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Experimental Investigation on Performance and Emission Characteristics of VCR Engine Using Mahua Biodiesel with Al_2O_3 Nano Additives

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Abstract:
The depleting reserves of petroleum and environmental issues have led to the search for more environmental-friendly and renewable fuels.

Biodiesel obtained from various renewable sources has been recognized as one of the alternative fuel due to its biodegradability, high cetane number, no sulphur emissions and low volatility. Biodiesel derived from non-edible feed stocks such as madhuca indica oil are reported to be feasible choices for developing countries including India where consumption and cost of edible oil is very high .The aim of present work is to optimize the biodiesel production from madhuca indica oil through transesterification process. The various performance and emission parameters like brake mean effective pressure (BMEP), brake power (BP), brake specific fuel consumption(BSFC), mechanical efficiency (Mech. Eff.), brake thermal efficiency (BTE), CO emissions, CO_2 emissions, HC emissions, NOx emissions were evaluated at different torques and compression ratios in a 4 stroke, single cylinder variable compression ratio engine. These performance and emission parameters of diesel fuel were compared with that of B30, B50, and B30A100 and B50A100 and. The performance parameters of B50A100 blend shows that higher brake thermal efficiency and lower brake specific fuel consumptions compared with other fuel blends at different CR. And also found that HC and CO emissions decreases but except at full load CO2 emissions decreases as the blend content increases whereas the NOx emissions increases as the blend content increases.

Keywords: ***Transesterification, Performance, Emissions, Biodiesel, Nano additives, Mahua biodiesel.***

1.INTRODUCTION
In the economics of the country the transport sector plays an important role. Mainly the energy crisis depends upon the increasing in population and living of human beings. Now a days due to increase in the demand of diesel and other petroleum products, India is dependence on oil import is expected to increase by 92% in the year of 2030. To decreasing the energy crisis demand for an alternate liquid fuels especially the biodiesel is increasing.

There are some disadvantages by using biodiesel such as slightly decrease in fuel economy, slightly greater density, less cloud and pour points and higher NOx emissions. By using some of the techniques to reduce the above disadvantages which are modified fuel, fuel additives, hybrid fuel and result that reduction in emissions and improvement in performance of the engines. By the addition of nano additives with biodiesel results give better fuel properties, to improve the combustion efficiency and also to reduce the harmful engine emissions. And also addition of the additives the diesel fuel causes a decrease in particulate emissions, decrease in the oxidation temperature and increase in the percentage of the NOx emissions.

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2. LITERATURE SURVEY

G.V.LPrasad et al, (2016) [1] Observed that emulsion fuels reduces the fuel consumption on fossil fuels. The KBD (Karanja bio-diesel) and Alumina blend KBD emulsion fuel has prepared o 93% and KBD 5% distilled water, 2% of surfactants by a maintain hydrophilic- lipophilic balance , and Nano partials are mixed with 50ppm and 100ppm with KBD emulsion fuel. Significantly improvement in engine performance as well as reduction in the harmful emissions is obtained.

Swarupkumar Nayak et al, (2014) [2] Done an experimentation on single cylinder water cooledengine with mahua biodiesel blends and observed that increase in brake power and brake thermal efficiency as result showed that both CO and HC emissions decreases with Increases the percentage of dimethyl carbonate additive with mahua biodiesel percentage in biodiesel, and smoke and NO_X emissions also decreases with increases in additives percentage in the biodiesel fuel.

Sudheernandi et al, (2013) [3]Done the experiment on 7 B.H.P single cylinder four stroke variable water cooled kirloskar engine at rated speed of 1500 rpm with different blends of mahua oil at 200 bar injection pressure. Efficiencies observed that betterwith 75% Trans esterifiedmahua oil and thermal efficiencies of mahua oil is 25% more than diesel.

C. Syed Aalam et al, (2015)[4]Effect of fuel injection pressure on the combustion, performance and emission characters of a common-rail diesel engine using mahua methyl ester blend (MME20) specific fuel consumption (SFC) and NOx emission increases, and brake thermal efficiency (BTE) decreased due to combustion characteristics and fuel properties of MME20. For better utilization of mahua methyl ester blend, fuel injection pressureincreasedfrom 22Mpa to 88Mpa. Exhibit higher BTE and better combustion character when compare that of other injection pressure. HC,CO and Smoke level gradually falls with increases in the fuel injection pressure due to better mixture.

G.Lakshmikanthetal,(2013)[5]During experimentation he observed that Performance of four stroke direct injection compression ignition by using mahua oil biodiesel blend with diesel. Brake thermal efficiency of mahua oil biodiesel and its blend are lower than the diesel. At maximum Torque, the brake thermal efficiency of mahua oil biodiesel and its blend 16.44% and 11.52% lower than diesel.

Hariram.V et al, (2014) [6] on single cylinder, direct injection CI engine kirloskar 240 bar injection pressure, performance tested withmahua biodiesel blends performance parameters like BSFC, BTE, EGT and Exhaust emissions such as UBHC, CO, NOx and Smoke density were evaluated with MOME blend, at B20 blend was found to be a favorable alternative fuel for CI engine due to increased BTE, Reduces the BSEC at higher Torques and lower CO, HC, Smoke emissions observed.

3. PREPARATION OF BIODIESEL

In trans esterification process the vegetable oils are reacted with alcohol in the presence of catalyst producing biodiesel. In this process Mahua oil react with methyl alcohol in the presence of catalyst (KOH) to produce glycerol and fatty acid ester. The methyl alcohol (200 ml) and 7.5 grams of KOH were taken in a round bottom flask to form potassium methoxide.

After that the potassium methoxide mixed with Mahua oil (1000 ml). The mixture was heated up to 60-65^{0}C and held at that temperature with constant stirring speed (500 rpm) for 2 hours forming ester. After that it was allowed to cool and settle in flask for 12 hours. Then two layers were formed in the separating flask. From that we observed top layer was methyl ester and bottom layer was glycerol. After remove the glycerol, the methyl ester was washed with distilled water to remove the excess methanol. Due to the transesterification process improved the fuel properties

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like viscosity, specific gravity, and flash point. The properties of diesel, Mahua biodiesel and B30, B50 are listed in Table 1.

Table 1: Esterified fuel properties

Biofuel	Density (Kg/m³)	Viscosity at 40°C	Flash point (°C)	Fire point (°C)	Calorific value (KJ/kg)
Diesel	840	3.2	58	62	43,400
B30	858	2.39	106	115	42,294
B50	866	3.47	116	121	41,870
B100	890	4.89	206	211	36,955

4. EXPERIMENTAL METHODOLOGY

4.1 Experimental setup

Fig 4.1: Computerized VCR Engine Test Rig

Table 2: Engine Specifications

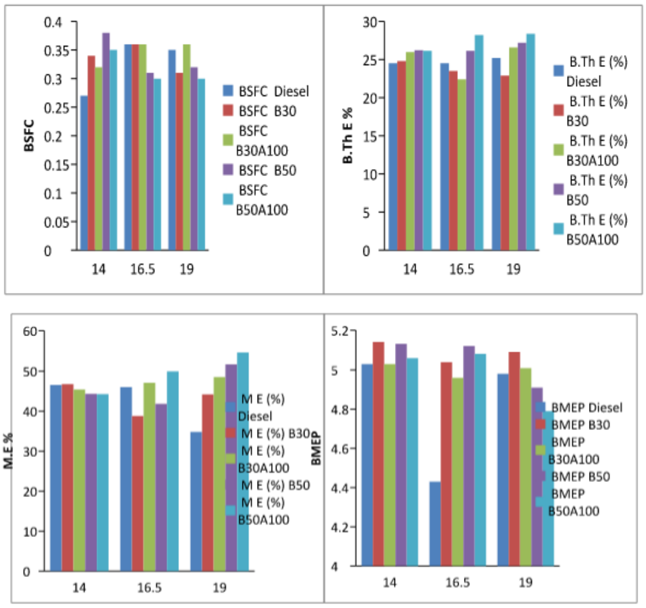
TEST RIG SPECIFICATIONS	
Engine	4 stroke, 1 cylinder
Maker	Kirloskar
Rated Power	3.7KW(5HP)
Compression Ratio	12:1 to 20:1
Rated Speed	1500 rpm
Dynamometer	Eddy current dynamometer
Stroke Length	110 mm
Bore Diameter	80 mm
Swept Volume	562cc

4.2 Experimental procedure

- Check all the electric supply should be ON position and check water supply to engine.
- Check the fuel supply and start the engine by cranking.
- Warm up the engine for 10 minutes
- Adjust the compression ratio14:1, 16.5:1and 19:1.
- Torque the engine gradually and slowly.
- Log the data in computer, at each corresponding Torque and compression Ratio in multi fuel engine software.
- Fuel oil is to be drained from the engine and fuel injection system and fuel tank for conducting test on other blends.
- Engine need to be rested between test runs to avoid overheating and damage to sensors.
- Exhaust gas composition test and smoke test should be check at every moment.
- Repeat the same procedure for all the test fuels. i.e., Diesel, B30, B50. With and Without Nano powder.
- Experiment was done at thee compression ratio for selected test fuel at five different Torques. Emissions and smoke opacity were torqued at each and every iteration.

5. RESULTS & DISCUSSION

5.1 Performance Characteristics



- B50A100 at CR 16.5:1, BSFC is lower than comparative with diesel and B30 blend because oxygen availability is high in biofuels.
- Brake thermal efficiency is high at CR 19:1 with B50A100 blended fuel compared with diesel

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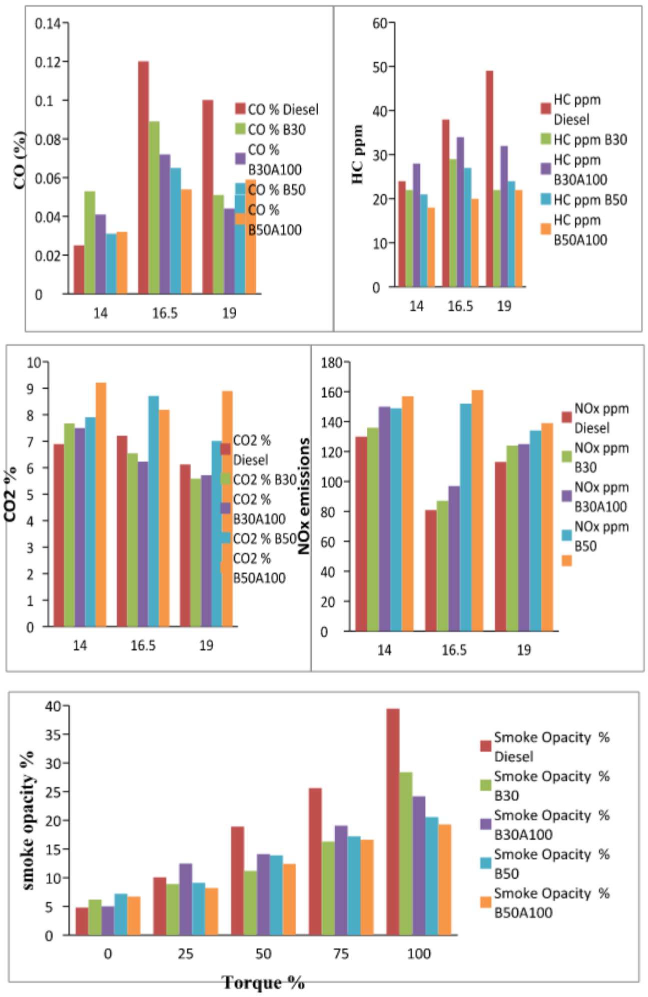
- Mechanical efficiency is increases at CR 19:1 with B50A100 with upon diesel and B30 blend
- Brake mean effective pressure is reduces at CR 19:1 with B50A100 blended fuel along with diesel and B30 blend.

5.2 Emission Characteristics



CONCLUSIONS

Varying compression ratio at different emissions is,

- HC emissions are reduces B50A100 with comparative diesel with B30A100 , B50 &B30 at CR 16.5:1 full Torque condition better oxidization fuel.
- On CR 14:1 CO emissions are lower than other compression ratios at B50A100 blend comparative with diesel and remaining blends.
- CO_2 emissions are high on 19:1 compression ratio with B50A100 blended biofuel comparative B30& B30A100 and diesel fuel.
- NO_x emissions are high at 16.5:1 compression ratio which is oxidization fuel has better atomization on combustion chamber as upon comparative with diesel fuel and B30 biofuel blend.
- At various Torquesconditions smoke emissions were at B50A100 thatshows as lowest possible smoke at all Torques when compared to diesel on 19:1 CR at 200 bar injection pressure.
- Higher reduction is at full Torque condition. It shows that 19.3% lower smoke, at higher combustion temperature compared to diesel 39.45% at full Torque conditions.

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