Evaluation of Performance and Emission Parameters of a Diesel Engine Working on Bio-Diesel and Hydrogen Based Additive Blends

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Abstract— Biodiesel is a promising substitute as an alternative fuel has obtained significant importance due to the increasing cost and fast diminution of conventional fossil fuels and environmental concern. The pongamia pinnata oil is blended with the diesel and hydrogen based additive i.e. Hydrogen Peroxide (H_2O_2), the hydrogen based additive acts as complementary fuel and oxygen present in additive may improve the combustion characteristics. The physical properties such as density, flash point, fire point, kinematic viscosity, calorific value are determined for fuel blend Experimental investigation are carried out to find the performance parameters like brake power, specific fuel consumption and emission characteristics like oxides of nitrogen emission of hydrocarbon emission of carbon dioxide and carbon monoxide of the engine are determined by using Single cylinder, four stroke diesel engine.
Key words: Sonication, Blending, Diesel Engine

I. Introduction

Vegetable oils have very similar physical and chemical properties when compared to that of diesel fuel which make them a promising alternative for conventional fuels. The greatest advantage of vegetable oil is that they are renewable and ecofriendly. Biodiesel is basically extracted from vegetable or animal fats Biodiesels provides many advantages such as minimal aromatic and sulphur content, higher cetane number, higher flash point, biodegradable and non-toxicity.

II. Literature Review

Viswanath k kaimal, p.vijayabalan [1]conducted experiments on Rice bran oil, Neem oil and pongammia oil, The experimental result showed that the carbon monoxide, hydrocarbons, NOx emissions are lesser in Pongamia oil comparatively Neem and Rice bran oil. BSFC of the pongamia oil was lesser than Neem & Rice bran oil.

Nagaprasad K. S, D. Madhu [2] Used hydrogen peroxide as additive along with the diesel at injection timing 10 &15 degree BTDC. 2, 5 & 10 % blends are used.

- At 10% H_2O_2 brake thermal efficiency was 15%, was equal to the pure diesel value.
- By advancing injection timing from 10 to 15º, efficiency of the blend increased than the pure diesel.

Rachan D Shekar, Dr H R Purushotham[3]Studied on various method of hydrogen induction to the compression ignition engine.

- Mixing of hydrogen based chemical in to diesel fuel.
- Manifold injection of hydrogen by electrolysis.
- Injection from readily available hydrogen cylinders.

III. Blending

Blending is the process of mixing diesel, biodiesel and additive at measured proportionate to obtain homogeneous fuel mixture, and blending will be done on volume basis.

- Stirring: Magnetic stirrer is used to stir the fuels, first biodiesel and additive is added to the beaker and it is stirred for 10 minutes after that diesel is added to the beaker again mixed fuel is stirred for next 10 minutes

Fig. 1: Stirred Process

- Sonication: It is the act of applying sound wave (energy) to agitate the particles in the fuel mixture, this is carried out by sonicator which produces ultrasonic waves i.e., >20kHz by the supply of electric current, stirred biodiesel mixture is kept in the water bath of sonicator, sonication process will be carried out for next 60 minutes and then blended fuel is allowed to cool in natural air.

Fig. 2: Sonication Process

A. Blends Prepared

60% diesel 40% pongamia → (D60 B40)
60 % diesel 38% pongamia 2% H_2O_2 → (D60 B38 A2)
60% diesel 30% pongamia 10% H_2O_2 → (D60 B30 A10)

IV. PROPERTY TEST

Blends properties have direct influence on performance parameters of an engine hence density, viscosity, flash & fire point calorific values are determined for various blends.

Parameters	Unit	Diesel	D60,B40	D60 B38 H2%	D60 B30 H10%
Density	Kg/m^3	835	860	840	860
Viscosity at 40^{0}C	centistokes	3.1	3.024	3.321	3.408
Flash point	^{0}C	52	82	85	80
Fire point	^{0}C	57	90	88	85
Calorific value	KJ/kg	44800	42483	39268	40570

Table 1: Property Test

V. EXPERIMENTAL SETUP

A four stroke diesel compression ignition single cylinder engine is used, having compression ratio of 17:5. Fresh air enters engine through the air filter and fuel is cleaned in the fine grade fuel filter after that it enters to fuel pump and it is injected to the engine trough the injector. Water is used to cool the engine it enters the water jackets of the engine and it takes away the heat from engine cylinder wall, for that constant water flow is maintained throughout the experiment. For the measuring purpose engine fly wheel is connected to the eddy current dynamometer and EGA is used to determine the emission parameters.

Sl. No	Parameter	Specification
1	Engine Type	Kirloskar
2	Speed	1500
3	Brake Power	3.7 kw
4	Cubic Capacity	0.661 liters
5	Compression Ratio	17.5 : 1
6	Operating Pressure	205 bar
7	Injection Timing	23^0 BTDC
8	Dynamometer	Eddy current dynamometer

Table 1: Experimental Setup

VI. RESULTS & DISCUSSION

Experiments are carried out at inlet opening pressure 205 bar, crank angle at 23^0 BTDC and constant speed of 1500rpm at different loads for diesel fuel, D60 B40 and D60 B30 A10 blends. Performance and emission parameters are shown in the graph.

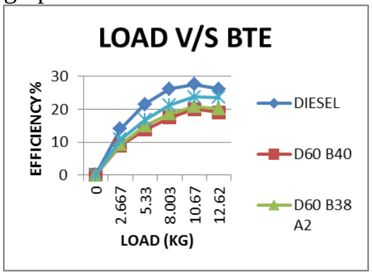

Fig. 1: Load v/s BTE

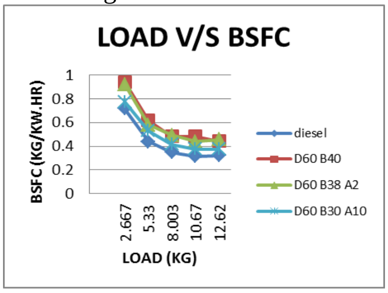

Fig. 2: Load v/s BSFC

The variation of brake thermal efficiency for different load as shown in the graph 1, it is observed that D60 B30 A10 is the optimum blend compared to the other blends and nearer to the diesel. This is due to the decomposition of H_2O_2 at higher temperature and releases the heat hence BTE increases.

The variation of brake specific fuel consumption for different load is as show in the graph 2, it is observed that BSFC is less for D60 B30 A10 blend compared to other blends and nearer to the diesel.

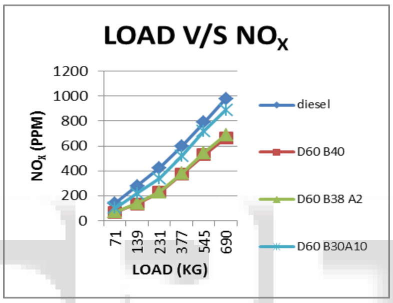

Fig. 3: Load v/s NOX

The variation of NOx emission for different load is as shown in the graph 3 it is observed that D60 B38 A2 has less NOx compared to other blends emission, as the additive percentage increasing NOx is increasing this is due to high operating temperature & pressure as the percentage of additive increase, and the decomposed O_2 from H_2O_2 reacts with the nitrogen to form NOx.

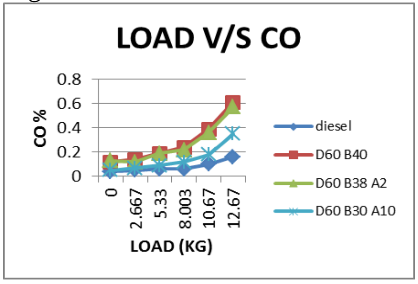

Fig. 4: Load v/s co

The variation of carbon monoxide (CO) emission for different load is as shown in the graph 4; it is observed that D60 B30 A10 has less CO emission compared to other blends as the additive percentage increasing CO is decreasing. This is due to absence in the carbon content in the additive hence overall co emission will reduces.

The variation of un burnt hydro carbon (HC) emission for different load is as shown in the graph 5; it is observed that D60 B30 A10 has less HC emission compared to other blends as the additive percentage increasing HC emission is decreasing. Due to the extra oxygen molecule available for better combustion of the fuel as the additive increased.

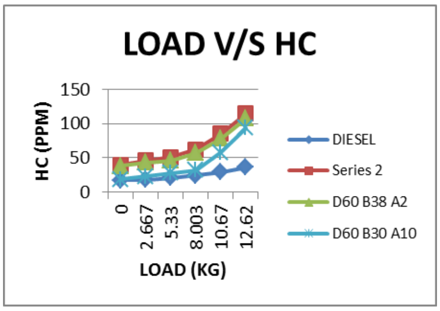

Fig. 5: Load v/s HC

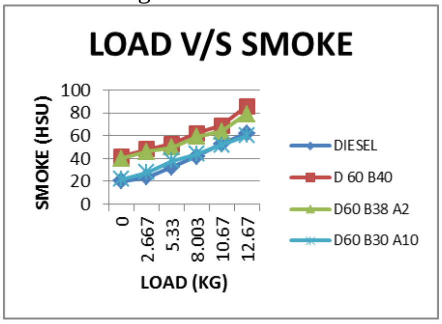

Fig. 6: Load v/s smoke

The variation of smoke content for different load is as shown in the above graph6; it is observed that D60 B30 A10 has less smoke content compared to other blends and nearer to diesel because of clean combustion of the fuel.

VII. Conclusion

A four stroke CI engine was run using diesel, Pongamia pinnata and hydrogen peroxide at compression ratio of 17.5:1 crank angle 23^0 BTDC and at injection pressure of 205bar. The performance and emission parameters are evaluated.

- Properties of blended fuel are tested; density and calorific value of the fuel increased as the increase of additive where kinematic viscosity doesn't show much variation, flash and fire point are reduced in small value.
- D60 B30 A10 blend found maximum brake thermal efficiency, this is because of the increase of hydrogen peroxide content which dissociates in to water and oxygen at higher temperature and releases energy.
- NO_x emission for optimum blend is increased due to reaction between dissociated oxygen molecule with nitrogen at higher temperature and pressure.
- HC, CO, CO_2, smoke emissions are reduced because of the no carbon content in the additive, clean burning of fuel reduces the emission constituents.

References

[1] Viswanath k kaimal[1], p.vijayabalan[2] effects of using pongamia, neem and ricebran methyl esters in a ci engine, Volume- 2, Issue- 3, March-2014 International Journal of Mechanical and Production Engineering.

[2] Nagaprasad K. S.[1], D. Madhu[2] effect of injecting hydrogen peroxide into diesel engine, International Journal of Engineering Sciences & Emerging Technologies, April 2012, Volume 2, Issue 1, pp: 24-28.

[3] Rachan D Shekar[a], Dr H R Purushothama[b] Hydrogen Induction To Diesel Engine Working On Bio Diesel: A Review, Procedia Earth and Planetary Science11 (2015) 397–404

[4] Muhammad Saad Khan[1], Iqbal Ahmed[2], 1M I Abdul Mutalib[3] and 1M A Bustam[4] Characterization of Diesel-Hydrogen Peroxide Fuel Blend, Journal of Energy Technologies and Policy, Vol.3, No.11, 2013

[5] Venkata Ramesh Mamilla[1], M. V. Mallikarjun[2], Dr. G.Lakshmi Narayana Rao[3] Preparation of Biodiesel from Karanja Oil, International Journal of Energy Engineering, DOI 10.5963/IJEE0102008

