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EXPERIMENTAL AND THEORETICAL INVESTIGATION ON PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL FUEL BLENDS

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ABSTRACT

In the present investigation, the theoretical studies have been carried out for optimization of different operating parameters using various Bio-Diesel Blends. Also finally compared the experimental results over the theoretical results. The simulated programme is a versatile tool for all Stationary Internal Combustion Engines without conducting the actual experiments.

Key words: Bio-Diesel blend, Stationary Internal Combustion Engine.

INTRODUCTION

The interest in diesel engines can be ascribed to the fact that they are much more efficient than petrol engines. Developers of the diesel engine have made considerable progress in reducing harmful exhaust emissions such as HC, NOx and PM.

The reduction of engine out emissions and bsfc are major research aspects to engine development in light of increasing concern about environmental protection and preservation of fossil fuel reserves. To be compliant with future stringent exhaust gas reserves, the development of modern diesel engines requires not only a further improvement of the combustion and injection process but also adequate reformulation of diesel fuels.

The use of oxygenates for reformulated diesel fuels appears to be a very promising path towards reducing gaseous and particulate emissions. Oxygenated fuels can be either synthetically prepared oxygenates of high cetane number and low heating value such as Acetate, Alcohol, and Maleate.

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In the present work three oxygenates can be selected namely 2-ethoxy ethyl acetate, 2-butoxy ethanol, Di butyl Maleate based upon the oxygen content, flash point, solubility in diesel fuel and stability and fuel properties such as viscosity, cetane number, lubricity, corrositvity, toxicity and biodegradability.

In each oxygenates three blend is prepared. The blend percentage is 10%, 20%, 30% oxygenates and 90%, 80% and 70% of diesel. The stoichiometric combustion equations is formulated and simulation programming of these oxygenates-diesel fuel blend was carried out.

EXPERIMENTAL

Literature review

Noboru Miyamoto, Hideyuki Ogawa, Nabi Md. Nurun, Kouichi Obata and Teruyoshi Arima (1998) were suggested that, "By the addition of sufficient oxygenate to ordinary diesel fuel, significant improvements were simultaneously obtained in smoke, particulate matter, NOx, THC, and thermal efficiency. Noise reduction was also be obtained for the oxygenates with higher ignitability". Improvements in the exhaust gas emissions and the thermal efficiency depended almost entirely on the oxygen content in the fuels regardless of the blend ratio and type of oxygenate.

T. C. Zannis, D. T. Hountalas and D. A. Kouremenos (2004) were concluded that, "The addition of both Rapeseed Methyl Ester and Glycol Ethers results to small increase of bsfc, decrease of combustion duration and ignition delay, significant decrease of soot, decrease of CO and HC emissions and increase of NOx emissions".

Bruce A. Buchholz, Charles J. Mueller and Ansis Upatnieks (2004) were suggested that, "The molecular structure and distribution of oxygen within an oxygenated diesel fuel strongly influences the ability of the fuel to reduce PM emissions. The 1, 4-maleate carbon is not found in exhaust PM nor in-cylinder deposits, indicating that the carbon oxygen double bond does not break during combustion".

C. D. Rakopoulos, D. T. Hountalas and T. C. Zannis (2004) were concluded that," A decrease of combustion duration with increasing fuel oxygen content wad evidenced in the case of oxygenated fuels".

Simulation

Simulation is the process of designing a model of a real system and conducting experiments with it, for the purpose of understanding the behaviour of the system.

Computer simulation

Computer simulation has gained a greater importance these days because of the availability of fast digital computers. Computer simulation is the process of formulating a model of a physical system representing actual processes and analyzing the same. Usually, the model is a mathematical one representing the actual processes through a set of algebraic, differential or integral equations and the analysis is made using a computer.

Advantages of computer simulation

1. It serves as a tool for a better understanding of the variables involved and their effect on engine performance
2. It systematizes knowledge obtained through expensive engine testing
3. It considerable reduces the time-consuming tests by narrowing down the variables that must be studied.
4. It helps in optimizing the engine design for a particular application, thereby reducing cost and time.

V-Theta diagram

Fig. shows the volume at various crank angles. With theta denoting the angular displacement of the crank from BDC, the volume VTHETA can be obtained by using the relation.

$$VTHETA = vdisp*[cr/ (cr-1)-(1-\cos\Theta)/2+l/s-1/2*\sqrt{}[(2l/s)\text{^}2-\sin^2\Theta]$$

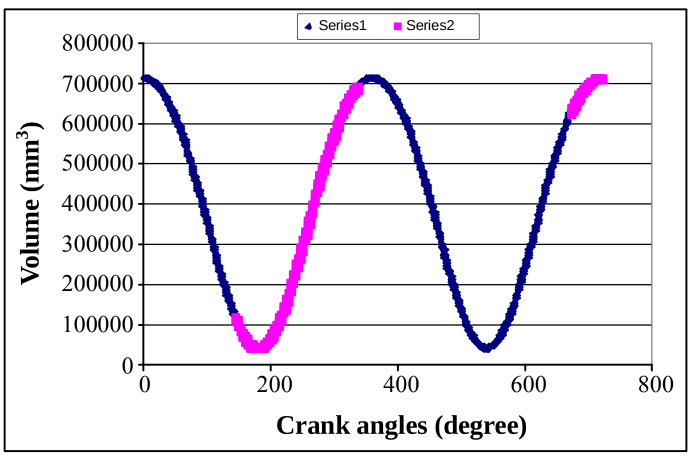


Fig. : Volume at various crank angles

Heat release rate as a function of relative duration of combustion

Fig. shows the relationship between the heat release rate and relative duration of combustion. The top curve represents the pure diesel fuel. The bottom curve represents the oxygenate-diesel fuel blends. The heat release rate of oxygenates are lesser than that of diesel fuel. This is mainly due to the lower calorific value of the oxygenates blend when compared with diesel fuel.

Comparison of heat release rate and relative duration of combustion of oxygenates blend and diesel

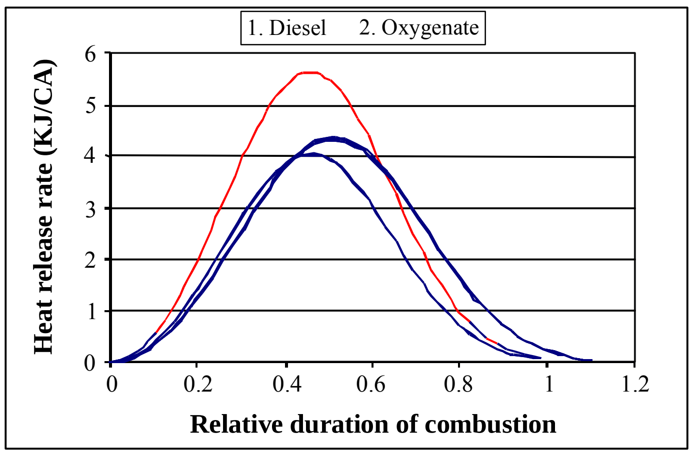


Fig. : Heat release rate as a function of relative duration of combustion

Thermal efficiency

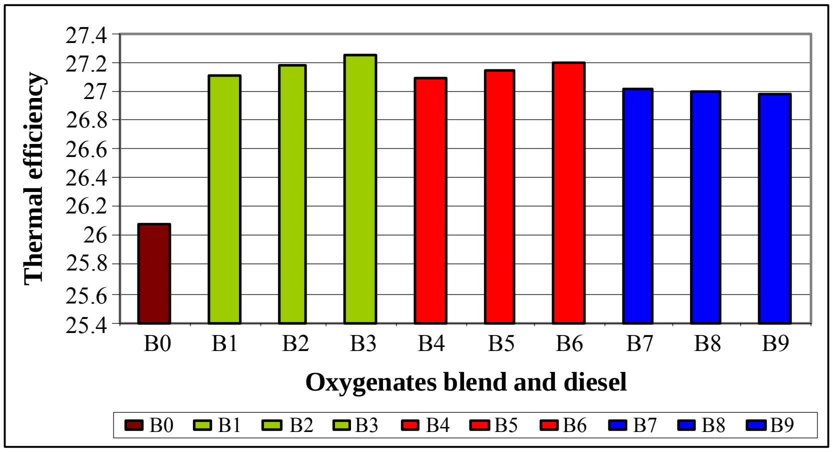
The thermal efficiency of pure diesel is 26.0811%. The thermal efficiency of all oxygenates blend is higher than that of diesel fuel. This is mainly due to the addition of oxygen containing compounds to diesel fuel has been proposed as a method to complete the oxidation of carbonaceous particulate matter and associated hydrocarbons.

From fig. it is clear that when the oxygenate percentage increases the thermal efficiency also increases in case of 2-Ethoxy Ethyl Acetate and 2-Butoxy Ethanol.

But in Di Butyl Maleate when the oxygenate percentage increases the thermal efficiency decreases. This is mainly due to the effect of molecular structure of Di Butyl Maleate. The carbon-hydrogen double bond does not break during combustion, which may lead to decrease the combustion efficiency. Therefore the thermal efficiency decreases.

Among all the blends the thermal efficiency of 30% 2-EEA will give higher thermal efficiency of 27.2487%. This is mainly due to higher oxygen content of the this fuel (around 40 wt.% 2-EEA, 27.1 wt.% for 2-BE, 28.0 wt.% for DBM).

Comparison of thermal efficiency of oxygenates blend and diesel



B0 = Diesel

B1, B2, B3 = 10%, 20%, 30% 2 Ethoxy ethyl acetate

B4, B5, B6 = 10%, 20%, 30% 2 Butoxy ethanol

B7, B8, B9 = 10%, 20%, 30% Dibutyl maleate

Future work

In the present work the thermal efficiency, mean effective pressure, power, mechanical efficiency of the C.I. engine can be determined by using simulation programming with oxygenates blend as the fuel. The future work includes Experimental Analysis of oxygenates blend with single cylinder 4-stroke diesel engine will be carried out and compare the results of both simulation and experimentation.

CONCLUSION

Among the various blends of oxygenates (10%, 20%, 30% 2-EEA, 2-BE, DBM), the blend 30% 2-Ethoxy Ethyl Acetate have higher thermal efficiency than other blends. This is mainly due to the higher in oxygen content (about 40%) of this blend when compared to other types of blends.

The Rate of Heat Release was also analyzed. The ROHR of oxygenates blend lesser than that of the diesel. This is mainly due to the lower calorific value of the oxygenates when compared to pure diesel.

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