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Experimental investigation of performance and emission characteristics of lemon grass as biodiesel

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Abstract: *At present every country is facing two major challenges namely energy crisis and environmental degradation. To meet these twin problems of fuel oil and air pollution caused by fossils fuels, alternative renewable clean burning fuel need to be explored. In this project, plant species, like lemon grass (cymbopogen citratusis) is discussed as source of oil for bio-diesel production. The bio-diesel that is produced from lemon grass through Transesterification process is used as a fuel. Performance test was conducted and compared with diesel. The emission characteristics were analyzed by varying load for diesel and biodiesel blends. The combustion test carried out for the best blend, i.e. pressure crank angle diagram drawn for best blend and also variation of pressure for different loads for the best blend is plotted on p-v diagram. The experimental results show that the brake thermal efficiency of all the blends is slightly lower or nearly equal when compared to diesel. But, slightly increased NO_X emission when compared to diesel fuel.*
Keywords: *Lemongrass biodiesel, Engine performance test, Emission test.*

I. Introduction

Biodiesel is a renewable fuel made from vegetable oils, animal fats and recycled cooking oil and greases. The properties of biodiesel fuel have higher viscosity, density and flash point than the diesel fuel [1]. Further the energy content or net calorific value of biodiesel is less than that of diesel fuel. There are various economical and environmental advantages to utilize this unique fuel. Indian Oil Corporation has tied up with Indian Railways to introduce the production of biodiesel producing crops over 1 million square kilometers. On 12 September 2008, the Indian Government announced its 'National Biofuels Policy'. It aims to meet 20% of India's diesel demand with fuel derived from plants. Biodiesel has physical and chemical properties similar to conventional petroleum-based diesel [2].

Bio - diesel has been accepted as clean alternative fuel by US and its production is about 100 million gallons. Each state has passed specific bills to promote the use of Bio - diesel by reduction of taxes sunflower oil, rape seed etc[3].

II. Experimentation And Methodology

1. Bio-diesel preparation

The lemongrass oil was converted into its ester by the process called transesterification process. The different steps involved in bio-diesel production are, the raw lemongrass oil was mixed with a base catalyst like NaOH/ KOH to produce glycerol. The oil and catalyst were placed in a round flask and the mixture was stirred for an hour. Then the mixture was cooled to room temperature to remove the fatty acids and biodiesel.

2. Fuel properties

The properties of biodiesel like specific gravity, viscosity, flash point, fire point and calorific value are important for better performance of the engine. The properties of the biodiesel understudy were recorded and presented in Table 1.

3. Experimental procedure

Experiments were conducted on a four stroke single cylinder, vertical water cooled diesel engine. The engine was provided with two fuel tanks for both diesel and biodiesel. The water flow rate was kept constant through the experiment. The engine was connected with eddy current dynamometer to control the engine torque. The engine specifications were shown in Table 2. Different biodiesel blends were used to run the engine at different loads to determine the performance of engine using the data which is obtained during the experiment.

The emission test was carried out during the performance test for different blends at different torque and blends. The prop was inserted in the exhaust pipe and the results were recorded by plotting the graphs for brake power to emission parameters (CO, HC,CO_2, NO_X). AVL Gas Analyzer was used to measure the emission parameters.

III. Equations

The following equations are used to find the different parameters of engine run by biodiesel:

1) BP= $\frac{2\pi NT}{60000}$ in KW

2) BSFC= $\frac{TFC}{BP} \times 3600$ in kg/k WH

3) FC= $\frac{MF}{1000 \times t}$ = $(V_f \times \rho) / 1000 \times t$ in kg/sec

4) η_{bt}= $\frac{BP}{HI} \times 100$ in %

IV. Figures and Tables

1) Performance Graphs

The variation of brake thermal efficiency and specific fuel consumption with respect to brake power for diesel, bio diesel-diesel blends are illustrated in Figs 1-6.

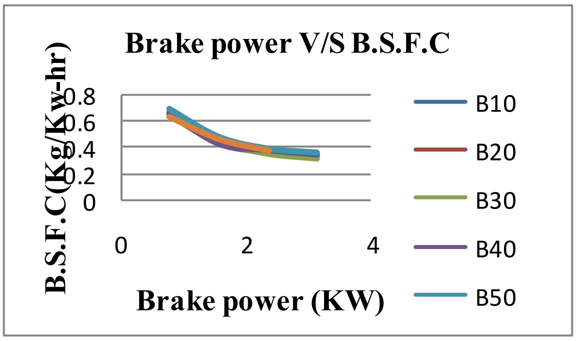

Fig 1: Brake power v/s Brake specific fuel consumption

The data in Fig.1 indicates that as brake power increased the brake specific fuel consumption decreased for all the blends. The brake specific fuel consumption of the B30 blend is much less when compared to diesel and other blends.

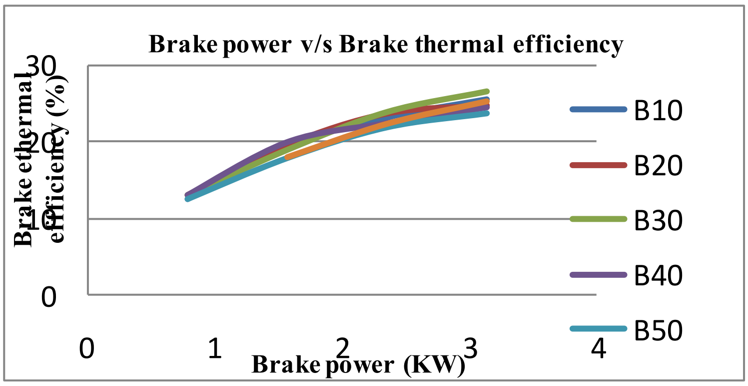

Fig 2: Brake power v/s Brake Thermal Efficiency

The data illustrated in Fig.2, shows that as the brake thermal efficiency increased with increase in brake power for all the blends. The brake thermal efficiency of the B30 (26.76%) is highest than the diesel (25.42%) and other blends at maximum power. The blending biodiesel have brake thermal efficiency higher than diesel and other blends.

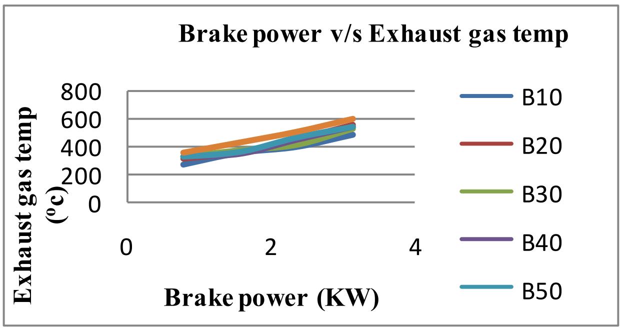

Fig 3: Brake power v/s Exhaust Gas Temperature

The data in Fig.3 indicates that the exhaust gas temperature increases with increase in brake power for all the blends. Diesel has the highest Exhaust Gas Temperature for all the values of brake power when compared to biodiesel blends.

2) Emission graphs

The variation of carbon dioxide, hydrocarbon, Oxides of nitrogen emissions with respect to brake power for diesel, bio diesel-diesel blends are illustrated in Figs 4-6.

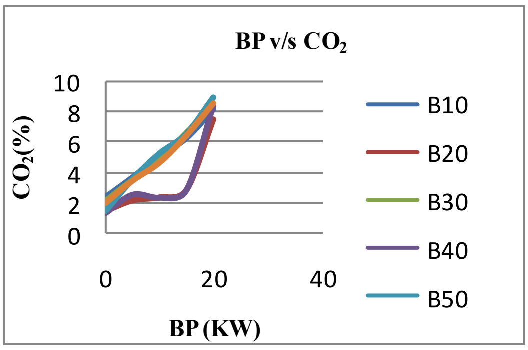

Fig 4: Brake power v/s Carbon dioxide

The data shows that carbon dioxide emission increased with increase in brake power for all the blends. B50 has the highest carbon dioxide emission than the diesel and B20 has the lowest carbon dioxide emission than the diesel. At higher brake power the effect of viscosity has increased the CO_2 emission for all the blends.

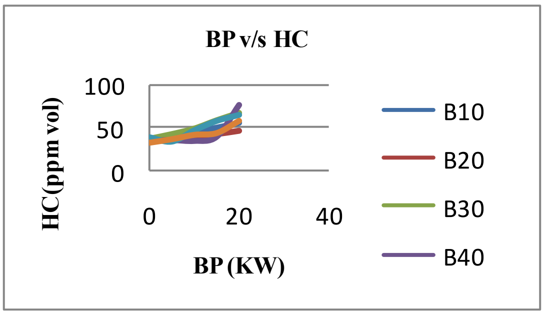

Fig 5: Brake power v/s Hydrocarbon

The data presented in Fig.5 indicates that hydrocarbon emission increased with increase in brake power. The emission of hydrocarbon for B20 is higher than diesel and highest hydrocarbon emission is observed for B20.At higher brake power the effects of viscosity has increased and hence the hydrocarbon emission is increased.

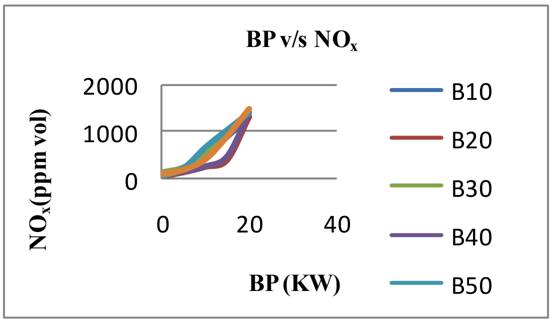

Fig 6: Brake power v/s Oxides of nitrogen

The NO_X emission for diesel and all the blends increasing with respect to brake power shown in Fig.6. Blend B20 showed the lowest NO_X emission when compared to diesel.

Table 1: Properties of diesel and biodiesel blends

Fuel	Specific gravity	Viscosity (cst)	Flash point (^{0}c)	Fire point (^{0}c)	Calorific value (KJ/Kg)
Diesel	0.82	2.6	55	64	42935.0
B10	0.839	2.04	54	58	42682.7
B20	0.835	2.49	57	61	42432.4
B30	0.892	2.92	59	63	42182.1
B40	0.869	3.12	60	64	41931.8
B50	0.882	4.73	62	66	41681.5

Table 2: Test engine specification

Make	Kirloskar
Capacity	3.7 KW
Compression ratio	80 mm
Stroke	110 mm
Cylinder capacity	533 cc
Speed	1500 rpm

V. Conclusion

Based on the performance and emission tests on the diesel engine, the following conclusions are drawn.

1. It was observed that the B.S.F.C decreases with increase in blend ratios when compared to diesel.
2. There was an increase in exhaust gas temperature with increase in blend percentage but it was less when compared to diesel.
3. It was observed that there was an increase in brake thermal efficiency (η_{bt}) as blend percentage increased, but when compared to diesel it was seen that there was a reduction in efficiency.
4. The production of CO_2 almost was near to diesel for all the blends.
5. The emission of NO_X was more in case of diesel when compared with other blends.
6. It is seen that the CO emission remains same as that of diesel for B20 blend. For remaining blends CO emissions being more when compared with diesel.

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