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IMPACT OF IGNITION ENHANCER ON PERFORMANCE AND EMISSION CHARACTERISTICS OF BIODIESEL BUTANOL BLENDS IN DI-DIESEL ENGINE

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ABSTRACT

The continuous increasing demand for energy and the decreasing petroleum resources has led to the search for alternative fuel which is renewable and sustainable. In this work, Pongamia biodiesel (50%) diesel (45%) butanol 5% (by volume) (B50D45Bu5), Pongamia biodiesel (50%) diesel (40%) butanol 5% (B50D40Bu10), Pongamia biodiesel (50%) diesel (35%)butanol 15% (B50D35Bu15) with 3% 2-Ethylhexyl nitrate (EHN) additive fuels were tested to evaluate the effects of the fuel blends on the performance and exhaust emissions of a diesel engine. 2-Ethylhexyl nitrate (EHN) has been used as a commercial cetane improver for a number of years and today is the predominant cetane improving additive. Engine performance parameters and exhaust gas emissions such as nitrogen oxides, carbon monoxide and hydrocarbon were measured. The results showed that butanol addition caused a slight reduction in B.S.F.C and increase in brake thermal efficiency; the emission values of the engine were improved. Therefore, 2-Ethylhexyl nitrate (EHN) can be used as a very promising additive to biodiesel butanol diesel blends.

Keywords: Biodiesel, 2-Ethylhexyl nitrate (EHN), Butanol, performance, Exhaust emissions

INTRODUCTION

Due to stringent emission regulation and depletion of fossil fuels fostered the research towards biofuels.Biofuels made from agricultural products reduce the country's oil imports.(Demirbas, 2010)Biodiesel is the most used renewable fuel in C.I engine.It has numerous advantages such as minimal sulphur& aromatic content,high cetane number,higher lubricity.The disadvantages of biodiesel are lower oxidation stability,higher pour point and lower calorific value.(Raopoulos, 2013)Based on several researches conducted prior,it is found that the biodiesel fuelled engine emit less carbon monoxide,hydrocarbon and particulate matter as compared to diesel but there is incrase in NO_X emission.(Joshi,)

Due to the emission benefits derived from the oxygen in the fuel molecule, the interest in the use of bioalcohol fuel blends in compression ignition engines has been increased (Money, 2001) Butanol is a feasible alternative fuel that has a number of desirable properties for use with diesel engines (Yilmaz, 2014) Compared to ethanol, Butanol has superior fuel properties which make it more suitable for application in diesel engines, such as higher heating value, good intersolubility with diesel fuel, and no corrosion to existing pipelines (Chang, 2014). Most studies have focused the use of ethanol as fuel in reciprocating engines. Fewer studies have reported the use of butanol as fuel, although butanol posses some better fuel properties than ethanol (Liu, 2013). Studies about utilization of butanol as fuel in diesel engines found that the soot emissions were effectively reduced.

Contrary to engine related techniques, properties of the fuel can also be altered by the addition of essential fuel additives to make biodiesel conductive for diesel engine (Siwale, 2013). The addition of fuel additives is gaining popularity, as this can be done with ease when compared to engine modification techniques. Fuel additives play a crucial role in changing the molecular structure of the fuel and the enhanced chemical reactivity benefits in attaining better performance (Vallinayagam, 2013).

However there is not much work done regarding effect of additives on butanol-biodiesel blends. Thus the intention of the current work is to begin exploring the effects of 2-Ethylhexyl nitrate (EHN) with butanol biodiesel blending on the performance and emissions characteristics of a diesel engine.

TRANSESTERIFICATIOIN

Transesterificatioin is most commonly used and important method to reduce the viscosity of vegetable oils The process of removal of all the glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is called Transesterificatioin. This esterified vegetable oil is called bio-diesel. Biodiesel properties are similar to diesel fuel. After esterification of the vegetable oils its density, viscosity, cetane number & calorific values are improved more.

Single-stage laboratory Transesterificatioin was performed in a small rectangular container equipped electrically operated stirrer. Pongamia oil and methyl alcohol are mixed in a 6:1 molar proportion and heated in 55^{o}C and then this combination is mixed with 2% sodium hydroxide and maintained at 60^{o}C for 60 min. Then it is allowed to settle by gravity for 24 h. After draining of the glycerol, upper layer was washed with water& vacuum distilled to remove moisture.

Experimental procedure and specifications:

For the experiments,four fuel types are used.Biodiesel 50% is used for all the blends.butanol was blendd with biodiesel through stirring on a magnetic stirring plate.Biodiesel butanol blends were prepared with 5%,10%,&15%of butanol concentrations by volume basis. Additive 2-EHN similarly to DTBP is a known acceierator for spontaneous ignition & has beeen used as cetane improver of diesel fuel in recent researches. In this study additive 2-EHN was added in the ratio of 3% in volume for incrasing the cetane number of biodiesel butanol blends and Specification of the engine are shown in table 1.

The Biodiesel was made from pongamia oil following the standard transesterfication process based on ASTMD6751.basic fuel properties for diesel,biodiesel and butanol are shown in table 2

Table.1.Engine specification

Type	Vertical, Water cooled, Four stroke
Number of cylinder	1
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Speed	1500 rev/min
Dynamometer	Eddy current
Injection timing and pressure	23° before TDC &
Injection pressure	220kgf/cm^2

Table.2.Properties of biodiesel,butanol and diesel.

Properties	Biodiesel	Butanol	Diesel
Heatingvalue (MJ/kg)	40.5	33.1	43
Density @20^{o}C(kg/m^3)	865	808	815
Viscosity@40^{o}C (mpa-s)	4.57	2.95	2.63
Flashpoint (^{o}C)	126	35	70
Cetane number	52	25	48

Experimental procedure

The load test was conducted by maintaining a constant speed at 1500rpm

1. The water flow is started and maintained constant throughout the experiment
2. The engine is allowed to run at the rated speed of 1500 rev/min for a period of 20 minutes to reach the steady state.
3. The fuel consumption is measured by a stop watch.
4. Then the load is applied gradually, which is connected to the Eddy Current Dynamometer. The load to the engine is varied as 20, 40, 60, 80 & 100% of the full load of the engine.
5. Experiments were conducted using sole fuel diesel. i.e. diesel and the corresponding fuel consumption, smoke density, exhaust gas temperature and exhaust emissions are measured and noted .
6. Then the engine is allowed to cool down before changing the fuel and then the experimental procedure was repeated for biodiesel butanol blends and the corresponding fuel consumption, exhaust gas temperature, & exhaust emission were measured.

Once the test fuels were prepared,test were performed at 20%,40%,60%,80%,100% for each fuel type.The fuel consumption,exhaust temperature and engine emissions were recorded.Exhaust gas temperature was measured with a type-k thermocouple,while gaseous emissions such as CO,HC,and NO_X were measured using an AVL gas analyzer.fig 1 shows the details of the experimental set-up.

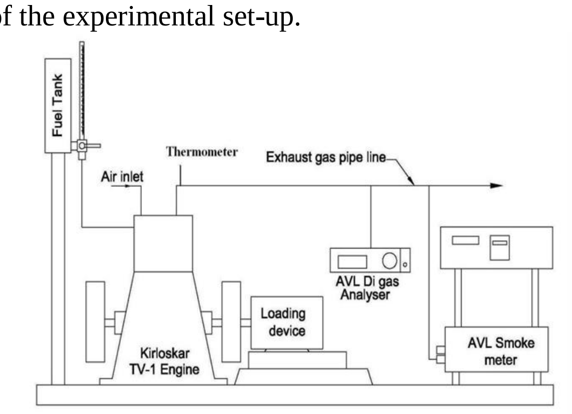

Fig.1experimental setup

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RESULTS AND DISCUSSION

PERFORMENCE AND EMISSION CHARACTERISTIS

Brake specific Fuel consumption: Fig. 2 shows B.S.F.C value of various blends with respect to engine load.It is clearly observed from fig that B.S.F.C decreases as the load increases because more fuel is required to carry a light load.In all cases diesel fuel shows lowest B.S.F.C as compared to biodiesel butanol blends because biodiesel &butanol has lower heating value.overall, in higher load butaol addition does not create significant change in B.S.F.C.

Brake Thermal efficiency: Brake Thermal Efficiency simply the inverse of product of B.S.F.C and lower calorific value. Asseen in fig.3 BTE for all butanol blends is slightly higher than that for neat dieselwith the increase being higher the higher the percentage of butanol in the blend.This may be attribute to enhanced oxygen content higher laminar frame speed of butanol biodiesel blends.

HC emission: Fig.4 shows, at low loads,hydrocarbon emission of biodiesel butanol blends are lesser than diesel.But at higher loads,Hc emissions does not show any significant change compared to diesel because 2-EHN opposing the effects (lesser cetane number) caused by butanol.

CO emission: Asseen in fig.5 CO emission decrease as the load increase .At high loads there is no significant different between in terms of CO emission. However, at lower load CO emission decrease mainly due to oxygen content of biodiesel and butanol blends.And also 2-EHN improves the combustion.

NO_x emisssion: Fig.6 shows the comparsion and variation of NO_x emissions as a function of engine load.Butanol and 2-EHN addition to biodiesel decrease NO_x and reduction increase as the butanol concentration rises.This may attributed to engine running over all leaner & temperature lowering effect of butanol due to higher heat of evaporation .And also 2-EHN reduces the ignition delay leads to more diffusive combustion .It also contribute to lesser NO_x emissions.This effect is very pronouced on emission product by B50 D35 Bu15 compared to other blends.

Exhaust gas temperature: Exhaust gas temperature as a function of load for all the fuel types is shown in fig.7 Butanol blended fuels produce lower exhaust gas temperature because butanol has a lower engry density and lower cetane number than diesel or biodiesel.additionally,the introduction of butanol to fuel blends increase the oxygen content while decreasing the overall energy content,both of which cause lower combustion and exhaust temperature.

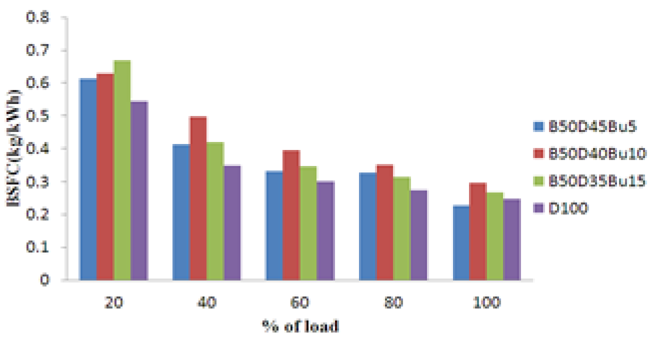

Fig.2.% of load vs. Brake specific Fuel consumption(Kg/kWh)

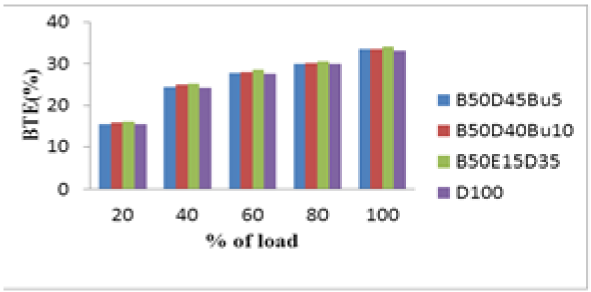

Fig.3. % of load vs. Brake Thermal efficiency(%)

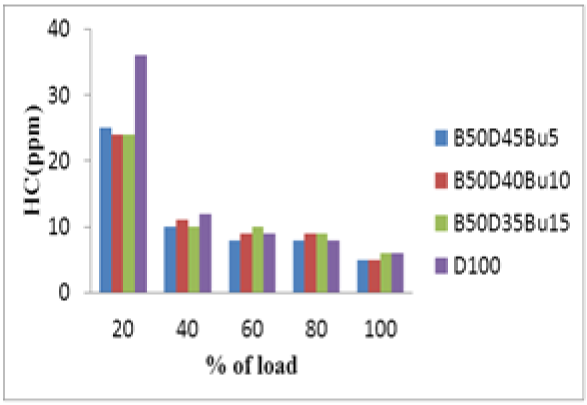

Fig.4. % of load vs. HC (ppm)

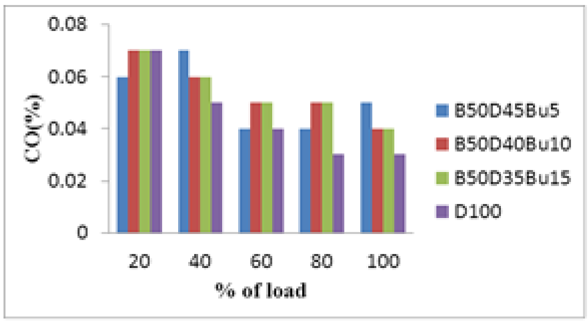

Fig.5. % of load vs.CO(%)

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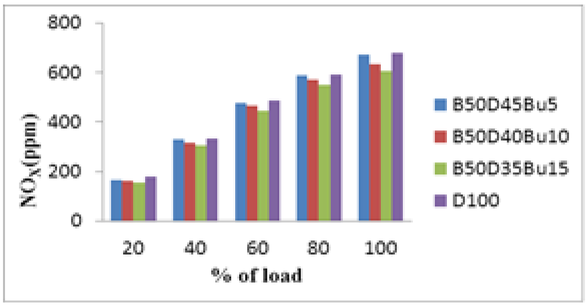

Fig.6.% of load vs. NO_x(ppm)

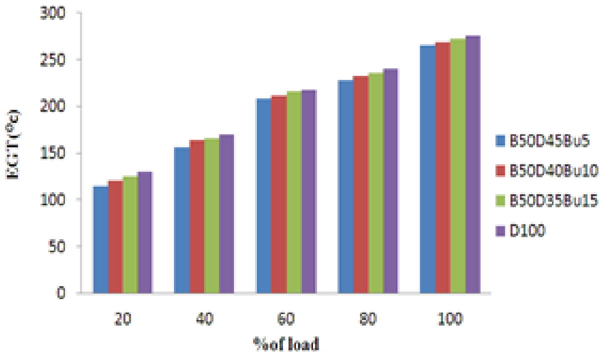

Fig.7.% of load vs. EGT (ºC)

CONCLUSION

Emission and engine performance experiments were conducted on a single cylinder diesel engine. The effects of 2-EHN addition in biodiesel Butanol diesel blends on engine performance, oxides of nitrogen, carbon monoxide and hydrocarbon values were investigated. The following major conclusions were drawn from this study:

1. Brake specific fuel consumption of B50D45Bu5 was comparable with diesel.
2. Brake thermal efficiency of all the butanol biodiesel blends are slightly higher than diesel.
3. The exhaust emission tests revealed that CO and NOx emission improved with butanol addition. Finally, it can be concluded that, 2-EHN can be used as a very promising additive to butanol biodiesel blends in conventional diesel engines, by this way exhaust emission values can be improved.

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