Comparison of Heat Flux by using Different Geometry of Cylinder-Fins

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Abstract — *The engine of an automobile remains exposed to a very high temperature and so its components also. This high temperature may result in wear and tear of engine components. So it becomes necessary to cool the engine with any available source. For cooling purpose, fins are provided on the engine body so that the rate of heat transfer gets increased. The basic science involved is that as we increase the surface area of the heated material the heat transfer rate increases accordingly from it. Fins are available in different size and material, as per the requirement of heat transfer. In this project, the heat transfer rate from fins of different material and geometry has been studied and compared. The fin materials used in this analysis are: Aluminium alloy 2014, Aluminium alloy 6061, Aluminium alloy A204, Aluminium alloy C443. The modification was done in size as well as geometry. For analysis the rectangular fin thickness was 3mm. Also a circular fin and curved fin of thickness 3mm and 2.5mm used in this analysis. The 3-D model of this existing engine was re-created in Creo-2 by using the dimensions. The thermal analysis was done in Ansys-16 and module used is Transient Thermal state. This module gave a comparison of heat flux of fins of different materials and geometry used in this project. A fin of particular geometry and material having highest rate of heat transfer has been selected.*

Keywords*- Cylinder-Fins, Heat flux, Heat flux per unit length, Design & Material optimization, FE Analysis.*

I. *Introduction*

We know that in case of IC engines, combustion of A/F ratio takes place inside the engine cylinder and hot gases are generated. The inside the cylinder of two wheeler temperature is 300 to 700c. Due to this high temperature the gasket or Film are burn. Fins is help to reduce the temperature around 200-300c. Too much cooling of cylinder is reduced its thermal efficiency so, the object of cooling system is to keep the engine running at its most efficient operating temperature. It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling. To avoid this wear-tear of the engine we can used the fins for cooling of engine and increase the performance of the vehicle.

Natural Air Cooling

Air passing through the cylinder slots and increase the heat flux of the cylinder. This heat flux is help to cooling the IC engine. Fins (or ribs) are sharp projection provided on the surfaces of cylinder block and cylinder head. They increase the outer contact area between a cylinder and the air. Fins is integral part of the engine.

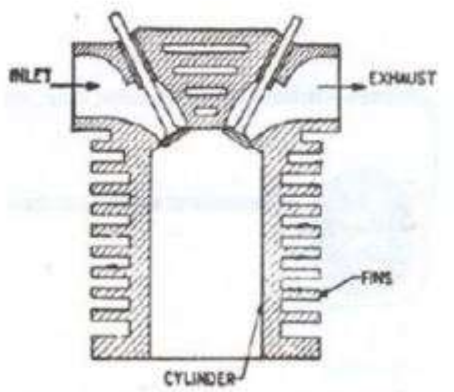

Figure 1.Natural Air Cooling

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. The amount of conduction, convection, radiation of an object determines the amount of heat it transfers. Increasing the temperature difference 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 economical or it is not feasible to change the first two options. Adding a fin to the object, however, increases the surface area and can sometimes be economical solution to heat transfer problems.

Figure 2. Automobile Fin

II LITERATURE REVIEW

Vishnu Vardhan Engine remains exposed to very high temperature and thermal stresses. Therefore fins are provided to cool the engine. Fin get exposed to atmosphere and increase the rate of heat transfer. By using ambient air, the heat transfer rate has been increased. It is well known fact that by increase the surface area the heat transfer rate can be increased. Thus by using cooling fins , engine can be cooled.The purpose of this project is to determine the thermal properties by changing the geometry, material of construction and thickness of the fin. The main aim of the project is to analyze the thermal properties by varying geometry, material and thickness of cylinder fins. Transitory thermal analysis gives an idea about the temperature and other quantities that vary over time. Thermal recreation helps us to find other design parameters which can help for improved life. At present aluminum alloy alloy A204 is being used which has thermal conductivity of 110-150W/mk. Also other aluminum alloys are being study which can be used to better performance.

Mukesh Didwania studied the heat transfer from different shaped fins in a small surface area. Mainly two type of fins have been studied, rectangular and circular. It is required to study the optimum dimension of the fin by using transverse heat conduction. Thus the aim is to calculate the maximum heat transfer rate and minimum pressure loss in the ductFor analysis a three dimensional finite volume based CFD Tool ANSYS 12.0 Fluent was used. Model has three basic parts as solid base, solid fin surface and rectangular duct. Heat supplied to solid fin and it conducted to solid fin surface and simultaneously it convected to air which was flowing in the duct. In solid works software, the modes have been recreated and then transferred to ANSYS12.0 Fluent. In Fluent software the boundary conditions were determined. All flows were the stated as steady state and incompressible in the solver. For turbulent flow analysis k-e turbulence model was considered. To solve the models Ghettoized 3D solver has been set to solve the models. For different Reynolds number the results were calculated for laminar and turbulent flow. The results were obtained as the contour plots, namely X-Y plots and vector plots for laminar and turbulent flow respectively which also included heat transfer rate and pressure loss. Heat transfer rate and pressure loss. According to the data it was concluded that for rectangular fin the heat transfer is minimum and maximum for the circular fin and pressure loss is minimum for the circular fin. Hence for maximum heat transfer circular fin can be used. It was also concluded that both money and time can be saved if experimental as well as mathematical analysis are implemented simultaneously.

Nagarani surface temperature in case of elliptical annular fin goes on decreasing slowly in the direction of major axis. Against the bigot number and shape factor the ste decreases. If the bigot number is less than 0.013 The rate of reduction of STE with increasing Bi is higher. The experimental results are validated with CFD result. The deviation is within acceptable range for surface temperature, STE and fin effectiveness are 5-8%. The GA developed is validated with the experimental result. It is observed that, the fin effectiveness is higher when the minor axis touches the circumference of the CT, and for smaller values of SF and smaller values of the radius of the CT. This optimization method is universal and may be used for optimization of EAF under specified volume. N.

III. PROBLEM DEFINITION:

Due to high temperature engine overheating. This overheating damages the internal component of the cylinder and decreases the thermal efficiency of the vehicle. Through this paper check the heat flux rate for different geometry with varying thickness 3mm to 2.5mm. Ansys work bench is utilized for analysis. The analysis is done for different models of fins that are commercially available now a days and a comparison is thus established between them. Also the material is changed so that better heat transfer rate can be obtained.

Modelling of Cylinder fins

Cylinder along with fin was modelled in Pro-E. The dimension of the cylinder along with fin was taken from commercially available bike data sheet. Fins with different geometries (circular and rectangular) were modelled using Pro-E.

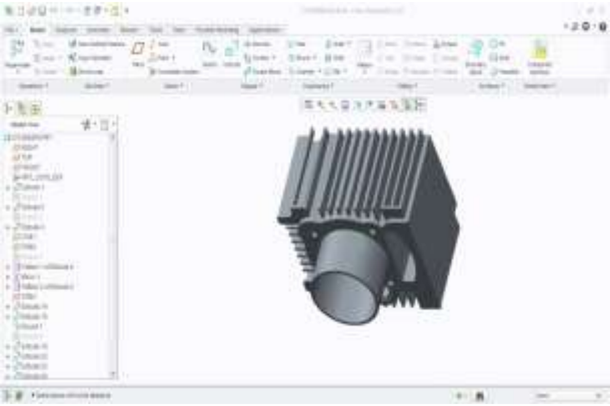

Fig 3 Rectangular Fins

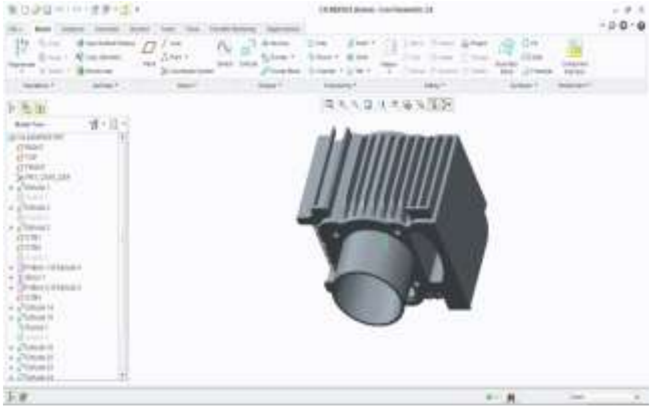

Figure 4 Curved Fins

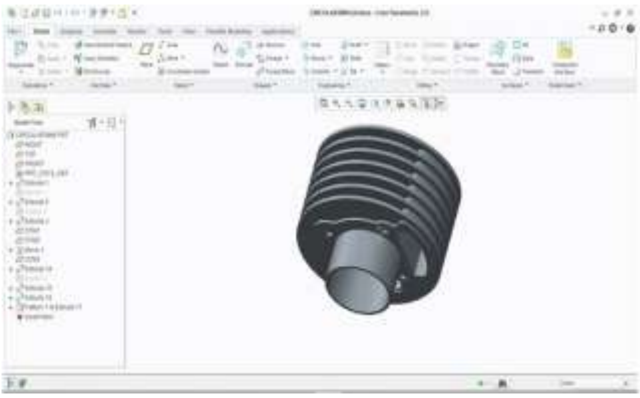

Figure 5 Circular Fins

Material Properties

Material	Density (g/cc)	Specific Heat (j/g C)	Conductivity (W/m C)
Aluminium 6061	2.7	0.896	180
Aluminium A204	2.8	0.963	120
Aluminium 2014	2.8	0.88	192
Aluminum C443	2.69	0.936	142

IV *FE ANALYSIS ON THERMAL ANALYSIS*

Apply boundary condition for different geometry is Rectangular Fins, Circular Fins and Curved Fins.

Internal temperature=285c
Thermal Conductivity=25W/m2c
Surrounding temperature=25c

(i) Rectangular Fins thickness 3mm

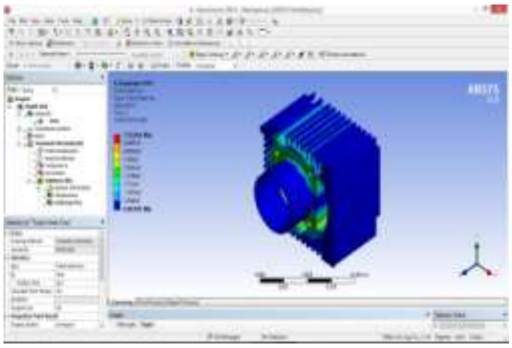

Figure 6(a) Material 2014

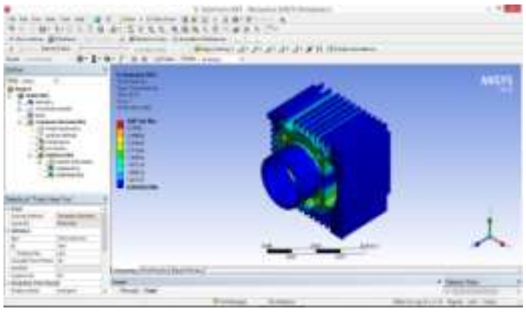

Figure 6(b) Material 6061

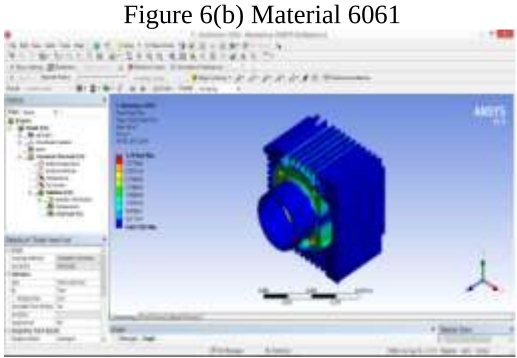

Figure 6(c) Material A204

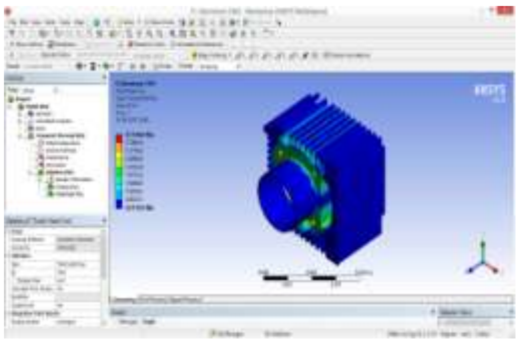

Figure 6(d) Material C443

(ii)Circular Fins thickness 3mm

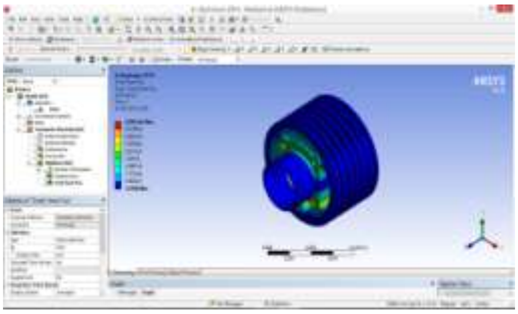

Figure 7(a) Material 2014

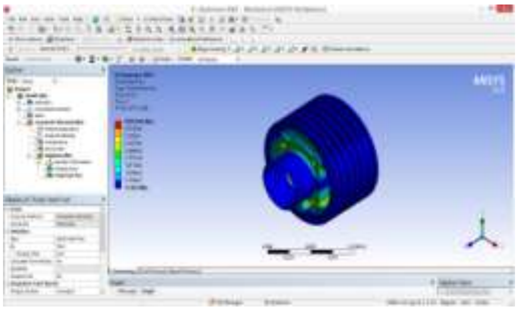

Figure 7(b) Material 6061

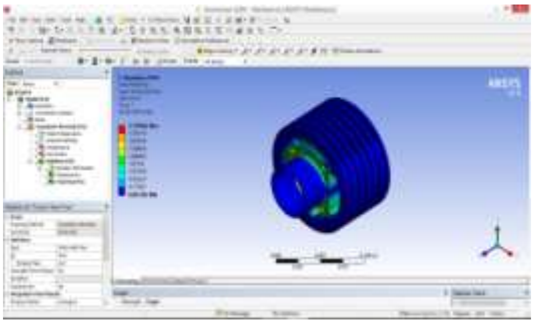

Figure 7(c) Material A204

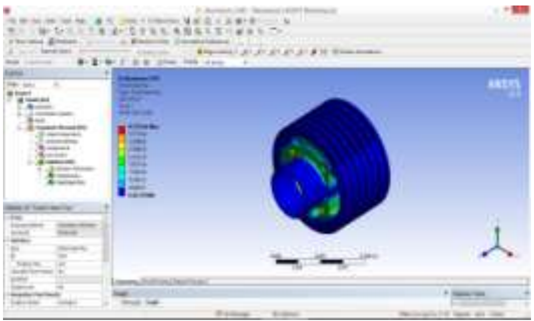

Figure 7(d) Material C443

(iii) Curved Fins thickness 3mm

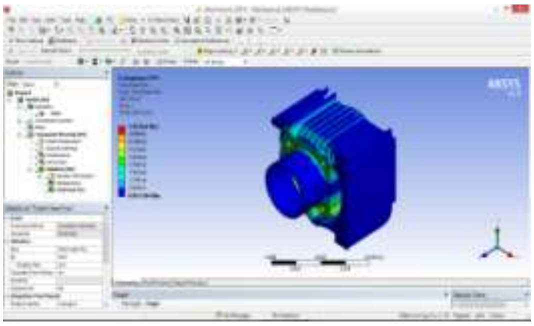

Figure 8(a) Material 2014

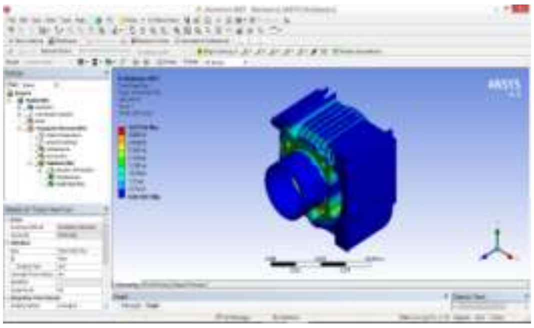

Figure 8(b) Material 6061

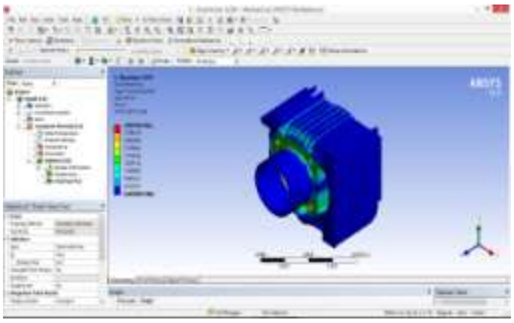

Figure 8(c) Material A204

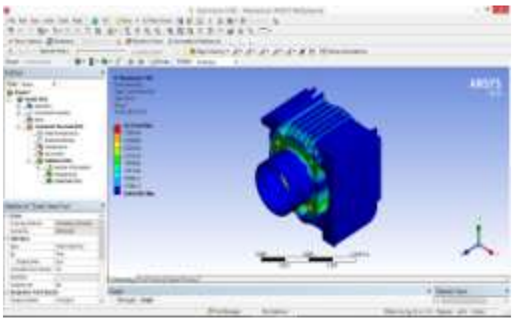

Figure 8(d) Material C443

(iv) Rectangular Fins thickness 2.5mm

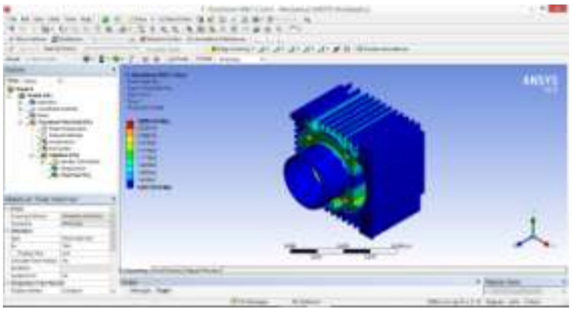

Figure 9(a) Material 6061

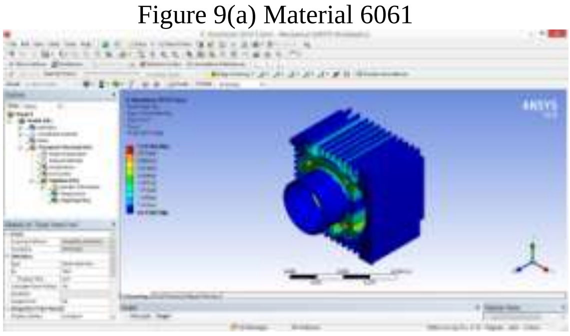

Figure 9(b) Material 2014

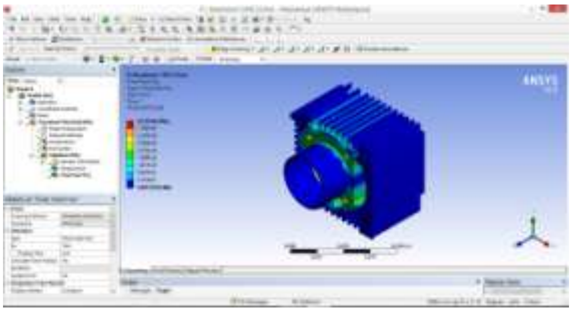

Figure 9(c) Material C443

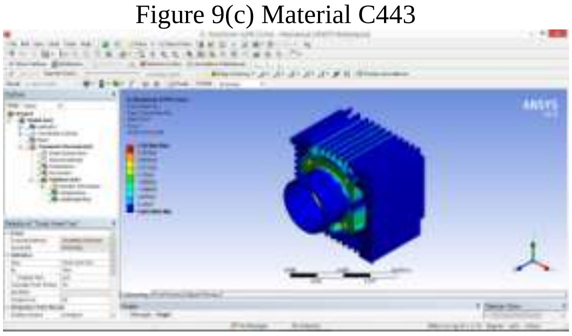

Figure 9(d) Material A204

(v) Circular fins thickness 2.5mm

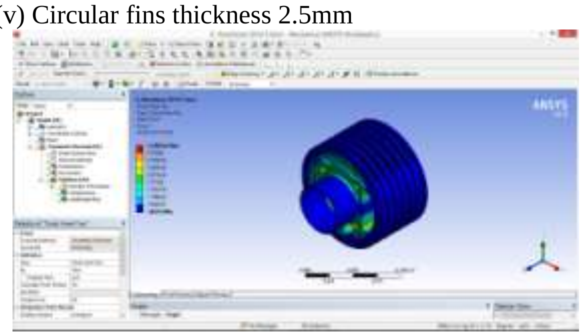

Figure 10(a) Material 2014

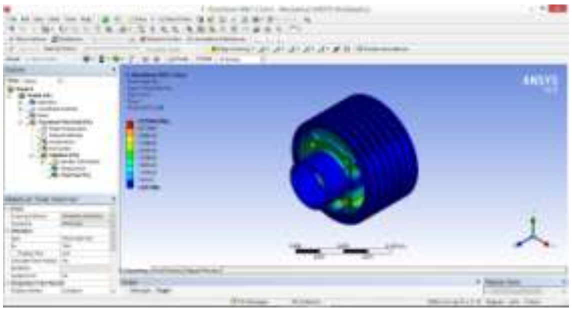

Figure 10(b) Material 6061

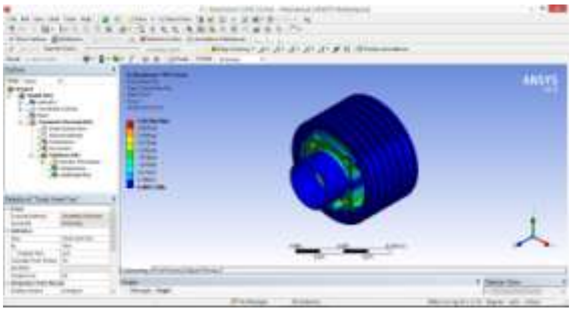

Figure 10(c) Material C443

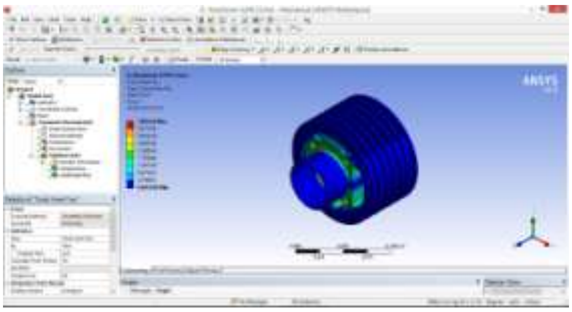

Figure 10(d) Material A204

(vi)Curved Fins thickness 2.5mm

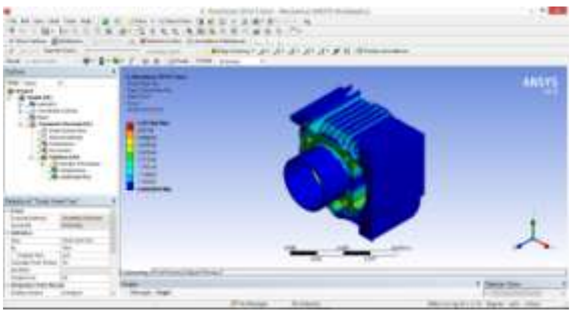

Figure 11(a) Material 2014

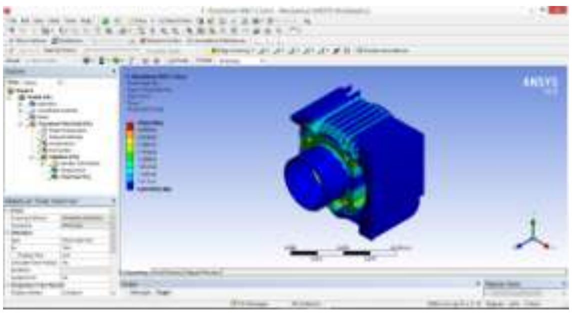

Figure 11(b) Material 6061

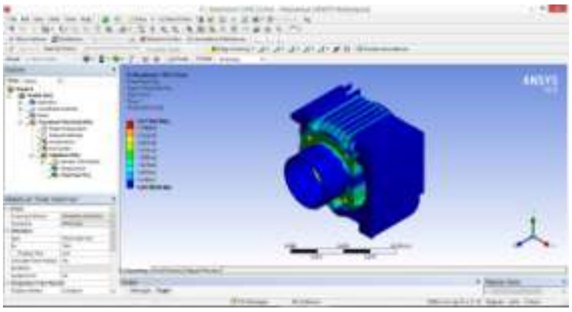

Figure 11(c) Material C443

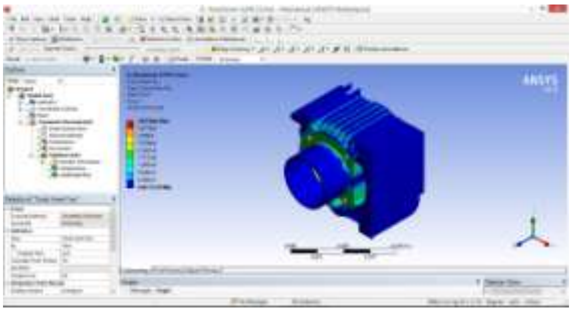

Figure 11(d) Material A204

V Result Discussion

In Figure 12, show the compression between the all different materials results of the heat flux "heat dissipation rate per unit area" of the cylinder fin body for different geometry.

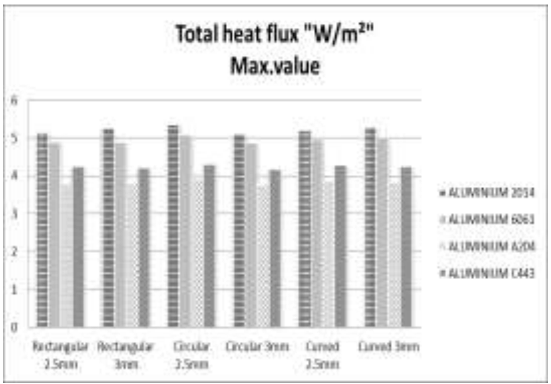

Figure 12 Comparison of all different geometry

VII CONCULSION

In this project a cylinder fin body of a100cc hero Honda bike has been redesigned in a 3d Pro-e Creo parametric software. The default fins thickness 3mm and it of rectangular shape. The default material is aluminium alloy A204. In his project fin shape has been changed to circular and curved and the thickness has been varied from 3mm to 2.5mm. A transient thermal Analysis has been on the fin body by changing its material, thickness and shape. The material used is aluminium 2014, aluminium 6061 and aluminium alloy C443

Hence we conclude that the circular fin of thickness 2.5mm example aluminium 2014 can give a better heat transfer rate rather than the present (default fin). Also we have found that the weight of circular fin of aluminium 2014 is quite less as compared to the other geometry of same material as well as other material.

VIII ACKNOWLEDGEMENT

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REFERENCES

[1] A.C.Deshpande, Mohd. Razik "Design and Finite Element Analysis of Two Wheeler Engine Fins". (IJESRT) ISSN: 2277-9655, June- 2015

[2] A. Vahabzadeh, D.D. Ganji, M. Abbasi. "Analytical Investigation Of Porous Pin Fins With Variable Section In Fully-Wet Conditions". Case Studies in Thermal Engineering 5 (2015) 1–12.

[3] Akhilnandh Ramesh, M. Jaya Arun Prasanth, A.Kirthivasan, M.Suresh. "Heat Transfer Studies on Air Cooled Spiral Radiator with Circumferential Fins". Science directs Procedia Engineering 127 (2015) 333 – 339.

[4]Arnold E. Biermann and Benjamin Pinkel. "Heat Transfer from Finned Metal Cylinders in an Air Stream".

[5] B N Niroop Kumar Gowd And Ramatulasi." Calculating Heat Transfer Rate of Cylinder Fin Body by Varying Geometry and Material" IJMERR ISSN 2278 – 0149 Vol. 3, No. 4, October 2014

[6] D.Vinod Kumar. "Design And Analysis of Gasket Sealing of Cylinder Head Under Engine Operation Conditions". International Journal of Innovations in Engineering And Technology ISSN: 2319-1058 Volume 2 Issue 3 – June 2013

[7]Chang-Chun Lee, Kuo-Ning Chiang,Wen-King Chen, Rong-Shieh Chen"Design And Analysis Of Gasket Sealing Of Cylinder Head Under Engine Operation Conditions". Finite Elements in Analysis And Design 41 (2005) 1160–1174

[8]G. Babu, M. Lavakumar," Heat Transfer Analysis and Optimization of Engine Cylinder Fins of Varying Geometry And Material". IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) E-ISSN: 2278-1684, P-ISSN: 2320-334x, Volume 7, Issue 4 (Jul. - Aug. 2013), Pp 24-29