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PERFORMANCE & EMISSION ANALYSIS OF CI ENGINE BY USING BLENDS OF COTTONSEED OIL & BUTANOL

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ABSTRACT
With a recent energy crisis, alternative fuel, especially for transportation, has been explored to reduce the consumption of gasoline, on the way of which use of alcohol & biodiesel have been successfully promoted to reduce this uneven diesel -gasoline consumption pattern; whereas, Diesel- Biodiesel& ethanol blends was tested for performance and emission with acceptable results. However, diesel biodiesel-ethanol blends still faces challenges in finding suitable emulsifier, preventing water absorption from ambient and adapting existing distribution infrastructure to cope with low flash point. Hence, the present study evaluates feasibility in using butanol blending with diesel-biodiesel due to no need for emulsifier, less moisture absorption and less variations in physical/chemical properties of the blends. Diesel biodiesel were blended at concentration B-10, B-20 and B-30 Diesel-biodiesel & Butanol were blended at concentrations of DBB [50:10:40], DBB [50:20:30], DBB [50:30:10], by volume without any emulsifier additive to observe solubility and stability. Relevant physical and chemical properties were measured and compared with specification of diesel. Then blends were tested with unmodified single cylinder diesel engine for engine performance, fuel consumption and emissions, with comparison to commercially available diesel in the market. The physical/chemical properties of the blends reveal acceptable values; whereas, the engine testing results reveal that DBB [50:30:20], can be used in single cylinder diesel engine without any modification to the Engine.

KEYWORDS: CI Engine, Cottonseed Biodiesel, Performance analysis, Emission analysis.

INTRODUCTION
Diesel engines are widely used for transportation, energy production, and agricultural and industrial applications because of their high fuel conversion efficiencies and durability. Petroleum-based fuels are used in diesel engines, which have a wide range of use in many sectors. However, it is well-known that petroleum resources are limited and depleting day by day. In addition, pollutant emissions resulting from diesel combustion have negative effects on both human health and the environment [1]. So it is necessary to reduce these emissions in diesel engines fueled with petroleum diesel fuels. The main regulated pollutants in diesel engines are nitrogen oxides (NOx), carbon monoxide (CO), unburned hydrocarbons (HC), and smoke, and they have been regulated by the laws in many countries. Therefore, due to the depletion of petroleum resources and increasing environmental concerns, there is great demand for finding alternatives to petroleum-based diesel fuel.

Alternative fuel means the term refers to substances (excluding conventional fuels like gasoline or diesel) which can be used as fuels. Which promise a harmonious correlation with sustainable development energy conservation, efficiency & environmental preservation, has become highly pronounced in present days [2].Almost all types of vegetable oils can be used to replace the diesel oil after proper filtration, degumming and dewaxing engines for a short-term period [3].Cottonseed oil may be used as resource to obtain bio diesel [4]. Transesterification is best method to decrease the viscosity & increase the volatility among all other process like pyrolysis, Dilution with hydrocarbon blending, Micro-emulsion. Biodiesel from edible and non-edible oil feedstocks has lower peak cylinder pressure and lower heat release rate ion [5]. Biodiesel mixtures showed less CO, PM, smoke emissions than those of neat diesel fuel. NO_x emission with biodiesel mixtures showed higher values when compared with neat diesel fuel. Compared to the neat diesel fuel, 10% biodiesel mixtures reduced PM, smoke emissions by 24% and 14%, respectively [6]. NOx emissions increased with n-butanol/diesel fuel blends during all operation conditions [7]. The oxidative stability of cottonseed biodiesel was correlated to content of pigment. Darker the color more stable the biodiesel [8].Moreover, adding alcohol into biodiesel blends improves the stability of blends [9]. Ethanol addition results in an improvement in BP, BTE and fuel consumption, however BSFC decrease because of lower C.V. CO & HC also reduced however CO2 may increased marginally [10].

The objective of present work is to study the performance characteristics on CI engine and to evaluate emission profiles for Carbon-di-oxide (Co_2), Carbon-Monoxide (CO), Nitrogen Oxides (NO_x), Unburnt Hydrocarbons(UBHC) for the selected blends of Diesel- Biodiesel- Butanol.

MATERIALS AND METHODS

The performance and emission test were conducted on a one cylinder, 4S, water cooled diesel engine. The specification of test engine is given in table 1. The setup consists of single cylinder, four strokes, Diesel engine connected to eddy current dynamometer for loading. It is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through data acquisition device for PØ PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand-alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rota meters are provided for cooling water and calorimeter water flow measurement. The setup enables study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. Lab view based Engine Performance Analysis software package 'Enginesoft' is provided for on line performance evaluation A multilayer gas analyzer were used to measure the exhaust gas emission. A schematic diagram of experimental setup is shown in fig. 1. The engine was started with diesel and kept in running till steady state attained for each and every fuel. The operating variables are determined at constant speed of 1500 rpm at varying load. The load varied from 0% to 100% with interval 25% .Fuel tank was cleaned every time while changing the fuel.

The tested fuels were diesel, it's mixture with cottonseed biodiesel and butanol. The blend of cottonseed biodiesel were selected is B-10(10% biodiesel+90%diesel), B-20(20%biodiesel+80%diesel) and B-30(30%biodiesel+70%diesel). The blend of cottonseed biodiesel and butanol were used DBB 50:10:40(50%diesel+10%biodiesel+40%butanol), DBB 50:20:30 and DBB 50:30:20. Diesel is used as base fuel for current study. Cottonseed biodiesel used for this study obtained from cottonseed and methyl alcohol by Transesterification process

Table 1: The specification of test engine

Engine Brand	Kirloskar Diesel
Engine Type	Water cooled
Dynamometer	Eddy current dynamometer
Number of cylinder	Single cylinder
Bore x Stroke	87.5 mm x 110 mm
Power	5.2 kW at 1500 rpm

Figure:
1. Engine ,
2. Alternator ,
3. Load cell
4. Diesel Tank ,
5. Pressure sensor,
6. TDC Position sensor
7. Computer,
8. Exhaust gas analyzer.
9. Air box ,
10. Data acquisition system,

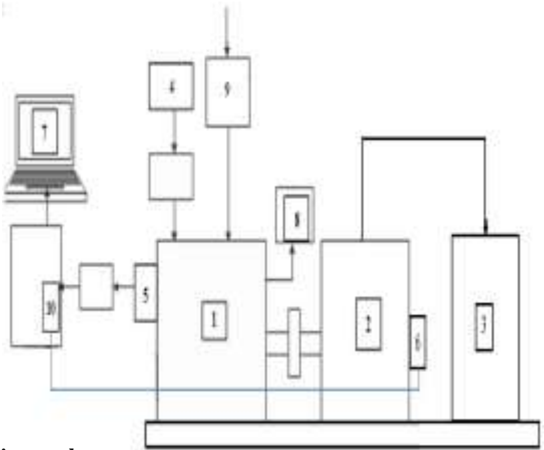

Fig.1 Experimental setup

Table 2: Properties of fuel used

Properties	Diesel	B-10	B-20	B-30	B-100	DBB 50:10:40	DBB 50:20:30	DBB 50:30:20
Density	830	835	836	840	876	830	832	835
Viscosity	2.9	3.9	3.8	4.2	5.9	2.6	2.9	3.6
Heating Value	42.5	42	41.5	40.9	38.55	41.8	42	42.5
Cetane Number	51	51.3	51.3	51.5	52.91	48.5	49.8	50.5

RESULTS AND DISCUSSION

Brake Power (BP)

Brake power of diesel engine increases with load. This trend is similar for all blends. As shown in fig. Brake power decreases slightly as percentage of biodiesel increases in blend. It is because of lower eating value of biodiesel and butanol. Maximum brake power observed with B-20 and B-30 blend at full load which is 3.37 kW. Minimum Brake power got 3.17 kW with DBB- 50-30-20.

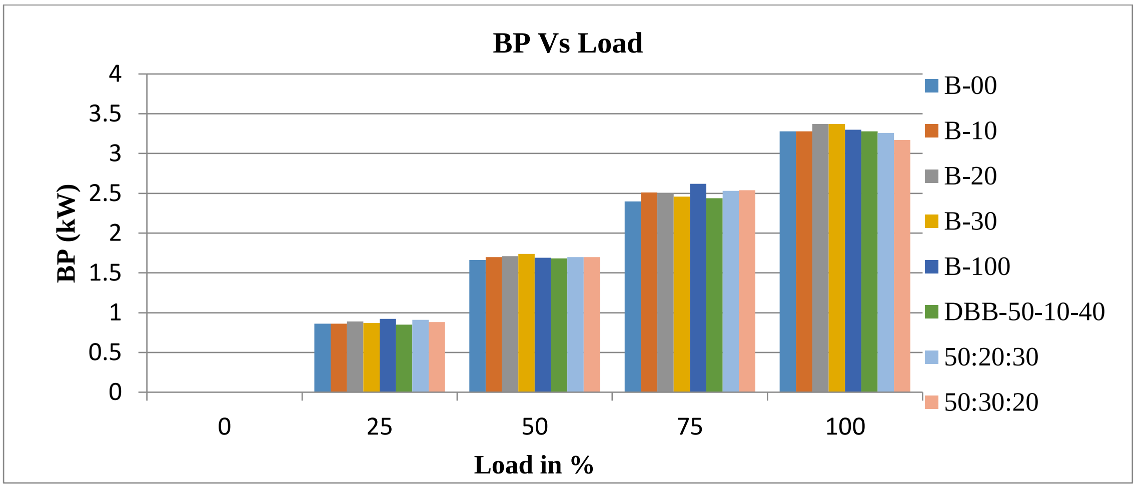

Fig.2 Comparison of BP

Brake Specific Fuel Consumption (BSFC)

A comparison of BSFC for various biodiesel blends is shown in fig. 2. It is observe that BSFC increases as percentage of biodiesel increases in blends. Pure diesel has lowest BSFC as compare to all biodiesel blends. This is because of lower calorific value of biodiesel. Maximum increment in BSFC was 6.52% for B-100 as compare to diesel and minimum increment was 2.32% for B-10.

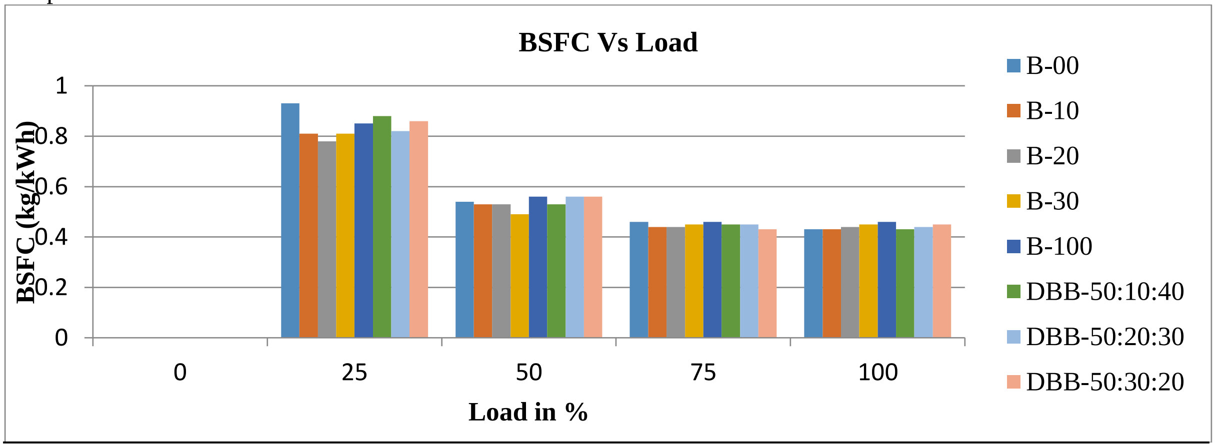

Fig.2 Comparison of BSFC

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Carbon Monoxide (CO)

A comparison of CO emission for various blends is given in fig.3. It is observed that CO emission reduced as percentage of biodiesel increase in fuel. Maximum decrement in CO was 33.8% for DBB 50:20:30 of pure diesel. It is because of higher oxygen content in biodiesel and butanol. Butanol is more oxygen than biodiesel. That is why DBB 50:20:30 showed less CO emission than B-20.

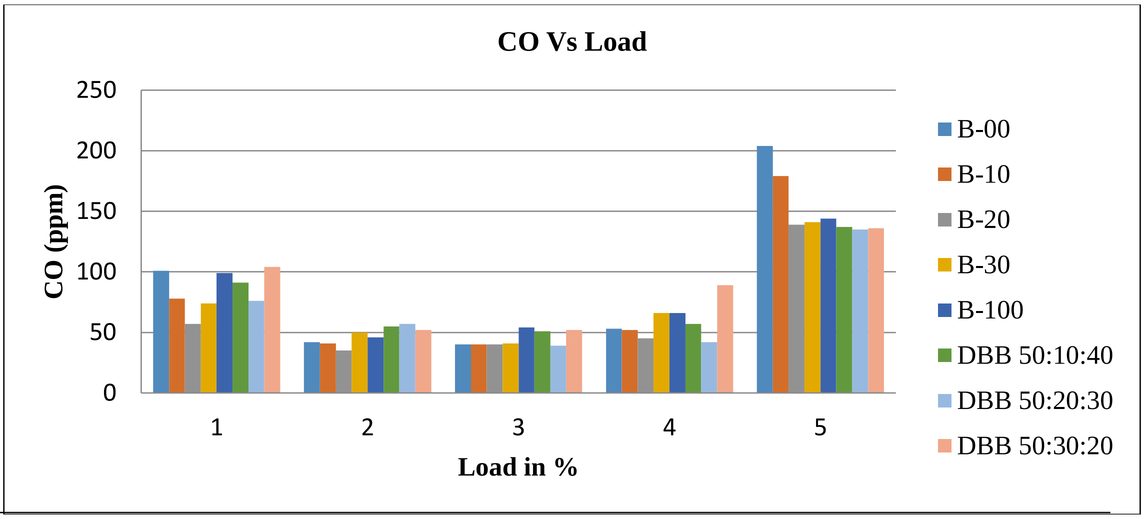

Fig.3 Comparison of CO

Hydrocarbon (HC)

Fig.4 shows the variation of hydrocarbon emissions for cotton seed biodiesel blends and diesel in comparison with diesel. It is noticed that for all test fuels hydrocarbon (HC) emissions are increasing with increasing load. Hydrocarbon emissions are reducing on increasing blend percentage. Maximum decrement in HC emission was 44.8% for DBB 50:20:30 of diesel. Reason is maximum amount of injected biodiesel combustion with availability of oxygen in it.

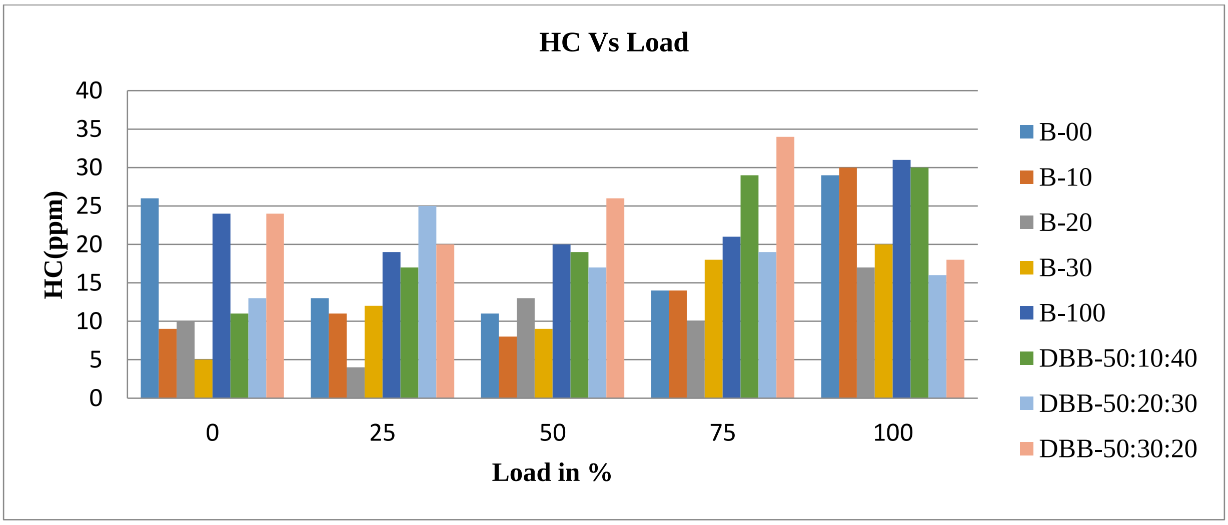

Fig.4 Comparison of HC

Nitrogen Oxides (NOx)

Fig.5 shows variation in No_x emission for various biodiesel blends. It is observed that No_x emission increase as percentage of biodiesel increases in fuel. Maximum increament of No_x emission was 33.27% of diesel for B-100. The increase in No_x emission when biodiesel blend used is because of rise in combustion temperature due to clean combustion of biodiesel as biodiesel content more oxygen. Diesel-Biodiesel-Butanol blends showed reduction in No_x emission. This because of cooling effect of butanol as it's higher latent heat of vaporization of butanol.

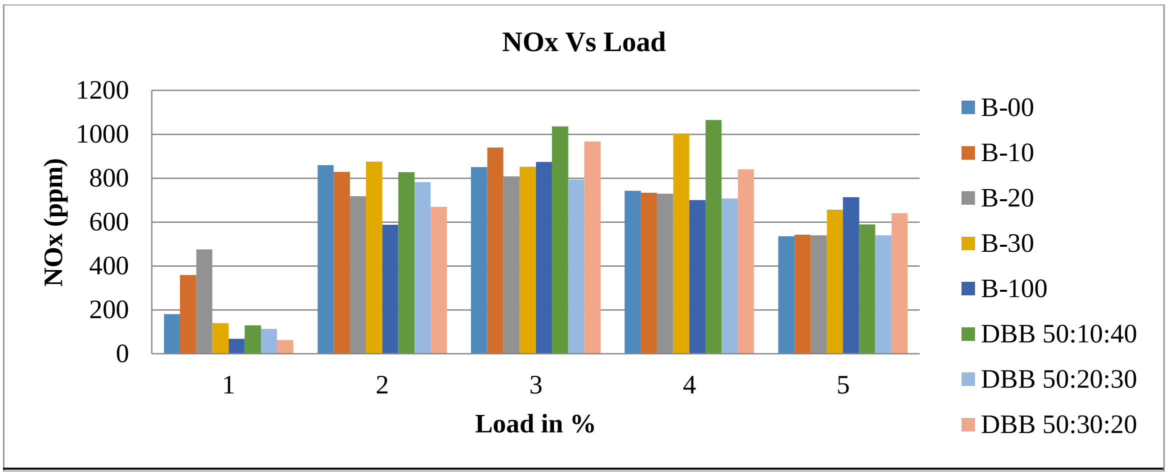

Fig.5 Comparison of NOx

CONCLUSION

Emission Parameters

- The blend B-20 and DBB 50-20-30 shows minimum emission of Unburnt Hydrocarbon at full load. Reduction in Unburnt Hydrocarbon is 41.37% and 44.82% for B-20 and DBB 50-20-30 respectively as compared to commercial diesel.
- The blend DBB 50-20-30 shows minimum emission of Carbon monoxide. Reduction in CO emission is 50%. However , DBB 50-30-20 and B-20 shows significant decrement in CO emission. CO decrement in DBB 50-30-20 and B-20 is 47.89% and 26.84% as compared to commercial diesel.
- The blend B-20 and DBB 50-20-30 reduces the carbon dioxide at full load by 3.88% and 4.94% respectively as compared to commercial diesel fuel.
- The blend DBB 50-30-20 shows maximum emission of Nitrogen oxides. It is 57% more than commercial diesel fuel. B-20 and DBB 50-20-30 shows 2.42% and 5.60% increament in nitrogen oxide emission.

Performance analysis

- Maximum brake power obtain 3.37 kW when B-20 blend is used. There in no significant change in brake power when biodiesel is used
- Maximum BSFC increased by 6.97 % compared to commercial diesel

From experimental results it reveals that among all the Biodiesel & DBB blends, the blend with proportion of [50:20:30] gives better result in terms of fuel properties and engine parameters like performance and emissions.

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