CFD Transient Thermal Analysis of Cylinder Fins with Triangular Holes by Using Different Materials

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Abstract- **Motors are ineffectual, so more warmth vitality enters the motor than turns out as mechanical power; the variety is squander warm which must be expelled. Inside ignition motors take out waste warmth through cool admission air, hot fumes gases, and unambiguous motor cooling. Motors with higher proficiency have more vitality clear out as mechanical movement and less as waste warmth. Some waste warm is important, it guides warm through the motor, much as a water wheel working just if there is some leave speed (vitality) in the waste water to divert it. Subsequently, all warm motors expect cooling to work.**

The cylinder block is an integrated structure comprising the cylinder of a reciprocating engine and regularly a few or the majority of their related encompassing structures (coolant passages, admission and fumes sections and ports, and crankcase). The term engine block is often utilized synonymously with "cylinder block" (albeit in fact refinements can be made between engine block cylinders as a discrete unit versus motor block structures with yet more reconciliation that involve the crankcase also).

In this investigation the model of motor cylinder block is structured and examined in the ANSYS 14.5. The primary spotlight on the investigation is to make as quick as warmth exchange from the cylinder block. For this the gaps are made in the cylinder block holes because of which the warmth exchange rates are expanded as quick. The near investigation of temperature, Heat transition and Directional warmth motion are breaking down for magnesium compound and Aluminium composites. The outcomes demonstrate that the cylinder block of Aluminium amalgam having circular holes with triangular holes is more powerful.

Index Terms- Cylinder block, Transient Thermal, ANSYS, Heat flux, Directional Heat Flux and Temperature.

I. INTRODUCTION

The Cylinder is the one of the significant segments in Motor, or, in other words high temperature varieties what's more, warm burdens. To cool the cylinder, blades are given on the surface of the cylinder to build the rate of warmth exchange rate. Balances are Basically Mechanical structures which are utilized to cool different structures through the procedure of convection and conduction. Expanded blades are notable for improving the warmth move in IC motors. The development of air cooling framework is exceptionally less complex. In this manner it is critical for an air-cooled motor to use the blades adequately to acquire uniform temperature in the Engine cylinder. An inner burning motor is a motor in which the ignition of a fuel happens in a burning chamber. Here, the extension of the high-temperature and high-weight gases created by burning applies coordinate power to segment of the motor, for example, cylinder, turbine cutting edges, or a spout. This power exchanges the segment over a separation, creating helpful mechanical vitality.

Air cooled motors are supplanted by water cooled motors which are more effective, yet each of the bikes utilizes Air cooled motors, since Air-cooled motors are lighter weight and lesser space prerequisite. What's more, in the wake of changing over the warmth to control Excess warmth must be evacuated cycle. The warmth is moved to the climate by methods for liquids water and air. In motors, warm is moved to the climate by liquids low temperature. Due to burning procedure Engine temperature isn't steady all through the power. On the off chance that overabundance warm isn't expelled, motor segments bomb because of extreme temperature.

The motor of the warmth will move to the air of the liquid temperature is low. As a consequence of the ignition procedure. Motor temperature does not meet the whole power supply. In the event that abundance warms are never erased, motor parts because of over the top temperature. Warmth from the regions of high-temperature zones of low temperature as appeared in the following figure the region beneath. At the point when motor oil is oxidized (consuming) warm age. The extra warmth produced by grating between moving parts. Just around 30% of the vitality discharged is changed over into helpful work. Whatever remains of the frame (70 percent) must be expelled from the motor to anticipate parts liquefied.

Fins are utilized as heat exchange fins to manage temperature in heat sinks or radiators. In the investigation of heat exchange, fins are surfaces that expand the rate of heat exchange to or from the earth by expanding convection. Expanding the temperature angle between the protest and the earth, expanding the convection heat exchange coefficient or expanding the surface region of the protest expands the heat exchange. Adding a balance to a protest expands the surface region and can be prudent answer for heat exchange issues. Generally, the reason and significance of fins as heat exchangers is to exchange heat from any segment which is subjected to temperature which makes harm it except if it is dispersed. This wonders were a basic criterion for the beginning of Fins as a heat exchanger in Engines, particularly Inner Combustion motors.

II. LITERATURE REVIEW

Various researches carried out in past decade shows that heat transfer through fin depends on number of fins, fin pitch, fin design, wind velocity, material and climate conditions.

N. Nagarani et.al. [2010] analysed the heat transfer rate and efficiency for circular and elliptical annular fins for different environmental conditions. Elliptical fin efficiency is more than circular fin. If space restriction is there along one particular direction while the perpendicular direction is relatively unrestricted elliptical fins could be a good choice.

Normally heat transfer co-efficient depends upon the space, time, flow conditions and fluid properties. If there are changes in environmental conditions, there are changes in heat transfer co-efficient and efficiency also.

S.H. Barhatte et.al. [2011] natural convection heat transfer from vertical rectangular fin arrays with and without notch at the center have been investigated experimentally and theoretically. In a lengthwise short array where the single chimney flow pattern is present, the central portion of fin flat becomes ineffective due to the fact that, already heated air comes in its contact. In the present study, the fin flats are modified by removing the central fin portion by cutting a notch.

Masao Yoshidaet.al.[2012] investigated effect of number of fin, fin pitch and wind velocity on air-cooling using experimental cylinders for an air-cooled engine of a motor-cycle in wind tunnel. Heat release from the cylinder did not improve when the cylinder had the more fins and too narrow a fin pitch at lower wind velocities, because it is difficult for the air to flow in to the narrower space between the fins, Therefore, the temperature between them increased. They have concluded that the optimized fin pitches with the greatest effective cooling are at 20 mm for non-moving and 8mm for moving.

Pulkit Agarwal et.al. [2017] simulated the heat transfer in motor cycle engine fan using CFD analysis. It is observed that ambient temperature reduces to the very low value; it results in over cooling and poor efficiency of the engine. They have concluded that over cooling also affects the engine efficiency because over cooling excess fuel consumption occurs.

Munukuntla Vidya Sagar et. al. [2017] simulated a cylinder fin body using SOLIDWORKS and transient thermal analysis done on ANSYS. These fins are used for air cooling systems for two wheelers. In present study, Aluminum alloy is compared with Magnesium alloy. The various parameters (i.e., geometry and thickness of the fin) are considered, by reducing the thickness and also by changing the shape of the fin to circular shape from the conventional geometry i.e. rectangular, the weight of the fin body reduces there by increasing the heat transfer rate and efficiency of the fin. The results show, by using circular fin with material Aluminum Alloy is better since heat transfer rate of the finis more. By using circular fins, the weight of the fin body reduces compared to existing rectangular engine cylinder fin.

They concluded that the value of surface heat transfer coefficient varies mainly with air velocity and the space between fins. The effect of the other fin dimensions is small.

Lots of research has been done for the increment in heat transfer rates of heat exchange but very less research work has been carried out in the case of engine cylinder fins with holes. A majority of research done in the past was on straight fins thickness, pitch and materials. The gap identified is to check effect of fins geometry on heat transfer.

III.METHODOLOGY

The ANSYS Workbench interface consists primarily of a Toolbox region, the Project Schematic, the Toolbar, and the Menu bar. Depending on the analysis type and/or application or workspace, you may also see other windows, tables, charts, etc.

A transient thermal analysis follows basically the same procedures as a steady-state thermal analysis. The main difference is that most applied loads in a transient analysis are functions of time. To specify time-dependent loads, you first divide the load-versus-time curve into load steps.

Each "corner" on the load-time curve can be one load step, as sketches. From and Transient thermal analysis, it is observed that individually both analysis have their own advantage in their respective fields of application but the present scenario is to analyze the variation of properties either linear or non-time. So analysis of the models developed in ANSYS 14.5 Design modular for Material (Magnesium alloy, Aluminum alloy).

Assumptions for analysis:

1. The temperature of the surrounding air does not change significantly.
2. Constant heat transfer coefficient is considered at the air side.
3. The heat generation is neglected.
4. Loads are constant.
5. Most of physical properties are constant

5.1 Model Description

The geometric dimension of the cylindrical block having circular fins with triangular holes is shown in the Figure 5.1. For simulating the cylindrical block have circular fins with triangular holes ANSYS 14.5 finite element control volume approach has been used.

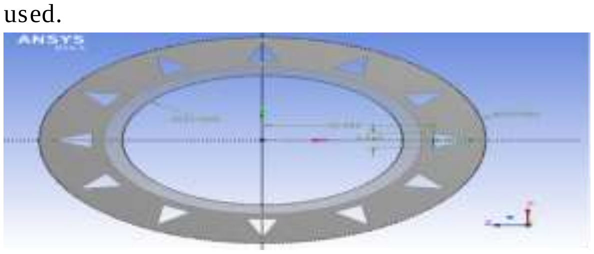

Fig. 1 Geometric dimension of the cylindrical block having circular fins with triangular holes

Firstly, ANSYS workbench14.5 software was installed on the system. The geometry of cylindrical block has circular fins with triangular holes has designed on design modular ANSYS 14.5. The geometry format in IGES file has been saved then it is imported to Transient thermal in ANSYS 14.5.

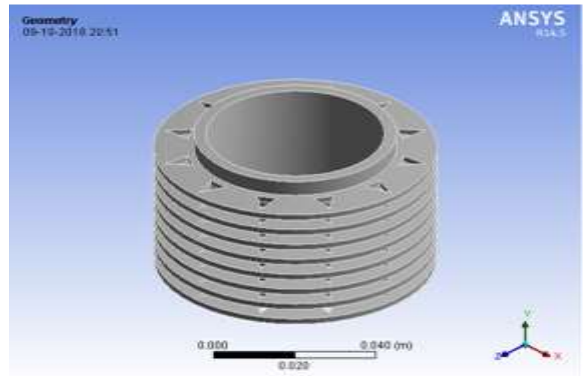

Fig 2 Geometry of cylindrical block having circular fins with triangular holes.

Meshing

By, default, a coarse mesh is generated by ANSYS software. Mesh contains mixed cells per unit area (ICEM Tetrahedral cells) having tetrahedral faces at the boundaries. The total numbers of elements are 6872 and total number of nodes is 14500. Curvature-On and Smooth – Medium.

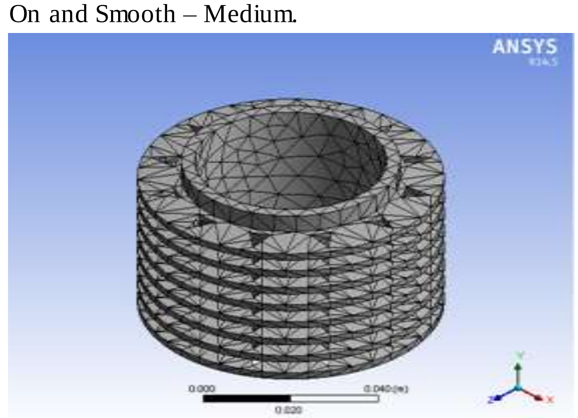

Fig 3 The meshing of cylindrical block having circular fins with triangular holes.

Name Selection

A different part of the cylindrical block having circular fins with triangular holes is selected and the names are given to them so that boundary conditions can be applied.

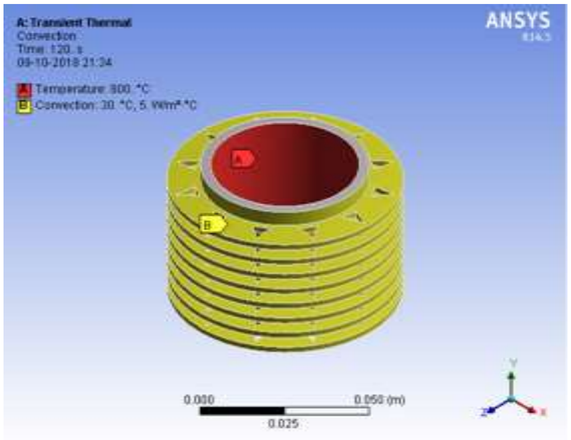

Fig 4 The Named selection of cylindrical block having circular fins with triangular holes.

Model Selection and Boundary conditions

In model selection the solver which is used is pressure based and this is steady state analysis. In which energy is on and viscous RNG k-epsilon standard wall function is used.

Table 1 Model Description

Object Name	Transient Thermal
State	Solved
Definition	
Physics Type	Thermal
Analysis Type	Transient
Solver Target	Mechanical APDL
Options	
Generate Input Only	No

Table 2 Boundary conditions

Load	Value
Inlet Temperature (K)	1073
Film coefficient (W/m^2-K)	5
Ambient Temperature (K)	303
Material	Aluminium Alloy and Magnesium Alloy

Table 3 Mechanical Properties of Aluminium Alloy and Magnesium Alloy

Material Name	Density (Kg/m^3)	Specific Heat (J/Kg-K)	Thermal Conductivity (W/m-K)	Coefficient of thermal expansion (per K)	Resistivity (ohm-m)
Aluminium alloy	2770	880	202	$1.2*10^{-5}$	$1.7*10^{-7}$
Magnesium alloy	1800	1024	156	$1.18*10^{-5}$	$1.6*10^{-7}$

After putting the boundary conditions, the solution is initialized and then iteration is applied so that the values of all parameters can be seen in a curve line graph. After the iteration gets completed final result could be seen.

IV. RESULTS AND DISCUSSIONS

CFD study is conducted to study the effect in heat dissipation in cylindrical block having circular fins with and without holes. Afterward, the effect of hole in heat dissipation is analyzed. The obtained results are presented below.

Contours for Aluminium Alloy with triangular holes

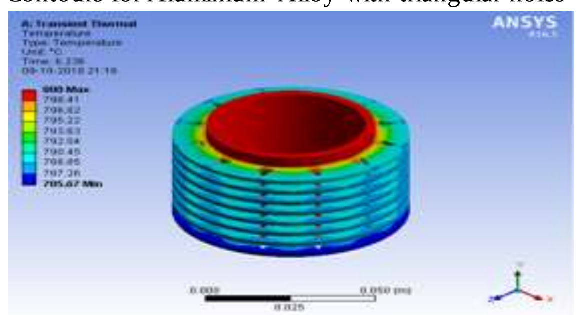

Fig 5 Temperature contour of cylindrical block having Aluminium alloy circular fin with triangular hole

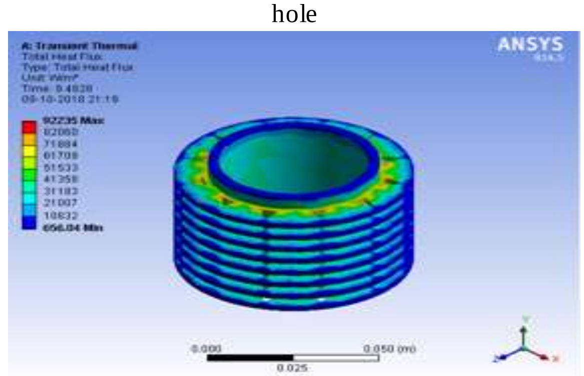

Fig 6 Total heat flux contour of cylindrical block having Aluminium alloy circular fin with triangular hole

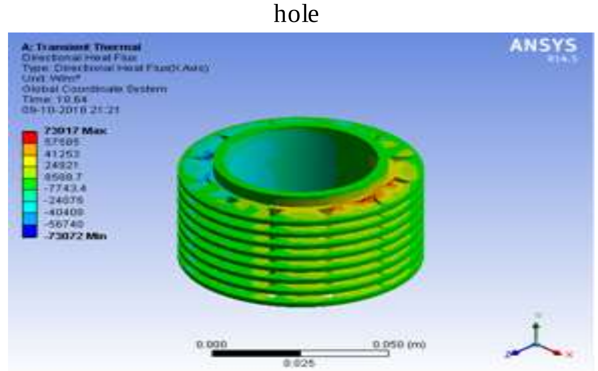

Fig 7 Directional heat flux contour of cylindrical block having Aluminium alloy circular fin with triangular hole

Contours for Magnesium Alloy with triangular holes

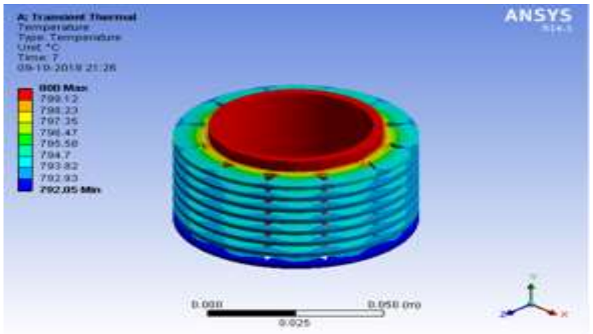

Fig 8 Temperature contour of cylindrical block having Magnesium alloy circular fin with triangular hole

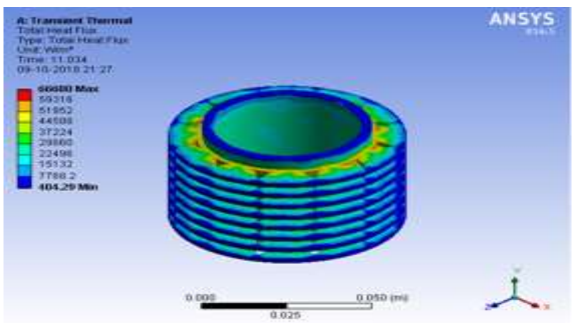

Fig 9 Total Heat flux contour of cylindrical block having Magnesium alloy circular fin with triangular hole

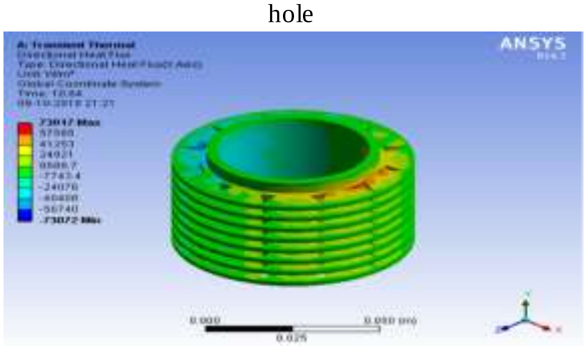

Fig 10 Directional Heat flux contour of cylindrical block having Magnesium alloy circular fin with triangular hole

Table 4 Comparison of Temperature Distribution

Time (in s)	Maximum Temperature (in °C)			
	Aluminium alloy fin	Magnesium alloy fin	Aluminium alloy fin with holes	Magnesium alloy fin with holes
At 10 s	793.69	797.58	785.67	792.05

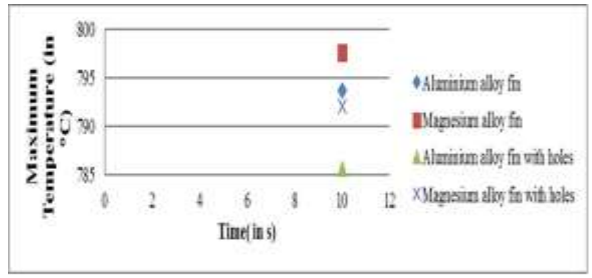

Fig 11 Comparison of Temperature Distribution with or without holes for different material.

V. CONCLUSIONS

After going CFD analysis through the comparison charts shown in the above, we can see that the results are quite encouraging. From the CFD analysis by using properties and boundary conditions the following conclusions are made:

From the above results it is clearly shows that the fin which is made up of Aluminium alloy with holes attain minimum temperature of 785.67 °C at 10 seconds in comparison to other where aluminum alloy without holes 793.69°C, Magnesium alloy fin without holes 797.58°C, Magnesium alloy with holes 792.05°C. So above values clearly show that Aluminium alloy fin with holes dissipates more heat as compare to other geometry. As compare to Magnesium alloy fin without hole, the change in percentage in temperature with holes is 1.20%. As compare to Aluminum alloy fin without hole, the change in percentage in temperature with holes is 1.25%.

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