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Design modification & analysis of two wheeler engine cooling fins and fabrication by using 3d printing

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Abstract— In the current world, I.C Engine has become the main prime mover, because of its availability and high power capability, but certain modification and innovation can save a lot of fuel and give high efficiency. Engine life and effectiveness can be improved with effective cooling. The heat transfer rate depends upon the fin geometry, fin thickness, air velocity. Insufficient removal of heat from the engine will lead to high thermal stresses and lower engine efficiency. The cooling fins allow the air to move the heat away from the engine. Low rate of heat transfer is the main problem of air cooling system. In this paper an attempt is made to simulate the heat transfer using CFD for different shape and geometry of Fins to analyze effects on rate of heat dissipation from fins surfaces. The geometry of engine fins are modeled in SOLIDWORKS and simulated in ANSYS CFD software.

Index Terms— Cooling fins, Heat transfer, Convection & Thermal Stresses.

I. INTRODUCTION

Air cooled motorcycle engines release heat to the atmosphere through forced convection. The rate of heat transfer depends upon the air velocity, geometry of engine fin and the ambient temperature. Motorbikes engines are normally designed for operating at a particular atmospheric temperature. There is an optimal cooling rate of an engine for its efficient operation. If the cooling rate decreases, it results in overheating leading to seizure of the engine.

Fins are extended surfaces often used to enhance the rate of heat transfer from the cylinder surface. To increase the rate of heat transfer either by increasing heat transfer coefficient or by increasing the temperature difference between the surfaces and surrounding fluid, the fins are commonly used.

II. METHODOLOGY

A. Modeling and Design

For the analysis purpose existing Model of Bajaj discover is taken and same model is modified with different geometry of fins and comparison is plotted in results. The Design of different geometrical shape of Fins was in SOLIDWORKS and Analysis done by the ANSYS CFD software and for mashing purpose ANSYS WORKBENCH was used. The computational domain consists of a rectangular volume of large dimensions containing the finned body at its Centre. It was focused on the fins and appropriate boundary conditions were applied at the domain ends to maintain continuity. A fine mesh has been created near the fins to resolve the thermal boundary layer which is surrounded by a coarse external mesh for better results and fast solution. A face mesh has been done by Tetrahedron element.

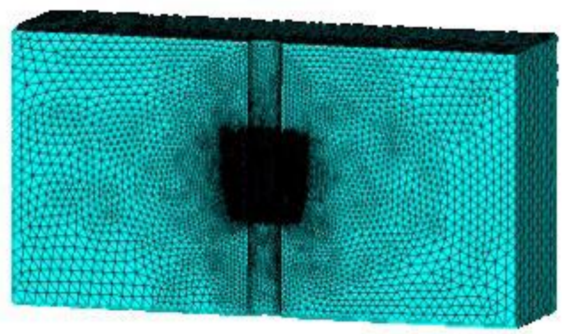

Fig.1, Sectional view of meshing with tetrahedron fluid elements

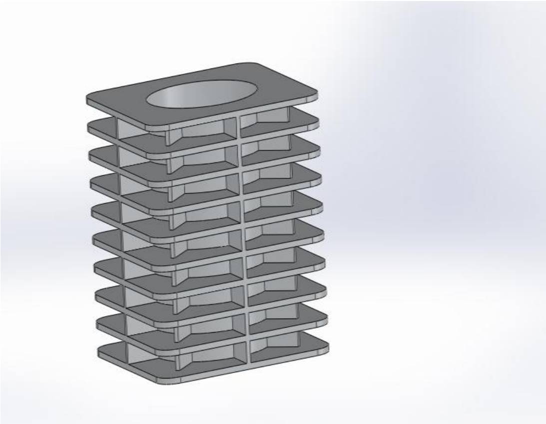

Fig.2,Straight fin

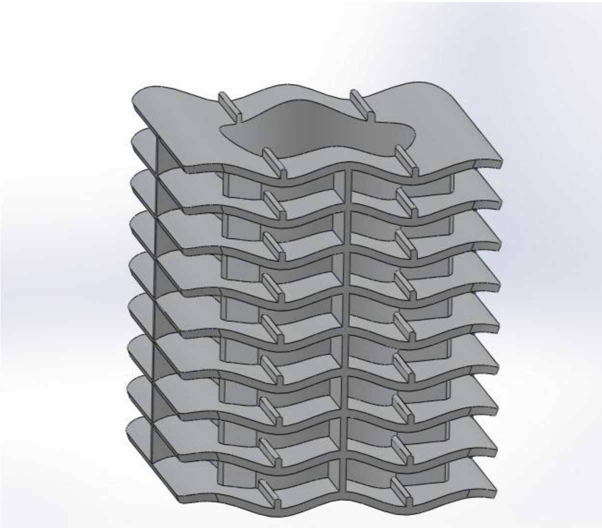

Fig.3(a),Wavy fins with projection

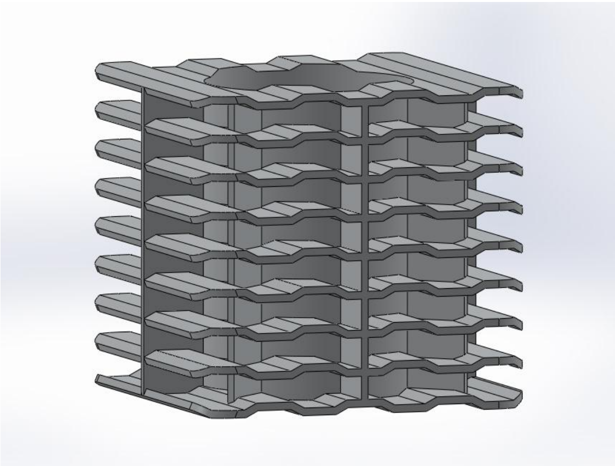

Fig.4(a),Step shape fin

B. Problem setup in Fluent

The flow around the fin has been solved at air flow velocity is 10 km/hr and air temperatures at 30°C. A three dimensional steady state heat transfer analysis has been done by assuming a constant temperature on the inner surface of the wall. The temperature at the inner surface is assumed constant at 250°C to account for heat generated due to combustion inside the engine.

For obtaining the relation between heat transfer coefficient and velocity, the temperature was maintained constant. Values of Heat Transfer Co-efficient and Turbulence Kinetic Energy were obtained for different velocities.

C. Mathematical Equations

For straight fin,

Effectiveness $\varepsilon = L_C^{1.5}(h/kA_{m)})^{0.5}$

By using effectiveness value, efficiency is calculated(graph method).

Heat transferred by the fin $Q = \eta A_S h(T_b - T_\infty)$

For Wavy fin with projection and step shape fin,

Heat transferred by the fin

$$Q = (hPkA)^{0.5}(T_b - T_\infty)\tanh(mL)$$

Fin Effeciency $\eta = \tanh(mL)/mL$

D. Design specification

TABLE I. Technical Specification of Mahindra MKM-NST 575 DI Tractor

Para Meter	**Straight fin**	**Wavy fin with projection**	**Step Shape fin**
Length	100mm	100mm	100mm
Width	100mm	100mm	100mm
Height	80mm	84mm	84mm
Thickness of each plate	2mm	2mm	2mm
cylinder inner Dia	60mm	60mm	60mm
Material	Al alloy	Al alloy	Al alloy
Air Velocity	10 Km/Hr	10 Km/Hr	10 Km/Hr

III. RESULTS AND DISCUSSION

E. HTC Values across the Fins

HTC values for the different air velocity are found out for the three shapes fins. Result figure (5) showing significantly increase in Heat Transfer Co-efficient for Step shape and wavy fins with projection.

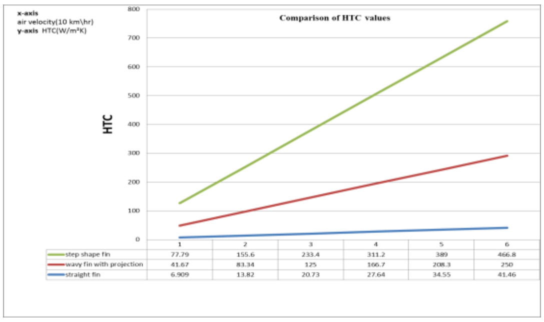

Fig. 5,HTC Values across the Fins

F. Kinetic Turbulence Energy Values across the Fins

A figure (6) shows variation in Turbulence energyTurbulence Energy can observe on changing the shape of the fin from Straight fin to Step shape fin and Wavy fin with projection. To increase the rate of heat transfers from any surface need to increase its surface area and turbulence of flowing air around the surface.

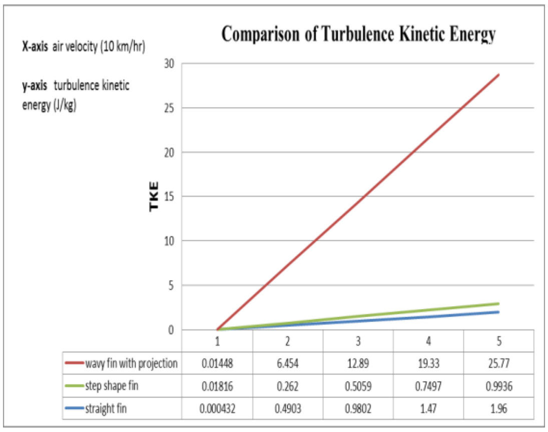

Fig. 6, Comparison of Kinetic Turbulence Energy

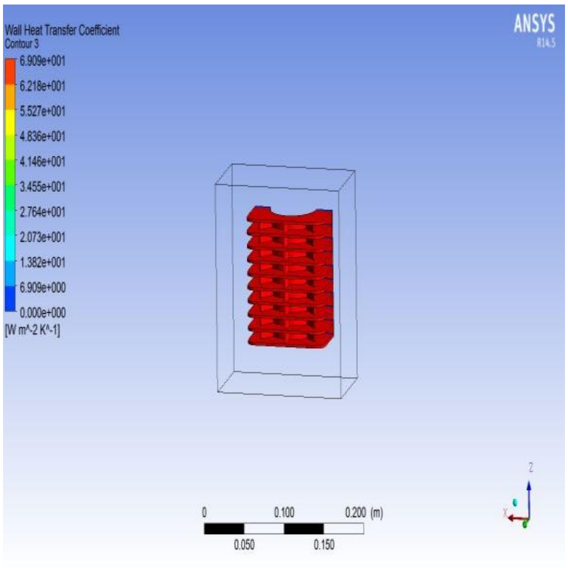

Fig. 7(a), HTC Results for Straight Fins

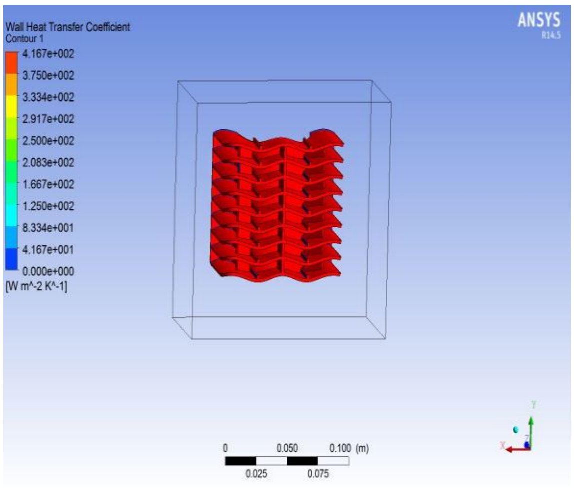

Fig. 8(a), HTC Results for wavy fins with projection

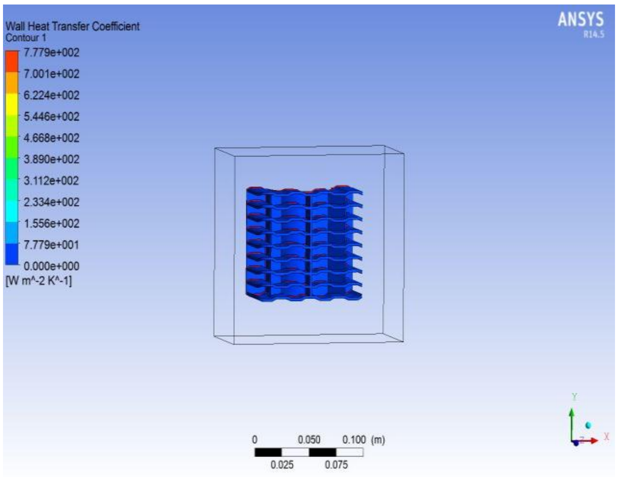

Fig. 9(a), HTC Results for Step Shape Fins

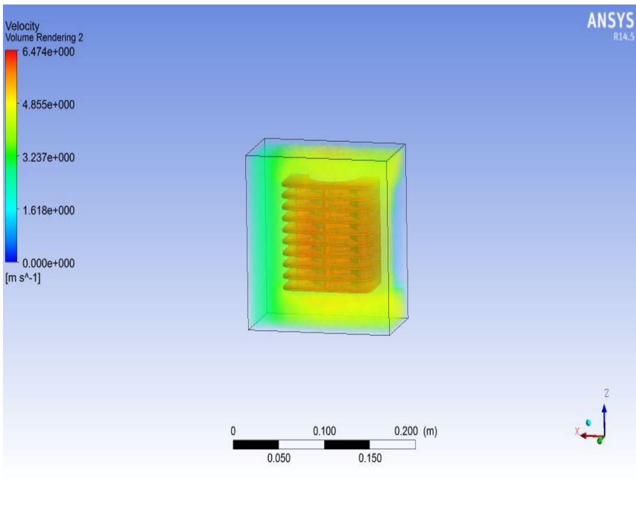

Fig 7(b), Velocity Results for Straight Fins

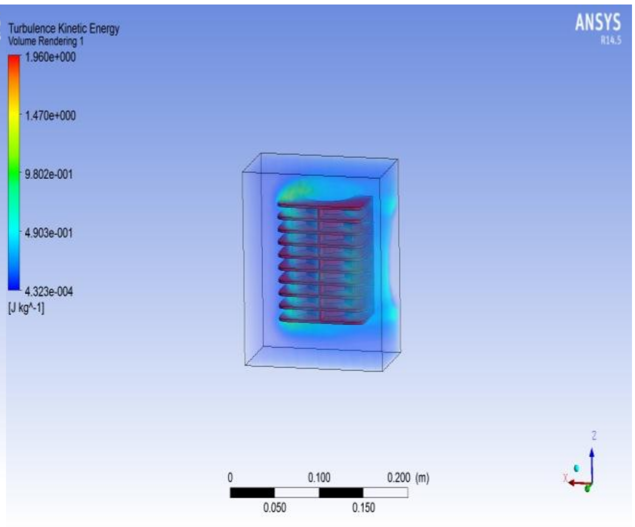

Fig. 10(a), TKE Results for Straight Fins

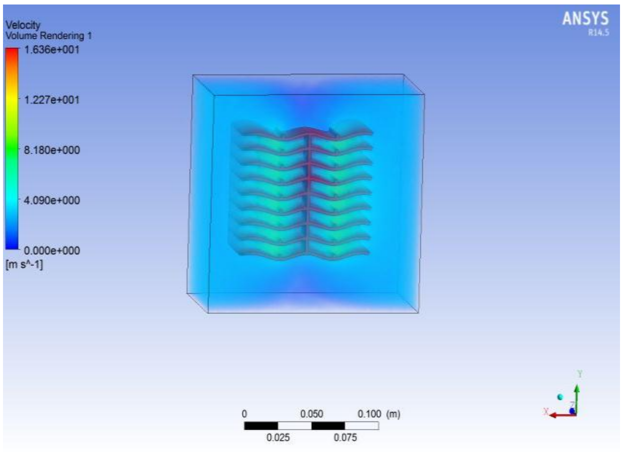

Fig 8(b), Velocity Results for wavy fins with projection

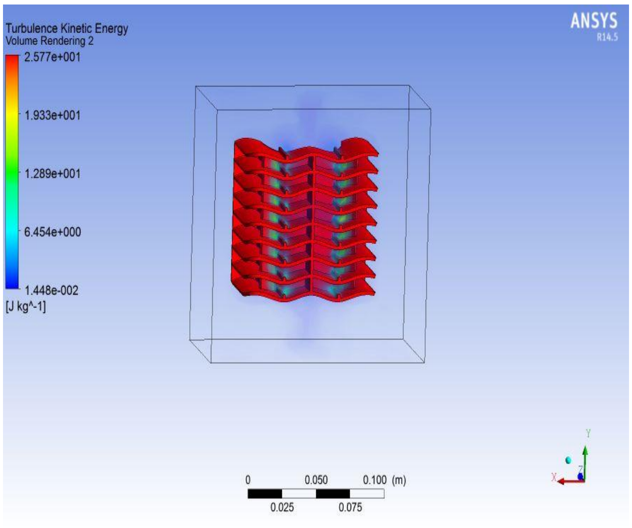

Fig. 11(a), TKE Results for wavy fins with projection

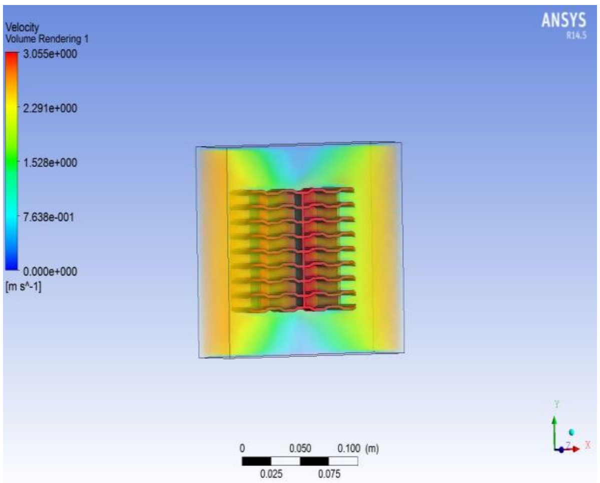

Fig 9(b), Velocity Results for Step Shape Fins

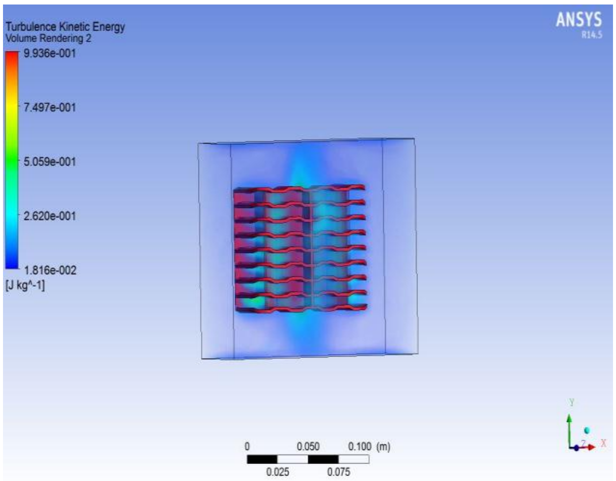

Fig. 12(a), TKE Results for Step Shape Fins

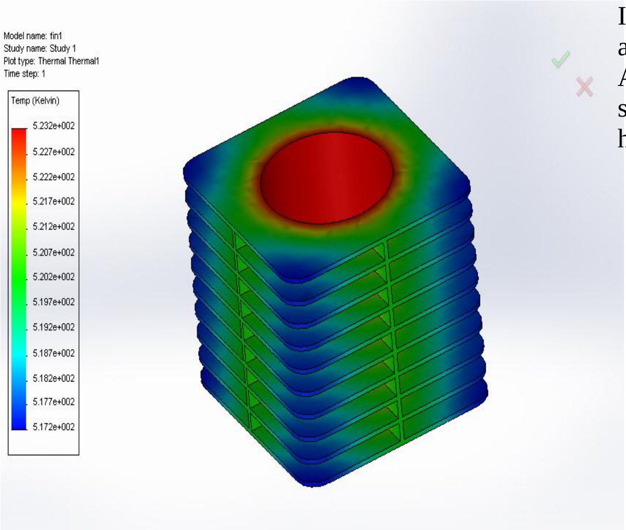

Fig. 10(b), Temperature distribution Results for Straight Fins

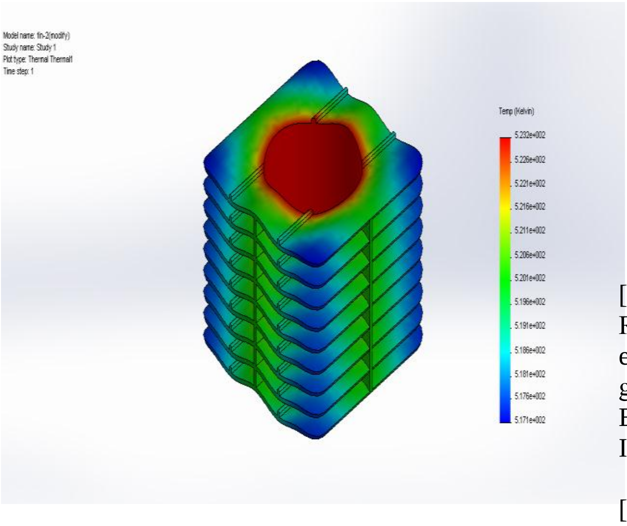

Fig. 11(b), Temperature distribution Results for wavy fins with projection

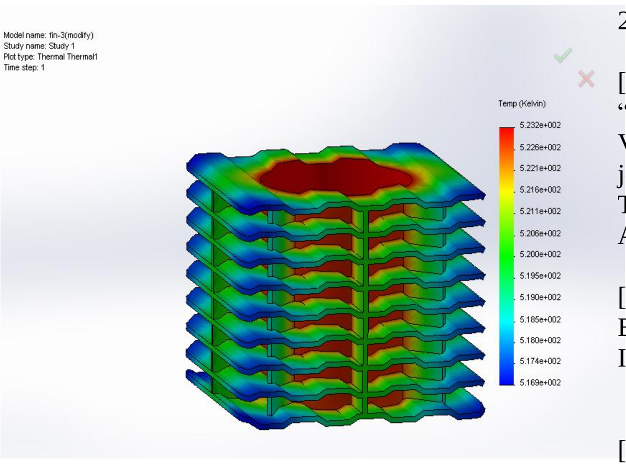

Fig. 12(a), Temperature distribution Results for Step Shape Fins

IV. CONCLUSION

In present work, a Motor Cycle Engine is modeled and CFD analysis is done by using ANSYS Fluent. A brief summary of the work completed and significant conclusions derived from this work are highlighted below.

- Models for three different shapes of Fins were developed and effects of wind velocity and heat transfer coefficient values were investigated. An Analysis is carried out in Ansys Fluent to find the effect of change in geometry of Fins in terns of HTC and air turbulence.
- Heat transfer rate increases after changing fin geometry and it is observed that HTC are more in case of Step shape Fin model as compare to wavy fins with projection model.
- Heat transfer rate increases after changing fin geometry and it is observed that turbulence are more in case of wavy fins with projection model as compare to Step shape Fin model.
- Due to non-uniformness in the geometry of Fins turbulence of flowing air increases which results in more heat transfer rate.

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