survey Report Analysis

Fins are the most effective instrument for increasing the rate of heat transfer. As we know, they increase the area of heat transfer and cause an increase in the transferred heat amount. A complete review on this topic is presented by **Krause et al, 2002**. Many engineering devices generate heat during their operation. If this generated heat is not dissipated rapidly to its surrounding atmosphere, this may cause rise in temperature of the system components. This cause overheating problems in device and may lead to the failure of component **VS Daund et.al, 2014**. Fins or extended surfaces are known for enhancing the heat transfer in a system. Liquid-cooling system enhances better heat transfer than air-cooling system, the construction of air cooling system is very simpler. Therefore it is imperative for an air-cooled engine to make use of the fins effectively to obtain uniform temperature in the cylinder periphery **Magarajan U et.al ,2012**. Fin performance can be measured by using the effectiveness of fin, thermal resistance and efficiency. Triangular fins have applications on cylinders of air cooled cylinders and compressors, outer space radiators and air conditioned systems in space craft **Sandhya Mirapalli et.al,2015**.

It is very important to predict the magnitude of heat transfer in designing engine, hence it is the objective in various analysis to study the dissipation of heat as well as temp distribution on the cylinder for the engine model.**H.N. Gandate 2014. Aziz and Bouaziz, 2011** used the least squares method for predicting the performance of a longitudinal fin with temperature-dependent internal heat generation and thermal conductivity and they compared their results by Homotopy Perturbation Method (HPM), Variational Iteration Method (VIM) and double series regular perturbation method and found that the least squares method is simpler than other applied methods. **Razani and Ahmadi 1977**, considered circular fins with an arbitrary heat source distribution and a nonlinear temperature-dependent thermal conductivity and obtained the results for the optimum fin design. **Unal 1987**, conducted an analytical study of a rectangular and longitudinal fin with temperature dependent internal heat generation and temperature-dependent heat transfer coefficient.

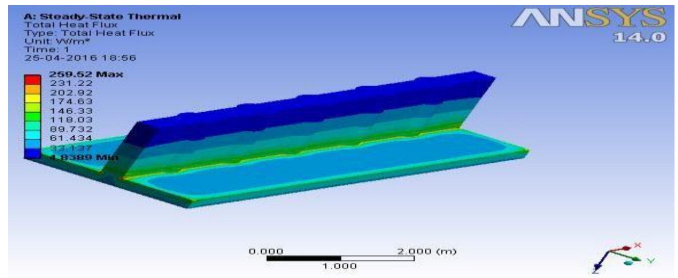
3. PROBLEM STATEMENT: The performance of fins with varying cross section and extension is designed and analyzed using Pro-E and ANSYS respectively. The results for fin shapes under variety of temperature along the fin length are observed. Also fin shapes are analyzed against varying ambient temperature. Finally the result and conclusion is discussed to nominate best and optimized type of fin shape with respect to performance.

4. METHODOLOGY: The complete methodology followed to perform this research can be plot and understand by single flowchart, which is shown below. This methodology is followed strictly step by step to find problem from literature, Model Bridge and further to analyze bridge model which is then followed by result, conclusion and future scope.

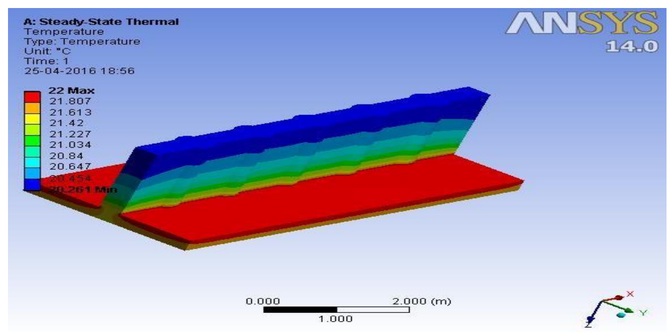


ANALYSIS

The model is created in Pro-E and than is imported to ANSYS for analysis purpose. The model is created uniquely for each type of fin extension. Meshing is than done for ANSYS model. Boundary conditions and material properties are than defined. Thermal analysis is performed for various fin extension types. Following figures are indicating the ANSYS view for circular type extension of fin.



Total heat flux for circular extension fin



Temperature along the length of circular extension fin

Length of Fin (mm)	FIN WITH DIFFERENT TYPES OF EXTENSIONS (Temp in degree C)				
	Rectangular	Trapezium	Triangular	Circular	No Extension
5	55.598	52.592	52.583	51.632	55.577
10	50.196	50.183	50.165	48.265	50.154
15	47.293	47.775	47.748	44.897	47.731
20	45.393	45.367	45.330	41.529	45.308
25	42.991	42.959	42.913	38.162	42.884
30	40.589	40.550	40.495	34.594	40.461
35	38.187	38.142	38.075	31.027	38.038
40	35.786	35.734	35.660	24.691	35.615

Fin Extension Type	Q$_{fin}$ in W at ambient temperature					
	30	28	26	24	22	20
Rectangular	**31.05**	**33.535**	**36.019**	**38.503**	**40.987**	**43.471**
Trapezium	**98.799**	**106.7**	**114.61**	**122.51**	**130.41**	**138.32**
Triangular	**78.202**	**79.058**	**84.914**	**90.77**	**96.626**	**102.48**
Circular	**117.7**	**121.37**	**116.05**	**96.993**	**79.842**	**84.681**
No Extension	**91.813**	**99.158**	**106.5**	**113.85**	**121.19**	**128.54**

7. Conclusion

1. Heat transfer through fin with rectangular extensions higher than that of fin with other types of extensions.
2. Temperature at the end of fin with rectangular extensions is minimum as compare to fin with other types of Extensions.
3. The effectiveness of fin with rectangular extensions is greater than other extensions.
4. Choosing the minimum value of ambient fluid temperature provide the greater heat transfer rate enhancement.

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