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Performance and Emission Characteristics of Mahua Oil in Direct Injection Compression Ignition Engine

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Abstract— Nowadays diesel engines are major contributors of many air polluting exhaust gasses such as carbon monoxide, unburned hydrocarbons, oxides of nitrogen and other harmful compounds. It has been shown that formation of these air pollutants can be significantly reduced by using biodiesel as alternate fuel. This study presents the results of experimental investigation on the effects mahua oil biodiesel and its blends on performance and emission characteristics of Direct injection compression ignition engine. Biodiesel from mahua oil was prepared through transesterification process with low molecular weight alcohols and sodium hydroxide. Experiments were conducted to evaluate the performance and emission parameters of a single cylinder, four stroke, water cooled, direct injection diesel engine. The results obtained from all the fuel blends were analyzed and compared with neat diesel operation.

Keywords— Mahua oil, Biodiesel, Alternate fuel, Diesel engine.

1. INTRODUCTION

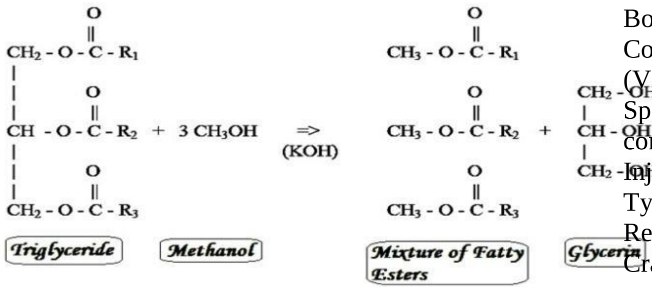
Fossil fuels such as petroleum, natural gas and coal have been meeting most industrial and commercial demands for relatively low cost, high energy density, transportable fuels for decades. However, being the main source of transportation fuels, petroleum is estimated to be running out within 50 years due to the limited storage under the stratum [1-3]. In addition, burning fossil fuels generates pollutant emissions and greenhouse gases (primarily concerned with carbon dioxide emissions) [4]. In the above context, alternate fuels based on vegetable oils represent a valid alternative to fossil fuels in internal combustion engines [5]. Even though vegetable oil is used as alternate for diesel fuel, it gives problems like injector cocking with trumpet formation, more carbon deposits and piston oil ring sticking, as well as thickening and gelling of the engine lubricating oil. To overcome these constraints, the processes like pyrolysis, microemulsification, transesterification were especially developed [6-8].

1.1. Many studies have been devoted to the development of vegetable oil based alternate fuels for internal combustion engines. Banapurmath et al., [9] have studied the performance and emission characteristics on a single cylinder compression ignition engine with 3 different biodiesel (methyl esters of honge, jatropha and sesame) and reported that all the fuels gave a slightly lower efficiency. HC and CO emissions were slightly higher and NOx emission decreased by about 10%. They have reported that these oils can be used without any major engine modifications. Pryor et al., [10] investigated the performance of compression ignition engine using neat soybean vegetable oil. They reported that the short term test with soybean oil indicated a performance similar to that of diesel fuel and the long term engine testing could not be carried out due to problems such as power loss and carbon build-up on the fuel injectors. Deepanraj et al., [11-13] evaluated the performance and emission Numbering and spacing characteristics of a single cylinder direct injection diesel engine with palm oil biodiesel and its blends. They found that the acceptable thermal efficiencies were obtained and the specific fuel consumption and exhaust gas temperatures were higher than the diesel. The exhaust emissions obtained were lesser than diesel. Suresh Kumar et al., [14] have investigated the performance and emission characteristics on a single cylinder diesel engine with pongamia pinnata methyl ester and reported decrease in NOx and HC emissions. A 40% blend (B40) of biodiesel in diesel has been recommended by the authors. The goal of this study was to investigate the performance and emission characteristics of a single cylinder, four stroke, direct injection, compression ignition engine fuelled with mahua oil biodiesel and its blends.

2. BIODIESEL PRODUCTION

The most common way of producing biodiesel is the transesterification of vegetable oils and animal fats. Oil or fat reacts with alcohol (methanol or ethanol). This reaction is called transesterification.

The reaction requires heat and a strong catalyst (alkalis, acids, or enzymes) to achieve complete conversion of the vegetable oil into the separated esters and glycerin.



Raw materials for Transestrification process:
Neutralized oil(one litre)
Methanol (250 ml)
Sodium hydroxide(NAOH) catalyst (6.25 gm)
Distilled water

Table 2.1 COMBINATIONS OF THE FUEL

S.NO	UVO(ml)	METHANOL(ml)	NAOH(gm)
1	400	92	2
2	400	88	2
3	400	84	2
4	400	80	2
5	400	88	2.4
6	400	88	2.2
7	400	88	1.8
8	400	88	1.6
9	440	88	2
10	420	88	2
11	380	88	2
12	360	88	2

Engine Specification :

Fig 2.2 Experimental setup of diesel engine

Manufacturer	Kirloskar Oil Engines Ltd., India,
Model	TV–I, naturally aspirated
Engine	Single cylinder, DI, Four Stroke
Bore / stroke	87.5mm/110mm
Compression ratio	16.5, 17.5 and 18 (Variable)
Speed	1500 r/min, constant
Rated power	5.2 kW
Injection pressure	240 bar/23° deg BTDC
Type of sensor	Piezo electric
Response time	4 micro seconds
Crank angle sensor	1-degree crank angle

3. .RESULTS AND DISSCUSSION

Experimental investigations have been carried to examine the performance and emission characteristics at different injection pressure of 160 bar, 180 bars and 200 bar. The details have been tabulated below and the graphs have been ploted. The engine was set to run at compression ratio 16.5:1, advanced injection timing 27°BTDC to arrive at the optimum for Mahua biodiesel blends (B10, B20, B40, B60, B80 B100).
The result for the variation in Brake specific fuel consumption, Brake thermal efficiency, total fuel consumption, friction factor, indicated power, specific fuel consumption, mechanical efficiency, input power, indicated thermal efficiency, break mean effective pressure, indicated mean effective pressure and economic load are shown in blow graphs.

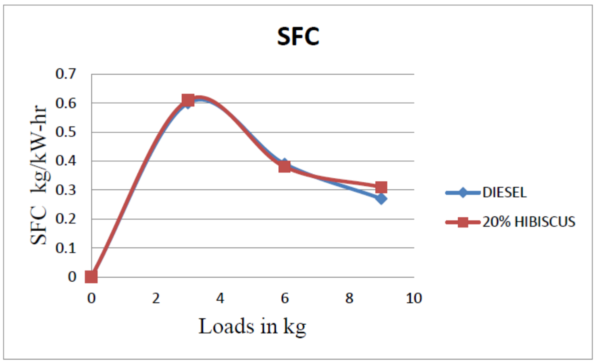
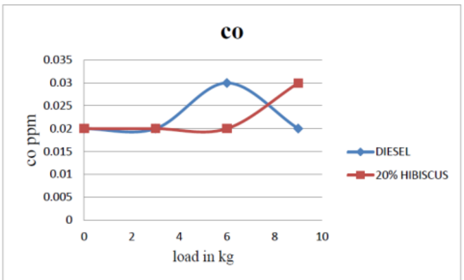


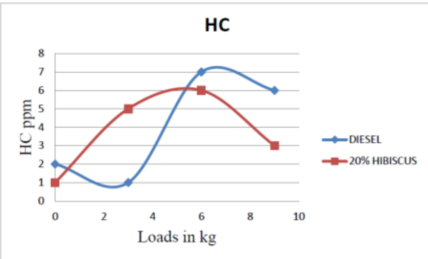
Fig 3.1 BRAKE MEAN EFFECTIVE PRESSURE

Name of the Items	LOAD-BP			
	0	3	6	9
CO	0.02	0.02	0.02	0.03
HC	1	5	6	3
CO2	0.5	0.8	1.2	1.4
O2	20.18	19.74	19.30	18.43
NOX	21	80	131	210
SFC	0	0.61	0.38	0.31
BTE	0	14	22.4	27.8

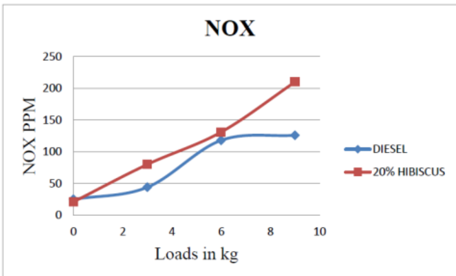
CARBON MONOXIDE VS LOAD



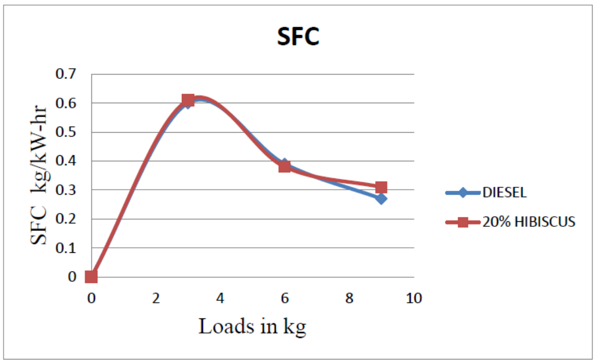
HYDRO CARBONS VS LOAD



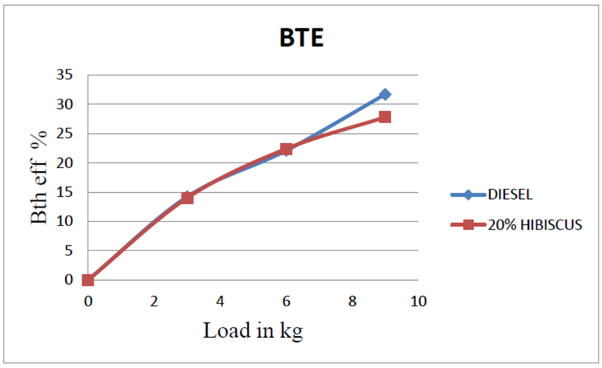
CARBON DIOXIDE VS LOAD



NITRIC OXIDE VS LOAD



SPECIFIC FUEL CONSUMPTION VS LOAD



BREAK THERMAL EFFICIENCY VS LOAD

4. CONCLUSION

Following are our conclusions summarize the experimental results presented in this paper

- Results shows that lower brake thermal efficiency for hibiscus seed oil, mainly due to its high viscosity and poor atomization of fuel compared to diesel.
- Specific fuel consumption, carbon monoxide and carbon diode and smoke opacity of hibiscus seed oil is higher than that of diesel because of its higher viscosity, poor combustion and density.
- Smoke emission for diesel engine is always less than that of varying blends and at varying loads.

Nitric oxide emission of Hibiscus seed oil is lower than that of diesel, this is mainly due to lower combustion temperature and incomplete combustion. 47

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