International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 03, March 2017
www.ijates.com
ijates
ISSN 2348 - 7550

MODELING AND ANALYSIS OF COMPOSITE AUTOMOTIVE V8 ENGINE

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ABSTRACT

Heat losses are a major limiting factor for the efficiency of internal combustion engines. Furthermore, heat transfer phenomena cause thermally induced mechanical stresses compromising the reliability of engine components. The ability to predict heat transfer in engines plays an important role in engine development. Today, predictions are increasingly being done with numerical simulations at an ever earlier stage of engine development. These methods must be based on the understanding of the principles of heat transfer. In the present work V type multi cylinder engine assembly is modeled. This model is imported to ANSYS and done the steady state Thermal and Structural analysis for predicting thermal stress, temperature distribution, heat flux by comparing with two different material (FU 2451) from existing material (Aluminium).Heat transfer is one major important aspect of energy transformation in internal combustion (IC) engines. Locating hot spots in a solid wall can be used as an impetus to design a better cooling system. Fast transient heat flux between the combustion chamber and the solid wall must be investigated to understand the effects of the non-steady thermal environment.

***Keywords*: Cylinder, Combustion Chamber, FU 2451.**

I INTRODUCTION

A V8 engine is a V engine with eight barrels mounted on the crankcase in two banks of four chambers, much of the time set at a privilege plot to one another yet frequently at a narrower edge, with each of the eight cylinders driving a typical crankshaft.

In its simplest form, it is basically two straight-4 engines sharing a common crankshaft. However, this simple configuration, with a single-plane crankshaft, has the same secondary dynamic imbalance problems as two straight-4s, resulting in vibrations in large engine displacements. As a result, since the 1920s most V8s have used the somewhat more complex cross plane crankshaft with heavy counterweights to eliminate the vibrations. This results in an engine which is smoother than a V6, while being considerably less expensive than a V12 engine. Most racing V8 continue to use the single plane crankshaft because it allows faster acceleration and more efficient exhaust system designs.

The V8 engine has served as the essential force plant for American vehicles since the Ford Engine Company created the progressive flathead V8 engine for its Ford roadsters in 1932. From that point forward, Chevrolet has delivered a great many little and huge piece V8s, including the standard of all engines, the 350-cubic-inch V8, while Chrysler idealized the Gigantic Hemi V-8 to power its muscle autos.

II CALCULATIONS

T_g = Gas temperature = 1000 ˚c + 273 =1273K

T_c = Coolant temperature = 190 ˚c +273 = 463 K

T_w = Cylinder wall temperature = 105˚c + 273 = 368 K

T_i= Inlet temperature of water = 15 ˚c + 273 =298 K

Velocity of water =20 m/s

h_g = 50 W/m^2K

Δx = 0.025 m

Stefan-Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ W/m^2K^4

Є = 1 (assuming black surface)

2.1 Radiation heat transfer coefficient

$h_{gr}= \epsilon\, \sigma((T_g)^2+(T_w)^2)(T_g+T_w)$

$= 1 \times 5.67 \times 10^{-8}((1273)^2 + (463)^2)(1273+463)$

= 180.611 W/m^2K

2.2 Convective heat transfer coefficient of coolant Jacket

h_c= (Nu . K)/L

Where Nu = $0.59\, R_e^{0.25}$

L = characteristic length

$R_e = (\rho\, v\, D)/ \mu$

Where D = 0.1 m and length l = 0.091 m

Mean temperature $T_f= (T_c +T_i)/2$ = (105 + 15)/2 = 60 ˚C

At 60 ˚C water properties in heat transfer data book

ρ = 983.3 kg/m^3 k = 0.654 Pr = 3.01 $\mu = 4.71 \times 10^{-4}$

Material	**Thermal Conductivity** k (W/m K)	**Heat Transfer** q' (W/m^2)
Aluminium	28	28280.88
FU 2451	60	28712.835

$R_e = (983.3 \times 20 \times 0.1)/ 4.71 \times 10^{-4}$

= 4175371.55

Since it is laminar flow (10^6 -10^9)

$Nu = 0.59\ R_e^{0.25} = 26.67$

h_c= (Nu . K)/L = (26.67 x 0.654)/0.091 = 191.67 W/m^2K

2.3 Aluminium

Thermal conductivity is 28 W/m K

$$U_{al} = \frac{1}{\frac{1}{hg}+\frac{1}{hgr}+\frac{\Delta x}{k}+\frac{1}{hc}}$$

$$= \frac{1}{\frac{1}{50}+\frac{1}{180.611}+\frac{0.025}{28}+\frac{1}{191.67}}$$

U_{al} = 31.59875

$q_{total} = Ual(T_g - T_c)$

= 31.5975 x (1273-378)

q_{total}= 28280.88 W/m^2

FU 4270

Thermal conductivity is 40 W/m K

$$U_{al} = \frac{1}{\frac{1}{hg}+\frac{1}{hgr}+\frac{\Delta x}{k}+\frac{1}{hc}}$$

$$= \frac{1}{\frac{1}{50}+\frac{1}{180.611}+\frac{0.025}{40}+\frac{1}{191.67}}$$

U_{al} = 31.8683842

$q_{total} = U_{al}(T_g - T_c)$

= 31.8683842 x (1273-378)

q_{total}= 28522.203 W/m^2

FU 2451

Thermal conductivity is 60 W/m K

$$U_{al} = \frac{1}{\frac{1}{hg}+\frac{1}{hgr}+\frac{\Delta x}{k}+\frac{1}{hc}}$$

$$= \frac{1}{\frac{1}{50}+\frac{1}{180.611}+\frac{0.025}{40}+\frac{1}{191.67}}$$

= 32.0814

$q_{total} = U_{al}(T_g - T_c)$

= 32.0814 (1273-378)

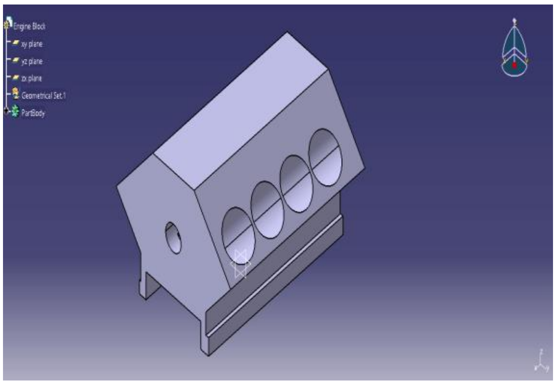
q_{total}= 28712.835W/m^2

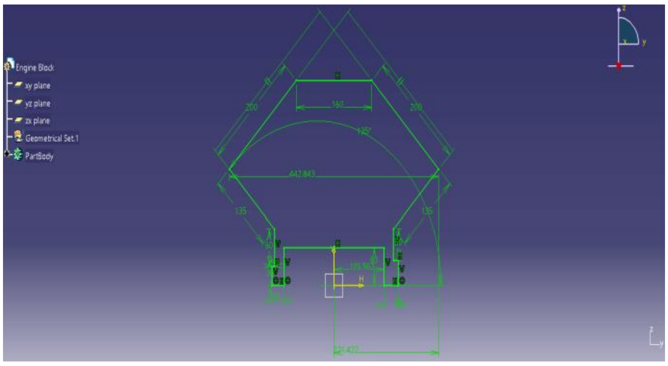
TABLE1: Theoretical values of Thermal Conductivity and Heat Transfer of materials and FU 2451 and for existing material Aluminium alloy and the total heat transfer obtained from the above mathematical calculations are shown.

III MODELING OF CYLINDER BLOCK

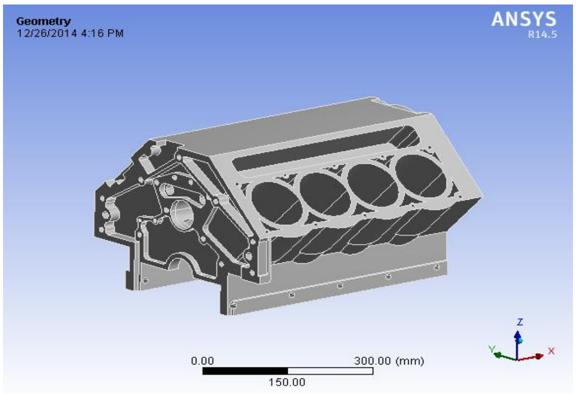
Modeling of cylinder block in CATIA 2D Part

Modeling of cylinder block in CATIA3D Model a of Cylinder Block





Analysis Results of Cylinder Block for Aluminium



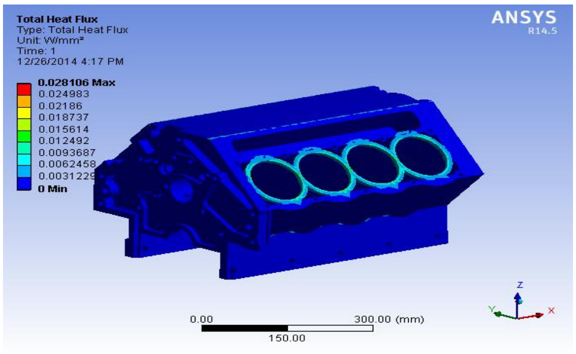


Fig 3 3D Model of cylinder block **Fig 4.shows the Heat flux produced in the cylinder block.**

International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 03, March 2017
www.ijates.com
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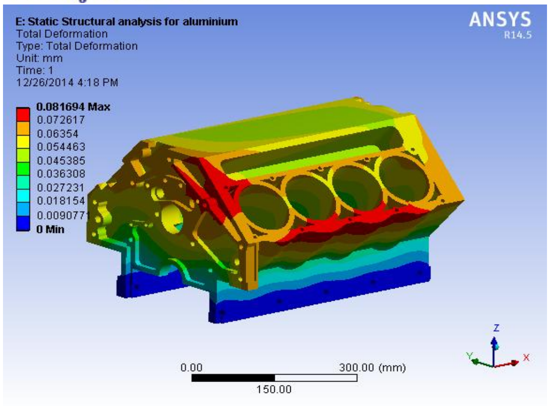
ISSN 2348 - 7550



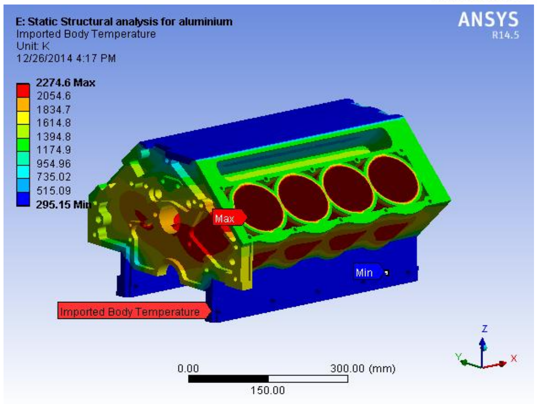
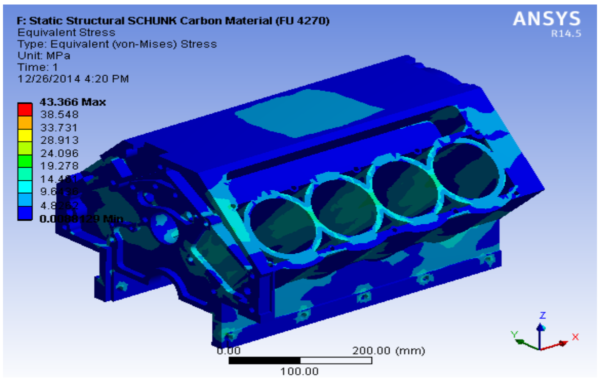


Fig5.Total deformation generated in cylinder block **Fig 6 Imported Body Temperatures**

Analysis Results of Cylinder Block for FU 2451



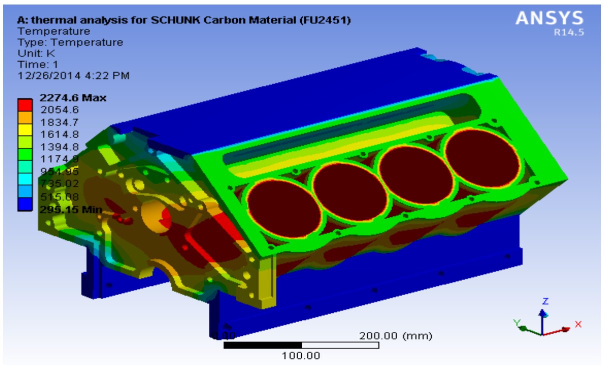


Fig 7. Equivalent stress induced in Cylinder Block of FU 2451 **Fig 8. Temperature distribution for Cylinder Block**

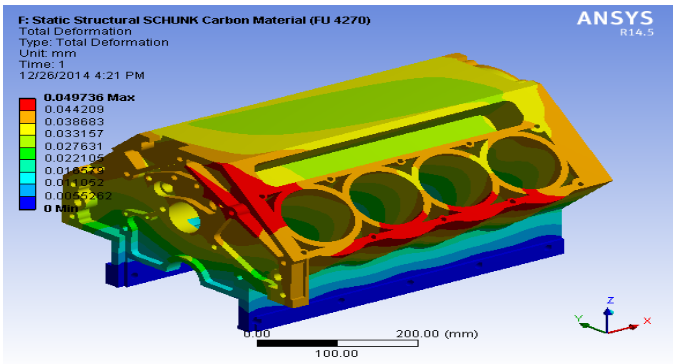


Fig 9. Deformation induced in Cylinder Block for FU2451

IV RESULTS AND DISCUSSION

In the present work modeling of V8 engine cylinder block was done using CATIA V5. This model was imported to ANSYS Work Bench and done the steady state thermal analysis and calculated the heat flux, normal stress, equivalent stress and deformation for the carbon material FU 2451 and compare th results with existing Aluminium and proposed the suitable material.

By doing the steady state thermal analysis using ANSYS work bench 14.5 V and by calculating the convective heat transfer amount through cylinder walls from the theoretical calculations, and calculated the heat flux and equivalent stress, normal stress and the total deformation produced for the cylinder block for Aluminium, FU 2451 along with their thermal conductivities, and their results are given in Table 2.

Table 6.1 Analytical Results (FEA) for Aluminium, FU 2451

Parameters	Aluminium(k= 28)		FU 2451	
	Max	Min	Max	Min
Temperature (K)	2274.6	295.15	2274.6	295.15
Total Heat Flux(W/m^2)	0.028106	0	0.028624	0
Imported Body Temperature (K)	2274.6	295.15	2274.6	295.15
Equivalent Stress(MPa)	75.172	0.014682	86.716	0.007112
Normal Stress(MPa)	31.15	-31.583	34.88	-26.101
Shear Stress(MPa) at XY Plane	14.521	-12.03	11.518	-17.515
Total Deformation(mm^2)	0.081694	0	0.077175	0

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ISSN 2348 - 7550

So from the above values by plotting results for two different materials with existing material it compared thermal Stress, temperature distribution and Heat Flux are lower in FU 4270 Material so this is best material for fast transient heat transfer between the combustion chamber and the solid wall.

It is important transient hotness exchange between the burning chamber and cylinder wall in V8 engine, transient hotness exchange depends largely on the materials of the cylindrical block. In the present work transient hotness exchange between the burning chamber and cylinder wall is compared for three different materials. For this first modeling of V8 cylinder block was done using CATIA V5, and analysis was done using ANSYS. Theoretical values of the thermal stresses, temperature distribution, normal stresses, heat flux and deformation are also calculated, and compared with ANSYS values.

By comparing for the FU 2451 carbon materials with existing material Aluminium alloy, it is concluded that thermal stress, temperature distribution and heat flux are lower in FU 2541 Material, so this is best material for quick transient hotness exchange between the burning chamber and the cylindrical wall.

V CONCLUSION

It is important transient hotness exchange between the burning chamber and cylinder wall in V8 engine, transient hotness exchange depends largely on the materials of the cylindrical block. In the present work transient hotness exchange between the burning chamber and cylinder wall is compared for three different materials. For this first modeling of V8 cylinder block was done using CATIA V5, and analysis was done using ANSYS. Theoretical values of the thermal stresses, temperature distribution, normal stresses, heat flux and deformation are also calculated, and compared with ANSYS values.

By comparing for the FU 2451 carbon materials with existing material Aluminium alloy, it is concluded that thermal stress, temperature distribution and heat flux are lower in FU 2451 Material, so this is best material for quick transient hotness exchange between the burning chamber and the cylindrical wall.

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