Numerical Investigation Exhaust Emission In IC Engine With Eucalyptus Oil Blend

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Abstract: **Majority of the automobiles run with internal combustion engines such as spark ignition (SI) and compression ignition (CI) engines which use conventional fuels such as Petrol, Diesel etc. The use of automobiles increasing day by day in the human life .As the use of the automobiles increase, the consumption of the fuels like petrol, diesel also increases and due to the increased consumption of the fuels depletion of fuel resources occurs. Along with the depletion the emissions emitted from the automobile engines increases and there by affect human health, and environment. The main emissions like hydrocarbons(HC) , carbon monoxide (CO) ,nitrogen oxides(NOx) and oxides of sulphur (SOx) emitted from automobile engines affect human lungs and also affects the environment which causes global warming and acid rains.**

From the above reasons in order to reduce the emissions various researches going on petrol and diesel engines. The petrol engines are used in light weight motor vehicles where as diesel engine are used in heavy duty motor vehicles. The petrol engines are very popular from the time of their invention; most of the automobiles are run by these engines mainly because of its simplicity and ease of operations, they are the choice for number of researches. As crude oil reserves are decreasing and increasing price of petrol alternative fuels are coming in to picture.

Now a day's most of the alternative fuels like ethanol, methanol, orange oil, eucalyptus oil are biomass derived and easily available. Alternative fuels which are renewable and also eco friendly reduce the dependency on fossil fuels and they help to preserve the atmosphere by reducing the emission levels. Alternate fuels can be in the form of solid, liquid, and gaseous fom. The solid fuels are not used in ic engines due to their physical properties, the liquid fuels are alcohols (ethanol, methanol) and vegetable oils (edible and non edible), and the gaseous fuels are LPG, CNG, H2, biomass and producer gas. Liquid fuels are easy to handle and calorific value of these types of fuels is more..

Many alternative fuels blends has been introduced in past and they gave satisfying results. Therefore, in this project the eucalyptus oil which is high octane biomass derived fuel is blended with petrol 15% by volume that is Eu15 and used as fuel in four stroke multi cylinder petrol engine and pollution characteristics were studied and analyzed using ANSYS-FLUENT software.

I. INTRODUCTION

The first chapter of the thesis devotes to the general view of a Petrol engine, in relation to the combustion and emissions. The chapter presents the operation of the Petrol engine with alternate fuels, especially bio fuels which are to be blended with petrol and also discusses intake system of air fuel mixture into the engine. At the end of the chapter, the types of fuels are presented.

Background of the petrol engines:

A petrol engine (known as a gasoline engine) is an internal combustion spark ignition engine, designed to run on petrol (gasoline) and similar volatile fuels.

The first practical petrol engines was built in Germany by Nikolas August Otto, although there had been earlier attempts by Etienne Lenoir, Siegfried Marcus, Julius hock and George brayton .

The first petrol combustion engine (one cylinder 121.6 cm3 displacement) was prototyped in 1882 in Italy by Enrico bernardi.

In most petrol engines, the fuel and air are usually premixed before compression (although some modern petrol engines now use cylinder – direct petrol engine) the pre-mixing was formally done in a carburettor . But now it is done by electronically controlled fuel injection except in small engines where the cost/ complication of electronics does not justify the added engine efficiency.

The process different from a diesel engine in the method of mixing the fuel and air, and in spark plugs to initiate the combustion process. in diesel engine only air is compressed (and therefore heated) and the fuel is injected into hot air at the end of the compression stroke and self ignites.

Alternate fuels for the petrol engine:

As the time passes it is believed that the petroleum products and crude oil will be not enough and will

be costly .various researches are going on for the improvement of fuel economy of engines. However as the demand and availability for petrol and diesel is somewhat un balanced and there is a need to balance since that is mainly happened due to enormous increase in number of vehicles if the same situation continuous then the scenario will be more disastrous and petrol and diesel will be more costly and limited .with increase use and the depletion of fossil fuels today more emphasis is given on the alternate fuels .

There is an essential need of alternate fuels in a way or other .Today intensive search for the alternative fuels for both spark ignition (SI) and compression ignition (CI) engines and it has been found out that the biomass derived fuels are suited for the alternate fuels .in spark ignition engines fuels like eucalyptus oil and orange oil are the suitable substituents for the petrol. they can be blended with petrol over a void range of percentage according to the requirement. Another reason for the need of alternate fuel for ic engines is the emission problems. Combine with other air polluting factors, the large no of automobiles is a major contributor to the air. The quality problems of the world. as this fuels cannot be run directly in the engines .therefore these are blended with gasoline at various percentage . one of the main reason for neglecting these fuels is the similarity in the properties of these with gasoline and they are miscible with gasoline without any phase separation .the engines used for these blending are for alternate fuels are modified engines which were originally designed for gasoline fuelling .the eucalyptus oil can be used in spark –ignition engines with very little engine modification has a blend with gasoline .since the octane number of eucalyptus oil is more than gasoline, so it enhances the octane value of the fuel when it is blended with low octane gasoline .at the same time the compression ratio (CR) which is dependent on knock can be increased when these fuels are blended with gasoline . .

The alternate fuel for the spark ignition engines generally having the high octane number than gasoline .The meaning of the octane number is the octane number is how the gasoline engine run smoothly and resistant to abnormal combustion in the gasoline engine. The abnormal combustion phenomenon in the gasoline engine is called Knocking or Detonation. Octane number is consists of two components n- heptane has an octane number of '0' which iso-octane (2,2,4 –trimethyl pentane) is 100. The two components are used to measure the octane number of a particular fuel. A 90%/10% blend of iso-octane/ n-heptane has an octane value of 90. The high performance of the engine has higher compression ratio(CR) and higher octane gasoline. The knocking in the spark ignition engines is occurring at the end of the compression of fuel mixture.

The alternate fuels which are used in gasoline engine like orange oil, eucalyptus oil, ethanol..Etc. They can be blended with the gasoline after the esterification process. The properties of blended fuel near to the properties of the pilot fuel.

II. LITERATURE SURVEY

Various researches which have been done in the past over a time of period came out to be very useful and informative while initiating the above research work.

IRWIN OSMOND TOPPO et. al[1]: carried out an experiment on ' CFD Analysis of combustion characteristics of jatropha in Compressed ignition engine.

POOLAR R.B.et. al [2]: carried out an experiment in the year 1993 with 20% by volume of orange oil were separately blended with gasoline brake thermal efficiency, exhaust emissions and combustion parameters were obtained. The experiment was conducted on small capacity (145.45 cc displacement volume, 4.3 kw at 5200 r.p.m) ,loop scavenged, air cooled ,single cylinder ,2 stroke –ignition engines with a compression ratio of 7.4. it was found out that the performance fuel blends was better than gasoline fuel. Experiment was performed on two compression ratios viz. 7.4 . it was found that the performance fuel blends was better than the gasoline fuel. Experiment was performed on two compression ratioviz 7.4& 9 and improvement of 20.5% in brake thermal efficiency was obtained at 2 KW , 3000rpm over the normal gasoline engine .Along with this hydrocarbon and carbon monoxide emission were reduced .While comparing the two fuel blends eucalyptus oil blend provides the results for the brake thermal efficiency with low exhaust emissions.

TAMILVEDHAN.D et. al [3]: carried out the experiment study on the performance ,emission characteristics of a methyl ester sunflower oil and eucalyptus oil on a single cylinder air cooled and direct injection diesel fuel and the results which were obtained by the above test were compared with the results while running with standard diesel when eucalyptus oil having low cetane number is mixed with methyl ester sunflower oil having high cetane number up to 50% results in increase in brake thermal efficiency by 2-3% percentage .the results also indicated the reduction of 37.5% in carbon monoxide emission for the MeS504Eu50 blend at full load while the hydrocarbon emissions were reduced at both low load and full load but considerably at full load that may be due to the complete combustion of the fuel load.

M. SENTHIL KUMAR et. al [4]: carried out experiment on the use of vegetables oil directly in

compression ignition engines .Along with that small quantities of orange oil were inducted along with air and ignited after compression .Methyl ester of Jatropha oil and diesel were also used as fuels for comparing the results with that of the vegetable oil.

III. CFD PROGRAMS

The availability of affordable high performance computing hardware and the introduction of user-friendly interfaces have led to the development of commercial CFD packages. Before these CFD packages came into the common use, one had to write his own code to carry out a CFD analysis. The programs were usually different for different problems, although a part of thecode of one program could be used in another. The programs were inadequately tested and reliability of the results were often questioned. Today, well tested commercial CFD packages not only have made CFD analysis a routine design tool in industry, but also have helped the research engineer focus on the physical system more effectively. All formal CFD software contain three elements (i) a pre-processor, (ii) the main solver, and (iii) a post-processor

The Pre-processor

Pre-processing is the first step of CFD analysis in which the user

(a) defines the modeling goals,

(b) identifies the computational domain, and

(c) designs and creates the Mesh system

Program Structure

FLUENT package includes the following products:

- FLUENT, the solver.
- Pre PDF, the preprocessor for modeling non-premixed combustion in FLUENT.
- FLUENT, the preprocessor for geometry modeling and mesh generation.
- T Mesh, an additional preprocessor that can generate volume meshes from existing boundary meshes.
- Filters (translators) for import of surface and volume meshes from CAD/CAE packages such as ANSYS, CGNS, I-DEAS, NASTRAN, PATRAN, and others.

Once a Mesh has been read into FLUENT, all remaining operations are performed within the solver. These include setting boundary conditions, defining fluid properties, executing the solution, refining the Mesh, and viewing and post processing the results.

FLUENT is ideally suited for incompressible and compressible fluid flow simulations in complex geometries. Fluent Inc. also offers other solvers that address different flow regimes and incorporate alternative physical models. Additional CFD programs from Fluent Inc. include Airpak, FIDAP, Icepak, MixSim, and POLYFLOW.

FLUENT uses unstructured meshes in order to reduce the amount of time user spend generating meshes, simplify the geometry modeling and mesh generation process, model more-complex geometries than user can handle with conventional, multi-block structured meshes, and let user adapt the mesh to resolve the flow-field features. FLUENT can also use body-fitted, block-structured meshes (e.g., those used by FLUENT 4 and many other CFD solvers). FLUENT is capable of handling triangular and quadrilateral elements (or a combination of the two) in 2D, and tetrahedral, hexahedral, pyramid, and wedge elements (or a combination of these) in 3D. User can adapt all types of meshes in FLUENT in order to resolve large gradients in the flow field, but user must always generate the initial mesh (whatever the element types used) outside of the solver, using FLUENT, TMesh, or one of the CAD systems for which mesh import filters exist.

MODELING THE GEOMETRY:

S.No	DESCRIPTION	VALVE
1	Fuel	Gasoline and eucalyptus oil
2	Engine type	V6
3	Displacement	2721cm3
4	Induction system	Twin –turbo (VGT)
5	Valves/cylinder	1
6	Bore x stroke	81mm X 88mm
7	Connecting rod length	160mm
8	Compression ratio(CR)	17.3
9	Intake valve max lift	8.00mm
10	Exhaust valve max lift	8.10mm
11	Intake valve diameter	25.9mm
12	Exhaust valve diameter	23mm
13	Intake duration	252CAD
14	Exhaust duration	291 CAD

Table Engine specifications for modeling geometry

(CAD) and computer-aided engineering (CAE) computer program that runs on Microsoft Windows. Solid Works is published by Dassault Systèmes. The geometry is modelled in a Computer Aided Designing Platform which allows building 3d models as per the realistic environment this helps in fasten work and will reduce cost without prototyping

Solid Works (stylized as SOLIDWORKS), is a solid modelling computer-aided design

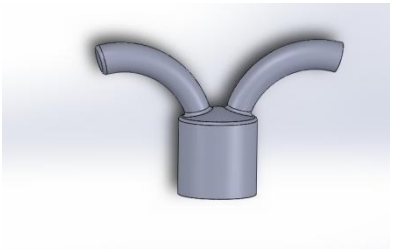


Fig 3D Volume of an ic engine designed in solid works.

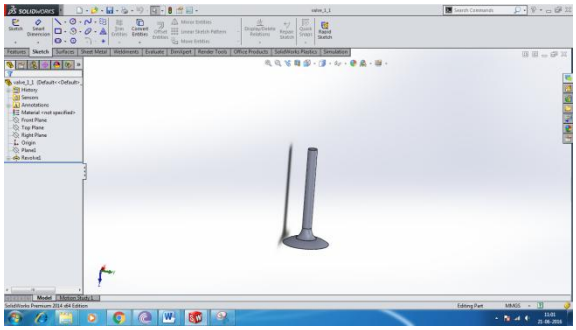
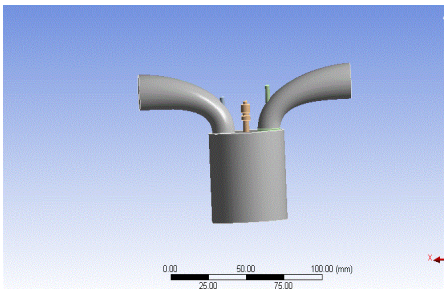


Fig Valve designed in the Solid Works

Fig shows the parts assembled engine for the analysis

IV. ANSYS WORKBENCH



The above Fig represents the volume imported to do the fluent analysis in ansys (step)

V. RESULTS AND DISCUSSIONS

The results show the contour plots of the different pollutants of the IC engine like as HC, NH3, NO etc.

THE CONTOUR PLOT OF THE HYDROCARBONS:

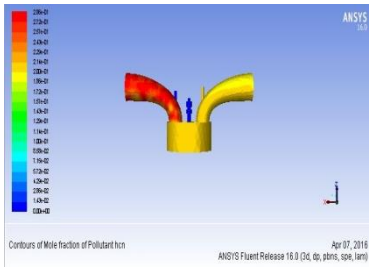


Figure shows the contours of Mole fraction of HC.

CONTOURS OF MOLE FRACTION OF NITROGEN MONOXIDE

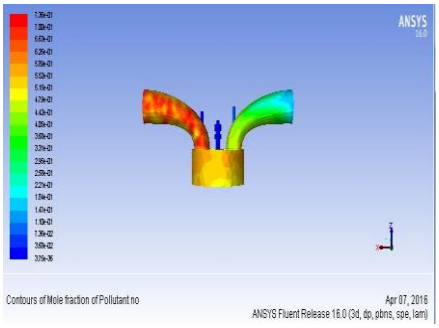


Fig shows the mole fraction of pollutant NO

CONTOURS OF THE MOLE FRACTION OF POLLUTANT NH3:

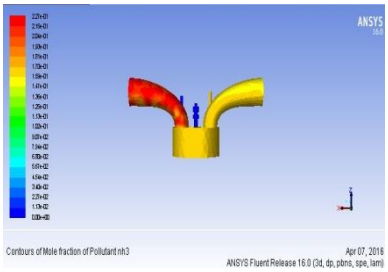


Fig shows the mole fraction of pollutant NH3

VI. CONCLUSION

EMISSION ANALYSIS:

The emissions coming out from the internal combustion engine undesirable. These emissions are exhausted into the surrounding pollute the atmosphere and causes the various problems like global warming, acid rain, smog ,odours and hazard to the respiratory system.

The engine running with the petrol as the fuel emission parameters are not specifically ideal that results in more emission of un burnt hydrocarbons

(HC), carbon monoxide (CO) and oxides of nitrogen (NOx)

Engine emissions are classified two types

1 Exhaust emissions

2 Non exhaust emissions

Exhaust emissions:

The exhaust emissions as the mentioned above are

- Un burnt hydro carbon(HC)
- Oxides of carbon
  - Carbon monoxide (CO)
  - Carbon dioxide (CO)
- Oxides of nitrogen(NOx)

These emissions common to both SI and CI engines

Non exhaust emissions:

Non exhaust emissions are the UN burnt hydrocarbons from the fuel tank and crank case emissions

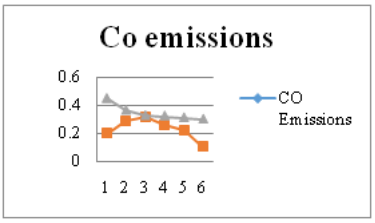


Fig shows the variation of CO emission with position

CAUSES OF HC EMISSION:

- In complete combustion due to improper mixing and flame quenching
- Leakage of exhaust valve
- Flow of fuel between the piston, piston rings ,and cylinder walls
- Deposition of fuel on walls
- Oil on combustion walls

The fig 7.2 shows the HC emissions with position .HC emissions low as compared to normal gasoline. the HC emission decreases when the gasoline blends with eucalyptus oil and operated entire conditions due to the reason for the less HC emission is equivalent ratio and easily decomposition of eucalyptus oil which gives more intermediate compounds and presence of oxygen in cineole which is main component of eucalyptus oil results in availability of more oxygen for carbon to react causing less HC emission.

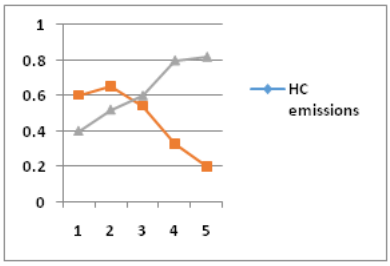


Fig shows the variation of HC with the position

OXIDES OF NITROGEN (NO) EMISSION:

The fig 7.3 shows the NOx emission with variation of position. NO emissions increases with continuously increasing with position increases because of the oxygen present in the eucalyptus oil and oxygenated fuel blends causes an increase in NO emission and also complete combustion of fuel high combustion temp is achieved which results in formation of NO.

Another major reason for raise in NO emission is due to longer ignition delay caused by eucalyptus oil and releases more heat during premixed phase of combustion

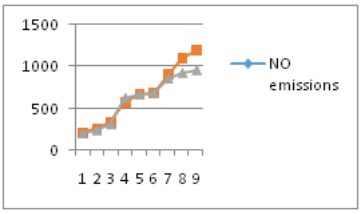


Fig shows the variation of emissions with position

Conclusions

After detailed cfd analysis of the 4-stroke si engine HC emissions low as compared normal gasoline engine operating conditions the reason due to equivalent mixture ratio and easily decomposition of eucalyptus oil gives more intermediate compounds and presence of oxygen n in cineole which is the main component eucalyptus oil results in availability of more oxygen for carbon to react causing less HC emission

CO emissions low due to the reason the enrichment of O_2 in eucalyptus oil principal component of cineole which increases the production of oxygen and promotes for the oxidation of CO during the engine exhaust process.

NO emission increases with continuously increasing because the presence of the oxygen in eucalyptus oil and oxygenated fuel blends causes an increase in NO emission

VII. FUTURE SCOPE

More experiments can be done by using different kinds of eucalyptus oil and gasoline blends. And also by changing the engine parameters, different

types of alternate fuels or fuel blending of alternate fuels different experiments can be done.

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