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PERFORMANCE EVALUATION OF DIESEL ENGINE WITH OXYGENATED BIO-DIESEL FUEL BLENDS

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***Abstract* -Automobile engines are usually petrol, diesel or gasoline engines. Petrol engines are Spark Ignition engines and diesel engines are Compression Ignition engines. Blended fuels are mixtures of traditional and alternative fuels in varying percentages. In this thesis, the effect of diesel and blended fuels in combustion chamber is studied by mathematical correlations applying thermal loads produced during combustion. Blended fuel considered in this thesis is biodiesel blended in different percentages. Percentages vary from 5%, 15% and 20%. FEA analytical approach is performed to validate the mathematical correlations. Boundary conditions to be taken are thermal loads i.e temperature, heat generated, heat transfer coefficient. FEA thermal analysis is done in ANSYS. The parametric model is done in Pro/Engineer.**

I. INTRODUCTION

Normally a fossil fuel occurs with an oxidizer (usually air) in a chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine (ICE) the expansion of the high-temperature and high-pressure gases produced by combustion apply direct force to some component of the engine. The force is applied typically to pistons, turbine blades, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy. The first commercially successful internal combustion engine was created by Etienne Lenoir.

i. Influence of composition of gasoline – ethanol blends on parameters of internal combustion engines by Alvydas Pikūnas, Saugirdas Pukalskas- The purpose of this study is to investigate experimentally and compare the engine performance and pollutant emission of a SI engine using ethanol–gasoline blended fuel and pure gasoline. The results showed that when ethanol is added, the heating value of the blended fuel decreases, while the octane number of the blended fuel increases. The results of the engine test indicated that when ethanol–gasoline blended fuel is used, the engine power and specific fuel consumption of the engine slightly increase; CO emission decreases dramatically. [1]

ii. The Influence of Gasoline/Ethanol Blends on Emisssions and Fuel Economy by F. M. Salih, G. E. Andrews-A 1117cc Ford Valencia SI engine was used to investigate the influence on emissions of relatively large (10-30%) additions of ethanol to gasoline. The ethanol was shown to extend the lean burn range and improve the specific energy consumption in the lean burn region. Addition of ethanol significantly reduced NO_x and Co by over 50% and increased slightly HC and condensible hydrocarbons, but had little effect on NMHC. [2]

iii. Experimental investigation on varying the compression ratio of SI engine working under different ethanol–gasoline fuel blends by A. A. Abdel-Rahman, M. M. Osman-Using different ethanol–gasoline fuel blends, a VARICOMP engine was used to study the effect of varying the compression ratio on SI engine performance. The performance tests were carried out using different percentages of ethanol in gasoline fuel, up to 40%, under variable compression ratio conditions. The results show that the engine indicated power improves with the percentage addition of the ethanol in the fuel blend. The maximum improvement occurs at 10% ethanol–90% gasoline fuel blend. © 1997 by John Wiley & Sons, Ltd. [3]

II.THEORETICAL CALCULATIONS

RENAULT Duster

The Duster is an entry level SUV from Renault that seeks to revolutionise the segment. The Duster comes equipped with a choice of petrol and diesel engines, decent fit and finish and good ride quality, on and off the road.

DIESEL ENGINE
TECHNICAL SPECIFICATIONS OF Rx E Diesel 85 PS

• Engine Type K9K Diesel Engine

Engine Description 1.5-litre 83.8bhp 4Cylinder K9K Diesel Engine

Displacement (cc) 1948cc

Power (PS@rpm) 83.8bhp@3750rpm

Torque (Nm@rpm) 200Nm@1900rpm

No. of Cylinders 4

Valves per Cylinder 4

Fuel Type Diesel

Fuel System CRDI

Turbo Charger Yes

- Transmission

Transmission Type Manual

Gears 5

Gear Box Type 5 Speed

Drive Type FWD

- Fuel Economy

Mileage Highway (km/liter) 20.46

Mileage City (km/liter) 18.0

- Dimensions and Weights

Overall Length (mm) 4315

Overall Width (mm) 1822

Overall Height (mm) 1695

Wheel Base (mm) 2673

Ground Clearance (mm) 205

Front Track (mm) 1560

Rear Track (mm) 1567

Gross Vehicle Weight (kg) 1758

No of Doors 5

- Capacities
- Suspensions

Front Suspension Independent McPherson Strut with Coil Springs & Anti-Roll Bar

Rear Suspension Torsion Beam Axle with Coil Springs & Anti Roll Bar

- Steering

Steering Type Power

Power Assisted Steering Electro Hydraulic Power Assisted

Minimum Turning Radius (meter) 5.2

- Brakes

Front Brakes Ventilated Disc

Rear Brakes Drum

- Wheels and Tires

Wheel Type Alloy

Wheel Size R16

Tire Type Tubeless Tires

Tire Size 215/65 R16

Power (W) =83.8hp

=83.8×746=62514.8W

Displacement (v_d) =1948cc

$=1.948\times10^{-3}m^3$

Speed (N) =3750 rpm

Capacity=1.5L

$=\frac{1.5}{1000}=1.5\times 10^{-3}m^3$

Mass =volume × density $=1.948\times10^{-3}\times821.31=1.5$kg

Molecular mass (m*)=233gr/mol

$P_{b\ mean}=\frac{n\,W}{vd\,N}$

$=\frac{2\times 62514.8}{1.948\times10^{-3}\times\frac{3750}{60}}$ =1026937.166N/m^2

$P_{b\ mean}$=break mean effective pressure in N/m^2

n= no. of power cycles

N=speed in rev/sec

V_d= Displacement in m^3

PV=MRT

T= $\frac{PV}{MR}$ (FROM UNIVERSEL GAS CONSTAT EQATION)

V=induced volume=$\frac{capacity\times speed}{2}$

1.948×10^{-3} (3750/60× 2) =0.060875m^3/sec

T=temperature in Kelvin

M =mass

R = universal gas constant=8.314 J/k mol

T=$\frac{1026937.166\times0.060875}{\frac{1.5}{0.223}\times4.184}$ =2320.896813

BLENDED FUELS

Oxygenated=5% Diesel =95%

M_d=1.5× $\frac{95}{100} = 1.425\times0.223 = 0.31775$kg

M_e=1.5× $\frac{5}{100} = 0.075\times0.060875 = 0.00456$kg

T=$\frac{PV}{MR}$

$= \frac{1026937.166\times0.060875}{\frac{1.425}{0.31775}+\frac{0.12}{0..00552}\times4.184}$ = 542.233 K

Oxygenated =15% Diesel =85%

M_d=1.5× $\frac{85}{100} = 1.275\times0.223 = 0.284325$kg

M_e=1.5× $\frac{15}{100} = 0.225\times0.060875 = 0.0136968$kg

T=$\frac{PV}{MR}$

$=\frac{1026937.166\times0.0608}{\frac{1.275}{0.284325}+\frac{0.225}{0.01369}\times4.184}$ =714.24K

Oxygenated =20% Diesel =80%

M_d=1.5× $\frac{80}{100} = 1.2\times0.223 = 0.2676$kg

M_e=1.5× $\frac{20}{100} = 0.3\times0.0608 = 0.01824$kg

T=$\frac{PV}{MR}$

$=\frac{1026937.166\times0.060875}{\frac{1.2}{0.2676}+\frac{0.3}{0.01824}\times4.184}$ = 714.218K

III.Generic Steps to Solving any Problem in ANSYS

Build Geometry

Construct a two or three dimensional representation of the object to be modeled and tested using the work plane coordinate system within ANSYS.

Define Material Properties

Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties.

Generate Mesh

At this point ANSYS understands the makeup of the part. Now define how the modeled system should be broken down into finite pieces.

Apply Loads

Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

Obtain Solution

This is actually a step, because ANSYS needs to understand within what state (steady state, transient… etc.) the problem must be solved.

Present the Results

After the solution has been obtained, there are many ways to present ANSYS' results, choose from many options such as tables, graphs, and contour plots.

THERMAL ANALYSIS

FUEL - DIESEL
MATERIAL – CAST IRON
Set Units - /units, si, mm, kg, sec, k

File- change Directory-select working folder

File-Change job name-Enter job name

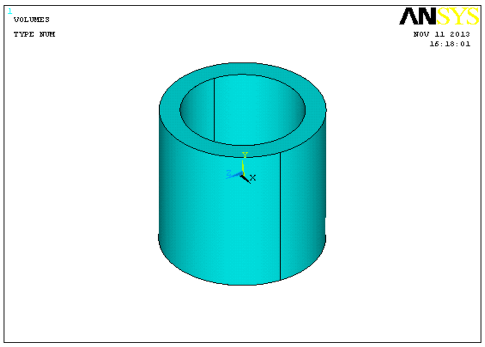
Select element-Solid-20node 90

Material Properties
Thermal Conductivity – 11.3 W/ m°k

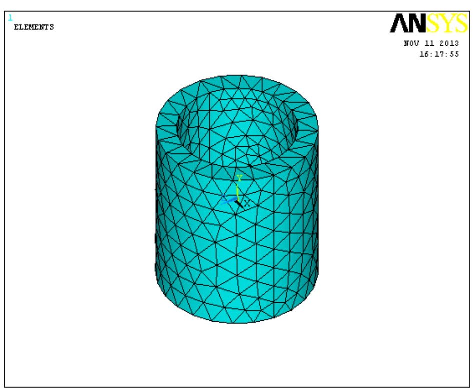
Specific Heat- 0.506 J/g °c

Density – 5.54 g/cc

IMPORTED MODEL



MESHED MODEL

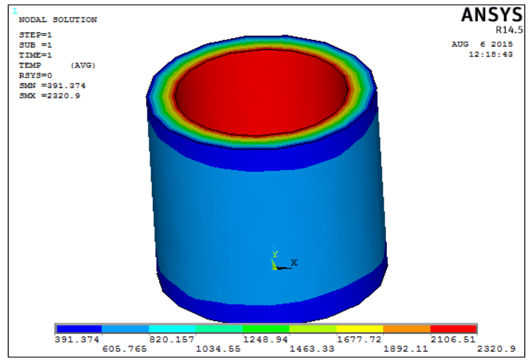


Loads
Apply Thermal-Temperature- on Area=2320.89K

Convections – on Area-Film Co-efficient – 0.039 W/mmK

Bulk Temperature – 303 K

General post processer- contour plot- nodal solution- Nodal Temperature



By using fuel as diesel, the temperature distribution is max of 2320.9K and min of 391.372K.

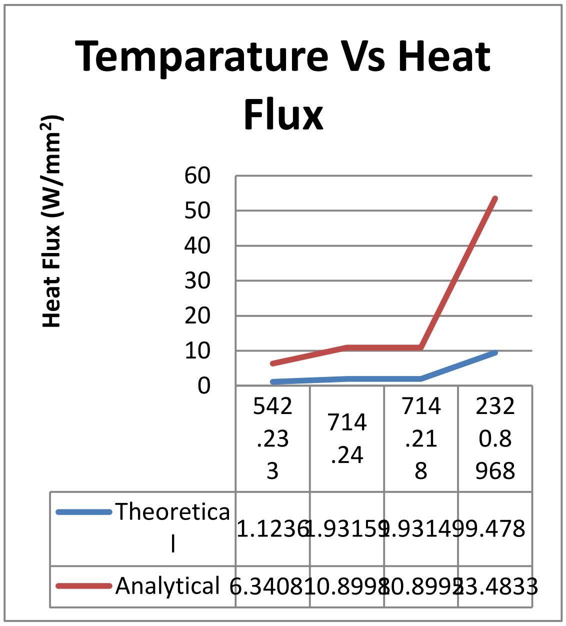
IV.RESULTS AND DISCUSSIONS

	Nodal Temperature (K)	Thermal Gradient (K/mm)	Heat flux (W/mm^2)
DIESEL	2320.89	473.308	53.4833
DIESEL+10%E	542.233	56.1133	6.34081
DIESEL+15%E	714.24	96.4585	10.8998
DIESEL+25%E	714.218	96.4533	10.8992

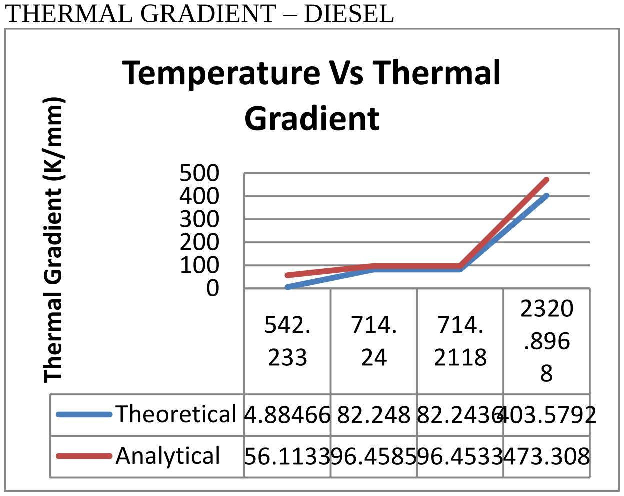
DIESEL ENGINE

	Thermal Gradient (K/mm)	Heat flux (W/mm^2)
DIESEL	403.5792	9.4780
DIESEL+10%E	47.8466	1.1236
DIESEL+15%E	82.248	1.93159
DIESEL+25%E	82.2436	1.931488

- Using Diesel as fuel, the rate of change in temperature over a distance is 403.5792K/mm and the rate of heat transfer over an area is 9.4780W/mm^2.
- Using Diesel and 5% Ethanol as fuel, the rate of change in temperature over a distance is 47.8466K/mm and the rate of heat transfer over an area is 1.1236W/mm^2.
- Using Diesel and 15% Ethanol as fuel, the rate of change in temperature over a distance is 82.248K/mm and the rate of heat transfer over an area is 1.93159W/mm^2.
- Using Diesel and 20% Ethanol as fuel, the rate of change in temperature over a distance is 82.2436K/mm and the rate of heat transfer over an area is 1.931488W/mm^2.



COMPARISON OF RESULTS BETWEEN ANALYTICAL AND THEORETICAL VALUES THERMAL GRADIENT – DIESEL



CONCLUSION

In this thesis, the effect of petrol, diesel and blended fuels in combustion chamber is studied by mathematical correlations to calculate thermal loads produced during combustion. Fuels considered are Diesel, Blended fuels. Blended fuels taken is oxygenated bio diesel fuels blended in different percentages. Percentages vary from 5%, 15% and 20%. Material used for cylinder is Cast Iron.

Theoretical calculations are done to calculate the temperature produced for combustion when fuel is changed. Thermal analysis is done on the cylinder applying temperature by changing the fuels used for combustion. The cases considered are Diesel, Diesel + 5% Bio diesel, Diesel + 15% Bio diesel, Diesel + 20% Bio diesel.

By observing the analysis results, by using only diesel as fuel the heat transfer rate is more than by taking blended fuels. When the blended fuels are considered, by increasing the percentage of bio diesel, the heat transfer rate is reducing. Theoretical calculations are also done to calculate thermal gradient and thermal flux. By comparing both analytical and theoretical results, the values are almost same.

So it can be concluded that, for blending fuels, less percentage of bio diesel is better.

REFERENCES

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