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Performance and Emission of a VCR Engine Using Mahua Oil as Bio-diesel

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The emission, performance and ignition characters of a four stroke single cylinder variable CR (compression ratio) multi fuel engine when energized with mahua methyl ester and its 20%, 40%, 60% furthermore, 80% mixes with diesel (on a volume Basis). The mahua methyl ester as a bio-fuel has been set up in this investigation. Bio-diesel produced from transesterification process has been utilized as a part of this investigation. Trial has been carried at a constant engine speed of 1500 rpm, 50% load and at CR (compression ratio) of 14: 1, 16.38: 1 and 17.5: 1. The effect of CR on fuel utilization, combustion pressure furthermore, exhaust emission has been researched and displayed. Ideal pressure proportion which gives best execution has been distinguished. The outcomes show higher ignition delay, raise in pressure, heat relies rate is lower at higher CR for mahua methyl ester when contrasted with that of diesel. The brake thermal efficiency of mahua methyl ester blends and diesel has been computed and the B20 is found to give most BTE. The different blends when utilized as fuel bring about reduced emissions of carbon monoxide, hydrocarbon and increment in nitrogen oxides.

1. Introduction

The advance of bio powers can be followed back to mid nineteenth century. In certainty, the improvement of diesel engine and bio diesel has concurrent history of mechanical progressions and financial battle. Bio powers offer upgraded work openings and in addition national independence (Kishore et al, 2008). Vegetable oils exhibit an extremely confident elective fuel to diesel oil, since they are inexhaustible, biodegradable and clean consuming, having properties similar to that of diesel. They offer comparative power yield with somewhat lesser thermal effectiveness because of their low energy content compare to diesel (Kishore et al., 2008). Bio diesel, produced from various vegetable oils (sunflower, rapeseed, soybean etc.), have been utilized as a part of IC engines without significant adjustments, with just marginally diminished performance. Various researchers have conducted experiments to study the performance and emission characteristics of diesel engine when vegetable oils, blends of vegetable oil and its derivatives are used as fuel and it has been found to be economical and competitive compared to diesel (Banapurmath et al., 2009).
Research tackles such examinations show that different sorts of vegetable oils, for instance, cottonseed oil, sunflower oil, soybean oil and their relating methyl esters, methyl ester, jojoba oil, palm oil methyl ester, olive piece oil, deccan hemp oil, corn oil, paradise oil, eucalyptus oil, poon oil, pongamia pinnata methyl ester, coconut oil-based cream empowers and pre-warmed waste singing oil has been used as an elective fuel for diesel engine. In these entire cases, engine showed an improved execution with diminishment in smoke, hydrocarbon and CO outpourings and augmentation in NOx release. In this manner, a reasonable picture has been formed overview the relative execution and radiation characteristics (Carraretto et al., 2004).
Pramanik et al., (2003) analyzed the combustion attributes of four stroke single cylinder DI (direct injection) variable CR (compression ratio) engine under CR of 19:1, l7:1, and 15:1when utilizing diesel and bio diesel–ethanol mixers as fuel. It has been watched that the gas pressure, most extreme rate rise in pressure and release heat rate increment with higher ethanol blend because of longer start delay. The gas exhaust temperature was observed to be less. The examination additionally inspected the characteristics of fuel burning of the diesel– bio diesel– ethanol mixes under different CR (compression ratio) and different loading

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conditions. The emission and performance tests have been done by utilizing the steady fuel mixes on an automated variable CR (compression ratio) engine and compared with pure diesel. The greater parts of the examinations are led in various sorts of engines with bio fuel arranged from various oils. The impact of parameters on the engine performance with emission attributes and characteristics of burning bio diesel has been stressed in many investigations (Senthil et al., 2003).
The emission and performance qualities of variable CR (compression ratio) engine utilizing different mixes at CR 18:1, 19:1, 20:1, 21:1 and 22:1 for half load and its examination with the after effects of standard diesel fuel. The ignition parameters, for example, Variations of injection pressure, rise in pressure, rate of heat release studied.

2. Experimental configuration

Fig. 1 demonstrates the schematic outline of the experiment set up. The engine test utilized is a variable CR (compression ratio) engine of multi fuel. Combined with eddy current dynamometer. The specification of the engine is shown in Table 1. Performance engine analysis investigation programming has been utilized for exhaust and performance results. The piezoelectric transducer and a CA (crank angle) encoder which measures the ignition pressure and The PT (pressure transmitter) Type 6613CA contain a piezoelectric sensor and a coordinated charge intensifier. The yield shaft of the eddy current is settled to a strain gauge type load cell is used to measuring load. Thermocouples are utilized to measure gas temperature at the engine exhaust, water outlet of calorimeter and water inlet of calorimeter, surrounding temperature engine and cooling water outlet. Air flow sensor is utilized to measure the air flow rate. A shell and tube gas to fluid heat exchanger is utilized as a calorimeter for leading the heat balance. The fuel stream is estimated by the utilization of 20 cc burette and stopwatch with level sensors. A mechanized information obtaining framework is utilized to gather, store and investigate the information amid the analysis by utilizing different sensors.

2.1 Experimental methods

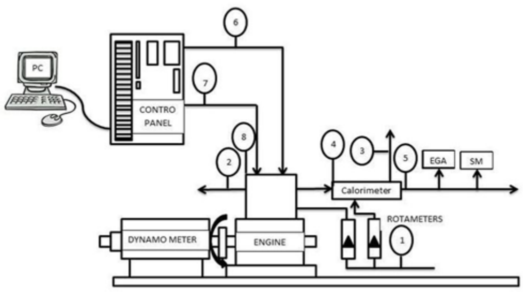

Figure 1: Experimental setup

Table 1: Engine specifications

General details	4-Stroke, VCR,water cooled, variable compression engine, compression ignition
Numberof cylinder	Single cylinder
Speed	1500 rpm
Stroke	110 mm
Compression ratio	5:1–22:1 (variable)
Bore	80 mm
Ignition	Compression ignition
Loading	Eddy current dynamometer
Load sensor	Strain gauge load cell
Starting	Manual crank start
Cooling	Water

The engine with variable CR (compression ratio) begins when the pure diesel is utilized and the engine achieves the working temperature; A 50% load is put on engine. The temperature of the cooling water settles at 600C. The Experiment is performed at constant 1500 rpm speed. In each test, measure fuel utilization and exhaust emissions, for example, (CO),(HC),(NOx),(CO2) and oxygen (O2). Since the underlying estimation, the brake thermal efficiency (BTE), (SFC)specific fuel consumption, the braking power (BP), indicated mean effective pressure (IMEP) and the exhaust gas temperature Correlation with CR (compression ratio) 14: 1, 16.38: 1 and 17.5: 1 for various blends are computed and recorded. In every working condition, combustion parameters and emissions values are stored in computer as results. A similar methodology is repeated for various blends of methyl esters of mahua oil. Table 2 shows precision of estimations and uncertainties of the result for various parameters. The diesel and bio-diesel properties of the blends are compressed in Table (Forson et al., 2004). The different values from references are mentioned.

3. Results and discussions

3.1 Brake thermal efficiency

The variation of (BTE) brake thermal efficiency for different CR (compression ratios) and for different blends is given in Fig. 3. It has been observed that the (BTE) brake thermal efficiency of the blend B40 is higher than that of the pure diesel at higher CR (compression ratios). It appears that the BTE of the blend B40 is higher for the compression ratio 17.5. The brake thermal efficiency of the pure diesel and blend B40 for compression ratio 17.5 is 26.08% and 31.48% respectively. By increasing the compression ratio of the engine, the BTE.

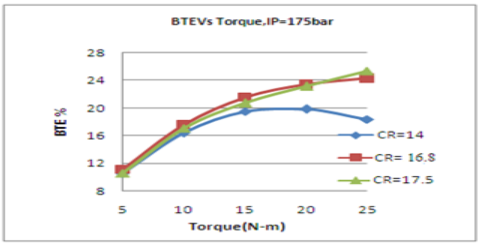

Figure 2: BSFC VS torque

Table 2: The measurements of uncertainty

Measurements	Accuracy
Engine speed	±2 rpm
Temperatures	±1 LC
Carbon monoxide	±0.02 %
Hydrocarbon	±10 ppm
Carbon dioxide	±0.5%
Nitrogen oxides	±15 ppm
Time	±0.5%
Calculated results	Uncertainty
Power	±1%
Specific fuel consumption	±2%
Crank angle encoder	±0.5L CA

Table 3: Fuel properties

Properties	Diesel	B10	B20	B30	B40	B100	Bio diesel standards ASTM D 6751-02
Specific Gravity	0.82	0.83	0.84	0.846	0.856	0.916	---------
Flash Point C	53	61	68	76	84	130	>130
Fire Point C	58	67	76	84	92	141	----------
Kinematic Viscosity at 40 C (mm2/s)	1.83	2.3	2.62	3	3.41	5.8	1.9-6
Calorific Value (KJ/kg)	41850	41600	41360	41115	40870	39400	---------

It additionally increments for a wide range of fuel tested. The BTE is proportionate to CR (compression ratio) (Kishore et al, 2008). The result indicates BTE increases for blend B40 at CR 17.5. The SFC of the B20 blend is lower than that of all other blend with a CR of 16.38 and 17.5 and is appeared in Figure 3. This might be because of fuel density, Heating value and viscosity of fuel. . B20 has higher content energy than B30, however lower than B10 and diesel.

3.2 Brake specific fuel consumption

It the (SFC) specific fuel consumption for B20 blend is lesser CR 17.5. The specific energy consumption (SFC) with increase in CR [16]. Specific energy consumption (SFC) B20 at CR 17.5 is 0.1 kg/kwh though for diesel it is 0.06 kg/Kwh. At higher level of blends, the SFC increases. This is because of the lower calorific value for the higher blends. Low estimations at lower blends (Pranil J et al, 2008).

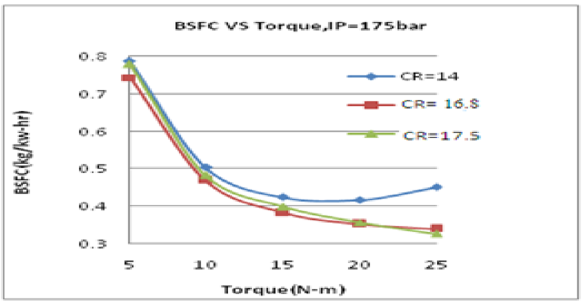

Figure 3: BSFC VS torque

4. Emission test result

4.1 (Hydrocarbon) HC emission

The varying in the outflow of hydrocarbons with various CR for various blends is appeared in Figure 4. It demonstrates that the analysis of hydrocarbons from different blends is more effective at higher CR. It is normal that the impacts viscosity, in the nature spray quality, HC (Hydrocarbon emission) increases with percentage of blend increases (Pugazhvadivu et al., 2005). In this experimentation, it demonstrates that the expansion in the CR (compression ratio) expands the outflow of HC for the B30 blend.

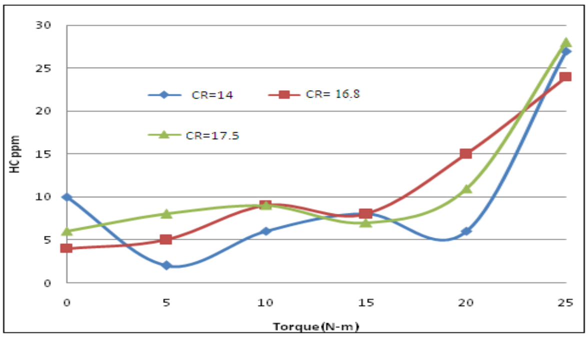

Figure 4: HC VS torque

The other mixtures B10, B20 and B30 produce less hydrocarbon emissions with a higher compression ratio than pure diesel. Due to the increase in ignition delay, the accumulation of fuel in the combustion chamber can cause a higher emission of hydrocarbons.

4.2 Emissions of nitrogen oxides (NOX)

The variations in the emissions of nitrogen oxides (NOx) as for various CR (compression ratio) for various blends are appeared in Figure 5. As appeared in the figure, the emission of NOx for diesel and different blends increase with the CR (compression ratio). From the figure, clearly for the 17.5 CR, the NOx emission of the B30 mahua oil blend is higher than that of the diesel. The other blend nearly takes after the pure diesel. The purpose behind a higher NOx outflow for blends is because of a higher greatest temperature. The main target of research is reduced the emissions of nitrogen oxide. The emissions of NOx for the diesel and the B30 blend for the CR 17.5 are respectively 621 ppm and 640 ppm.

4.3. Carbon monoxide emission

Figure 7 shows the variety of CO (carbon monoxide) discharge of blends and exhaust with different CR. The CO emission of the B20 blend is near the pure diesel and was higher for the CR of 17.5. Alternate blends B10, B20 and B30 have marginally bring down CO emission for the CR of 17.5. (Rakopoulos et al., 2006).

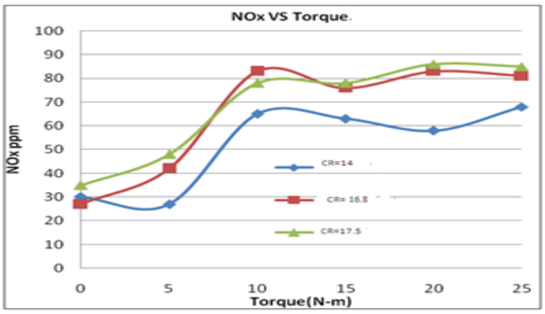

Figure 5: NOx vs torque

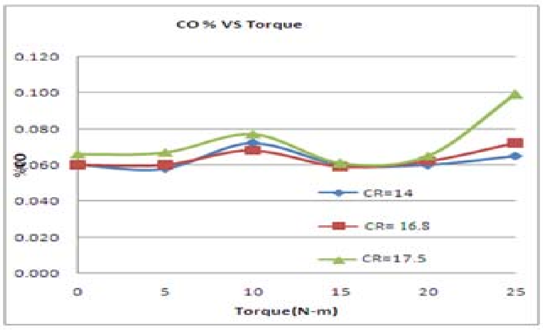

Figure 6: HC vs torque

The percentage of CO increases due to the increase in temperature in the combustion chamber, the physical and chemical properties of the fuel, the air-fuel ratio, the lack of oxygen at fast and the diminished measure of time accessible for finish ignition. One would expect that the impacts of fuel thickness on fuel splash quality will bring about an expansion in CO with vegetable oil energizes (Ramdhas et al., 2004).

5. Result and analysis

5.1 Combustion pressure

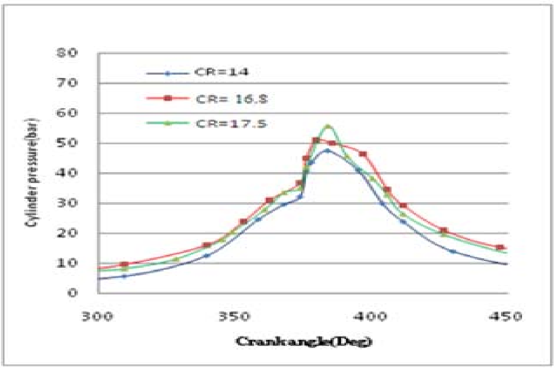

Figure 7: Cylinder pressure vs crank angle

The varying in the combustion pressure with respect to the angle of the crankshaft for different compression ratios and for different mixtures is shown in Figs. 7. It has been observed by the variation of the cylinder pressure for various compression ratios 14: 1, 16.38: 1 and 17.5: 1 that the mahua oil mixtures give a high combustion pressure compared to the pure diesel due to a delay ignition longer than mahua and may be due to the lower cetane number of the mixture. The fuel absorbs more heat from the cylinder immediately after injection and causes a longer ignition delay (Huzayyin et al., 2004). It is noted that 55.5 bar, 53.35 bar, 52.06 bar, 53.61 bar and 53.71 bar for pure diesel and Mahua B10, B20 and B30 petroleum blends.

With a CR (Compression ratio) of 17.5: 1, the increase biodiesel the B30 blend is altogether different from B20. This is expected to the quicker and more entire ignition of the fuel inside the combustion chamber. At bring down CR (compression ratio), combustion rate of diesel is more compare to Biodiesel blends.

6. Conclusion

- The BTE of the blend B20 is slightly higher than that of pure diesel at CR (compression ratio).
- The IMEP for blend is higher to lower CR (compression ratio).
- Higher compression ratio (CR) the exhaust gas temperature decreases.
- At higher compression ratio (CR) the hydrocarbon emission reduces.
- The emission of CO reduces the increase in blend percentage.

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