RESEARCH ARTICLE OPEN ACCESS

Modeling and thermal Analysis of an Air Cooled Engine Cylinder under Diversify the Fins Thickness

G.Gopinadh[1], S.Chandra sekhar[2], Surjan Shaik[3]
[1]*(PG Student , Department of Mechanical Engineering, SVEC, Pedatadepalli)*
[2] *(Asst-Professor , Department of Mechanical Engineering, SVEC, Pedatadepalli*
[3]*(Asst-Professor , Department of Mechanical Engineering, SVEC, Pedatadepalli)*
Corresponding Author : G.Gopinadh

ABSTRACT
In Entire Automobile system, internal combustion engine is the main component which is subjected to high temperature variations and thermal stresses. Heat will be released to the atmosphere via second mode of heat transfer of forced convection in An air cooled motor cycle engine .Heat fins are placed in outside surface of the air cooled engine cylinder. Here compute the rate of heat transfer based on the effects of fin geometry , the ambient temperature and the vehicle speed (velocity). Current paper is to analyze the effect of heat fin specifications on heat fin performance in practical working conditions which includes heat fin materials, variable thickness and variable pitch of heat fin .Heat fins of an air cooled engine cylinder is Designed in UG-NX 11 (Unigraphics) and thermal analysis is done by the ANSYS 18.0 and NX-Nastran software tools . current study is based on Transient structural analysis and transient Thermal analysis taken as a input is Heat transfer. Obtained results are Total Deformation, temperature distribution and heat flux of three variable materials like, Al6061 (aluminium alloys), AMC-SC1 (Mg alloy), CGI (cast iron alloy). Analyzed obtained results based on convective heat transfer coefficient functional requirements ,high temperature resistance and low weight factor among three materials AMC-SC1 (Mg alloy) is the optimum material and it is may be replaced placed conventional Al 6061 (aluminium alloy) for making of air cooled engine cylinder in further future.

Keywords – Heat fins, thermal analysis, heat flux,AMC-SC1,heat transfer coefficient

Date Of Submission: 21-08-2019 Date Of Acceptance: 05-09-2019

I. INTRODUCTION:

Automobiles are running based on the IC (internal combustion) Engines. Combustion of air and fuel takes placed on combustion chamber, combustion chamber is nothing inside of cylinder, in the combustion chamber hot gases and heat will be generated due to the combustion of Air-Fuel mixture. Generated hot gas temperatures are around 2300-2500 due to these peak temperatures may results oil film is burning in between engine moving parts, Results of these peak temperature combustion chamber parts automatically are seizing or welding ,So our requirement is to reduce the temperature must be around 150-200c and at this temperature range is 150-200c engine will work efficiently. There is no needed too much cooling from 2300-2500c to 150-230c it reduce the thermal efficiency of engine. So, one cooling system object is required for the reducing the peak temperatures, it keep the engine running at most efficient operating temperature. Here noted point is engine is inefficient when it is cold so design the engine based on the cooling system so it prevent cooling when the engine is warming up and till it produce to optimum efficient operating temperature , then it starts cooling. Here some noted points are:

1. About 20-25% of total heat generated is used for producing brake power (useful work).
2. Around 30-35% of total heat is removed based on this cooling system design
3. Some of heat is carried away through exhaust gases and friction

1.1.Types of cooling systems

Now a days in the world cooling systems are effectively used to reduce the heat to improve the thermal efficiency of Engine so in automobile industry the most frequently used cooling systems are

A. Air cooled system, and
B. Water cooled system.

A. Air Cooling System

In air cooling, air is used as an effective media to cool the engine by the convection mode of heat transfer. In small engines like 15-20 kW capacity air cooling system is frequently used.

Heat fins or extended surfaces are casted on cylinder walls, cylinder head for this cooling system.

When combustion is done in a combustion chamber heat will be generated in the engine cylinder will be regulate to the fins and when the air flows through the fins and heat will be dissolute to the air.

The amount of heat dissolute to air depends upon:

1. Amount of air flowing over the fins.
2. Surface area fins.
3. Thermal conductivity of heat fins

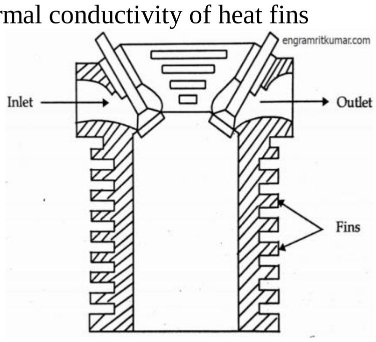

Fig 1: Air cooled engine cylinder with fins

B) Water Cooling System

Water cooling system another main important cooling system rather than air cooling system. In water cooling system, water is used as an effective media to cool the engine by the convection mode of heat transfer. Here cooling water jackets are attached surrounding of cylinder head, cylinder and valves etc,

When the water is circulated over the jackets and it absorbs the heat of combustion. Radiator is cooled partially by a fan through cool water circulation and partially by the flow developed by the forward motion of the vehicle. In this system based on water jackets cooling water is re circulated and reduces the heat of engine.

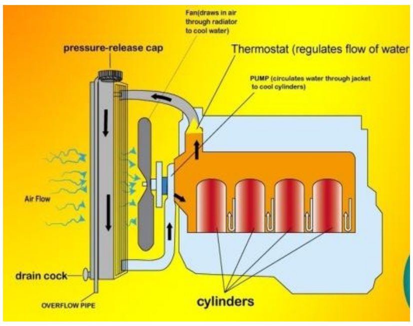

Fig- 2: Water Cooled Engine with Radiator

II. METHODOLOGY

Main intent of the project is to modelling cylinder with fins for SUZUKI FIERO 147cc engine. by varying the distance between the fins and fin thickness to review the thermal properties of the fins

Analysis is also done by changing the materials of fins., cylinder fin body surface is made by the cast iron material used in now day

This project main intent is based on varying the material for cylinder fin body to examine the fin body with changing other materials like Al 6061 (Al alloys) ,AMC-SC1 (Mg alloy),CGI (cast iron alloy) and also altering the thickness of the fins. Varying fin thickness are-1.5,2 and 2.5mm. Selected material for Analysis- Al 6061 (Al alloys) ,AMC-SC1 (Mg alloy),CGI (cast iron alloy

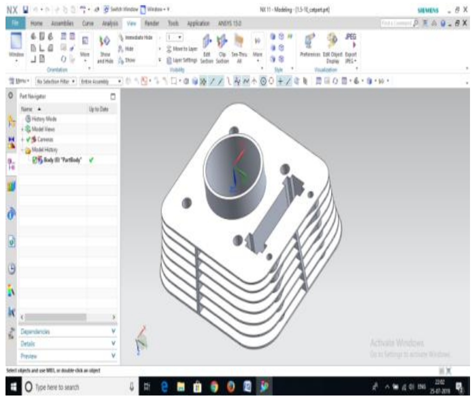

Fig-3: SUZUKI FIERO Cylinder is modeled in UGNX-11 (Unigraphics)

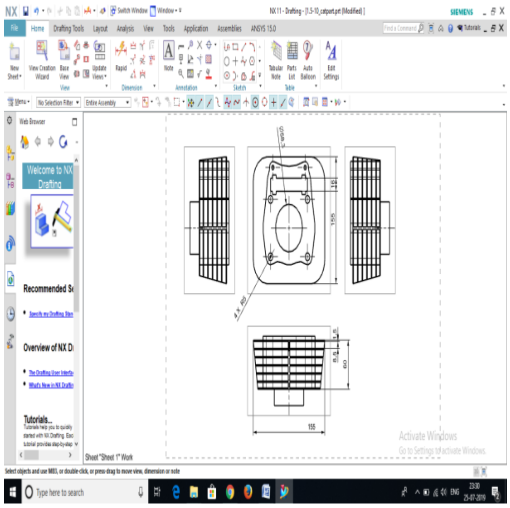

Figure 4: Cylinder model dimensions in UGNX-11 (Unigraphics)

III. DESIGN PARAMETERS FOR MODEL

Modeling of engine cylinder with heat fins are intricate shape which is designed by the advanced professional design software UGNX-11 (Unigraphics) is a complete solution for product development.UGNX-11 software delivers integrated, high performance design, simulation, documentation, tooling and manufacturing. UGNX-11 provides leading edge solutions for design that improve productivity throughout product development

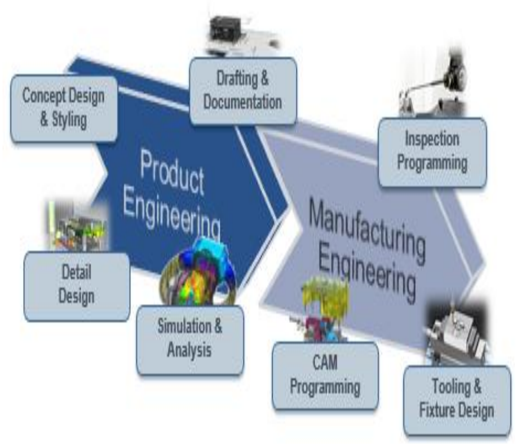

Fig-5: UGNX-11 CAD&CAM layout

Here UGNX-11 is used to successful generated 3D CAD model of cylinder heat fins with parametric dimensions.

Table- 1: properties of different materials

Properties	AL6061	CGI	AMC-SC1
E (GPa)	68.9	170	44
Poisson ratio	0.33	0.294	0.281
K (w/m ^{0} c)	160	38	115
α(/^{0}c)	2.32E-05	1.16E-05	2.20E-05
CP (J/Kg ^{0}C)	897	524	1030
ρ(kg/m^3)	2700	7100	1790

Design parameters for original model

Fin Thickness – 2.5 mm and
Fin Distance – 10 mm
Length of fin (L)=48.35mm
T_i = Inside temperature=300^{0}C
T_o = Outside temperature =35^{0}C
For the analysis purpose applied rate of film coefficient is 60sec-5 w/m2c

LC=L+T=48.35+2=50.35
R1=29.15(bore radius)
R2C=R1+LC=79.5
ή X=0.77
Q_{max} =2π (R2C2-R12) h (T0-T∞)=273.2 W
For the analysis purpose applied rate of film coefficient is 60sec-5 w/m2c

At 20sec-40 w/m^{0}c and 30sec-50 w/m^{0}c while vehicle is getting different speed

R2C/R1=2.27 AM=T(R2C-R1)=100.7
(LC)3/2(h/KAM)1/2=0.4875
Q_{actual}=273.2 X 0.77=210 W (on both sides of fin)

IV. RESULS AND DISCUSSION

Type-I: Aluminium 2.5 mm thick, 10 mm spacing

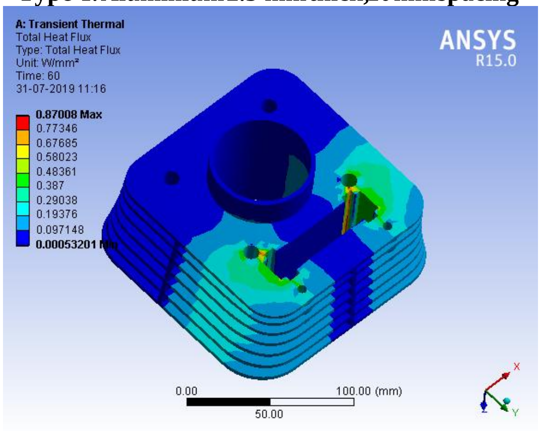

Fig-6: Total heat flux is 0.87008W/mm2

Type-II:**AMC-SC1 2.5 mm thick, 10 mm spacing**

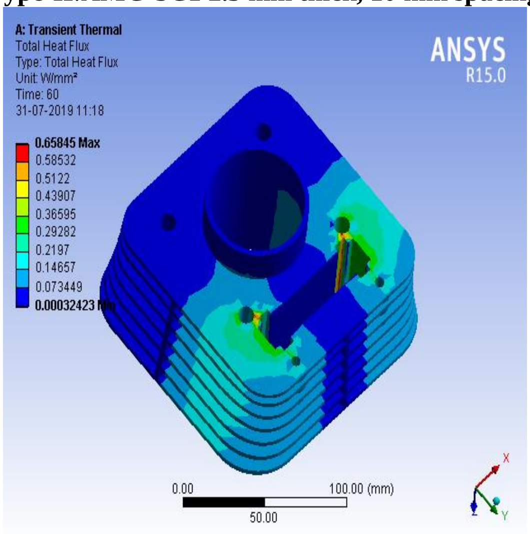

Fig-7: Total heat flux is 0.65845W/mm2

Type-III: CGI iron 2.5 mm thick, 10 mm spacing

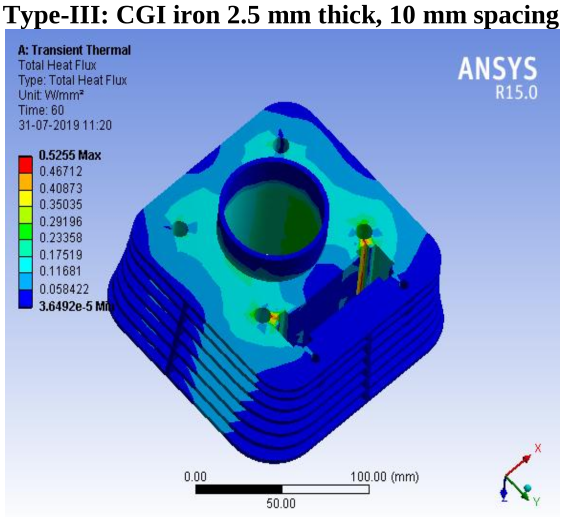

Fig-8: Total heat flux is 0.5255W/mm2

TABLE2: FIN THICKNESS 1.5MM, SPACING 10MM

material	Deformation mm	Heat flux	temperature distribution range
Al 6061	0.67525	0.80702	154.37-300.1
AMC -SC1	0.7527	0.60869	137.27-300.01
CGI	0.28814	0.48836	25.244-300.2

TABLE3: FIN THICKNESS 2MM, SPACING 10MM

material	deformation mm	Heat flux	temperature distribution range
Al 6061	0.67288	0.82786	153.36-300.04
AMC-SC1	0.74984	0.6246	136.33-300.04
CGI	0.28708	0.49692	25.103-300.29

TABLE4: FIN THICKNESS 2.5MM, SPACING 10MM

material	deformation mm	Heat flux	temperature distribution range
Al 6061	0.67125	0.87008	152.54-300.06
AMC-SC1	0.74772	0.65845	135-300.06
CGI	0.32865	0.5255	24.97.26-300.41

Current paper all obtained results like deformation, heat flux and temperature distribution are plot based on one of the versatile Mat- lab software

Here plot the optimum results obtained the deformation vs time of different material with fin thickness 2mm and10 mm spacing

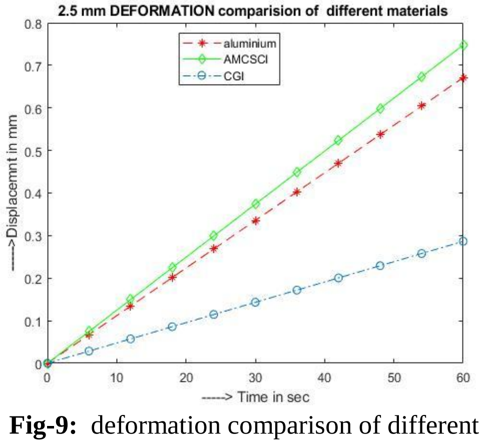

Fig-9: deformation comparison of different materials of 2.5mm fin thickness

Here plot the optimum results obtained the Heat flux VS temperature of different material with fin thickness 2.5mm and10 mm spacing

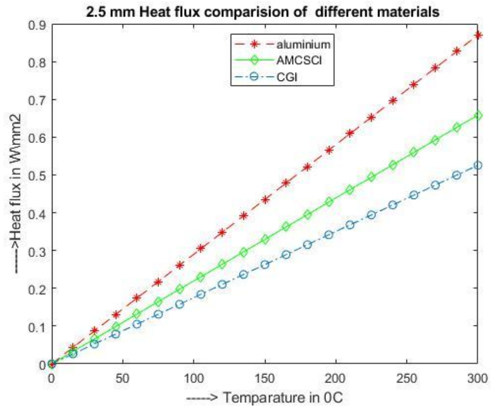

Fig-10: heat flux comparison of different materials of 2.5mm fin thickness

Brief study Current analysis above graphs display the optimum material and fin thinness of cylinder fins

V. CONCLUSION

UGNX-11 is a advanced 3D CAD software which is used to model the Suzuki Fiero cylinder heat fins with varying the heat fin thickness and spacing between fins with allowable dimensions. our current paper is design and transient thermal simulation is executed for three variety of materials like Al6061,AMC-SC1(Mg alloy), CGI(cast iron alloy). initially analyze the structural analysis of 1.5mm thickness and 10mm spacing of fins to generate the deformation of fins when apply the thermal results are transferred to the transient structural analysis to find out the heat flux and deformation results using transient thermal analysis. Conduct transient thermal analysis and analysed results are total heat flux, max deformation and temperature distribution of entire cylinder. Repeated transient structural analysis for deformation and transient thermal analysis for heat flux and temperature distribution is conducted at varying the fin thickness 2mm and 2.5 mm of 10mm spacing of fins with varying materials like AL6061,AMC-SC1(Mg alloy) and CGI (CAST IRON ALLOY) are selected for the purpose of analysis . By the end of the analysis exercise it conveys a message that to have an optimum material is AMC-SC1(Mg alloy) with 2.5mm thickness of fins are making of Air cooled Engine cylinder one need to choose higher values for convective heat transfer coefficient , thermal conductivity, heat flux,high temperature resistance value and low weight factor.

VI. FUTURE SCOPE

1. Examine the fracture analysis of engine cylinder when the sudden crash.
2. Simulation and Dynamic analysis of Engine block with piston
3. Analyze the fluid flow in combustion chamber using Ansys Computational fluid dynamics

REFERENCES

[1]. Thammala Praveen1, Dr.P.Sampath Rao2 , analyze the thermal properties by varying geometry material and thickness of cylinder fins' IJMET ,Volume 6, Issue 6, June (2015), pp. 95-118 Article ID: 30120150606010 .

[2]. B N Niroop Kumar Gowd1 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 .

[3]. A Sathish kumar, MD Kathir Kaman, S Ponsankar ' Design and thermal analysis on engine cylinder fins by modifying its material and geometry' Journal of Chemical and Pharmaceutical Sciences, ISSN: 0974-2115, JCPS Volume 9,issue 4 ,October - December 2016 .

[4]. Rahul Gupta1, Rajneesh Kumar2 'Heat Transfer Analysis of Engine Cylinder Fins Having Triangular Shape', International Journal of Scientific & Engineering Research, Volume 7, Issue 5, May-2016,ISSN 2229-5518

[5]. Sandeep Kumar1, Prof. Nitin Dubey2 'Investigation and Thermal Analysis of Heat Dissipation Rate of Single Cylinder SI Engine', IJEDR | Volume 5, Issue 2 | ISSN: 2321-9939

[6]. Shubham Shrivastava1, Shikar Upadhyay2 'Thermal Analysis of IC Engine Cylinder Block with Fins Perpendicular to the Axis of Piston Movement', IJIRMPS,ISSN 2348-7593 (Online) Vol. 3, Issue 2, pp: (139-149

[7]. D.ThornhillD, A.Graham, G.Cunningham, P.TroxierandR.Meyer,"Experimental investigation into the free air cooling of air-cooled cylinders" ,IJESRT, SAE Paper 2003-32-0034, (2003).

[8]. Pulkit Sagar , Puneet Teotia 'Heat transfer analysis and optimization of engine fins of varying geometry', (IOSR-JMCE), e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 7, Issue 4 (Jul. - Aug. 2013), PP 24-29.

[9]. Shubham Thange1 , Prof. Shivanad Karve2 'cfd analysis of heat transfer for wavy fins of icengine' ICRTESM-17,ISBN:978-93-86171-12-2.

[10]. Parmar Vivek jayeshbhai , 'A Review - Improving the Efficiency of IC Engine Fins by Varying its Material and Shape' IJARIIE, ISSN(O)-2395-4396Vol-4 Issue-1 2018 .

[11]. [B. Jayachandraiah, 'Modal Analysis of V-12 EngineCylinder Block Using Abaqus Software for Different Materials',IJRTE, ISSN: 2277-3878, Volume-7, Issue-ICETESM, March 2019.

[12]. Pankaj Agarwal, 'Engineering Materials And Additive Processes Used In Automotive Engine Blocks' IJASRE ,ISSN: 2454-8006, [Vol. 03, Issue 4, May -2017].

G.Gopinadh" Modeling and thermal Analysis of an Air Cooled Engine Cylinder under Diversify the Fins Thickness" International Journal of Engineering Research and Applications (IJERA), Vol. 09, No.09, 2019, pp. 20-24