International Engineering Research Journal

Performance and Emission Analysis of a Diesel Engine Fuelled with Waste Turmeric oil.

Waghmode D. R.†, Gawande J. S.‡

†PG student (Heat Power)Department of Mechanical EngineeringJSPM's RSSOER. SavitribaiPhule University, Pune, Maharashtra, India
‡Professor and Head of Mechanical Engineering department, JSPM's RSSOER.SavitribaiPhule University, Pune, Maharashtra, India

Abstract

In the present work, a single cylinder variable compression ratio diesel engine was tested with different blends of biodiesel obtained from waste turmeric oil. The different blends of biodiesel used are B00, B9, B18, B27, B36, and B45. The Engine performance (brake power, mechanical efficiency) and emission parameter (carbon monoxide, nitrogen oxide and hydrocarbon emission) were measured by using different blends of biodiesel has been studied behavior of engine. Engine experimental result shows that reduction in carbon monoxide, nitrogen oxide and hydrocarbon emission compare with diesel fuel together with brake power and mechanical efficiency close to diesel. There are slight increases in smoke opacity as for biodiesel mixture higher than diesel fuel.

Keywords:*Waste turmeric oil, Engine performance, Emission parameter.*

1. Introduction.

The continuous increases in requirement of fossil fuel, consequent upon the increasing population in present day, has made reduces of conventional fuel resources in future more quite fact. Also the gas emission from these fuel affect the climate and causing global warming. In such situation it is need to find out an alternative fuel overcome to this effect. In addition the energy sources clean and renewable, it will reduce environmental effect. In this detection of an alternative energy sources, scientist select the biodiesel-diesel blend as alternative fuel because of research work show that properties of biodiesel prepared from vegetable oil have very close to fossil fuel.

The experimental result has been compared and analyzed with standard diesel, it show that considerable improvement in performance parameter as well as exhaust emission. Reduction of carbon monoxide, hydrocarbon, carbon dioxide at expense of nitrogen oxide emission(Muralidharan, et al, 2011). Experimental analysis shows that increases in mechanical efficiency and brake power at high compression ratio. The emission of CO, HC dropped with increases in blending ratio and compression ratio (Nagaraja et al, 2015). Evaluate the performance and emission of DI CI variable compression ratio engine fueled with honne oil. At 18 CR break thermal efficiency less than diesel and brake specific fuel consumption higher than that diesel fuel. Reduction in carbon monoxide and hydrocarbon as compare diesel fuel at compression ratio 18(Channapatana, el at, 2015). Test conducted by using hydro treated refined sunflower oil emission and performance result show that decrease in CO, HC, NOx, BSFC and increases in brake thermal efficiency (Hemanandh et al, 2015). The engine performance for various PFAD biodiesel blends at various loads comparatively close to diesel fuel.(Malvadeav, et al, 2013).

From the literature review it can be inferred that a lot of research work has been carried out on evaluating the performance and emission characteristics of different grade of vegetable oils and biodiesel but there is no anyone work has been found on waste turmeric oil. This oil has the potential that become an alternate for conventional diesel oil. Waste turmeric oil is produced from leaf of turmeric crop which is source of raw material. This crop cultivated in western maharashtra side. These leafs are crushed and mixed with steam to remove the oil. After that oil and steam is separated finally golden yellow colour oil is obtained. Waste turmeric oil and its blends with diesel fuel are selected as fuel for VCR single cylinder engine. The different blends of waste turmeric oil and standard fuel are prepared to carry the test.

1) Performance and emission characteristics of variable compression ratio engine using various blends at different load.
2) Compare its performance and emission parameter with diesel fuel.

2. Biodiesel production.

Vegetable oil has similar density, calorific value, cetane number, viscosity compared to pure diesel fuel. However this straight vegetable oil cannot be used directly in engine because it create problem in

compression ignition engine. Such as poor fuel atomization, piston ring sticking, clogging of fuel injector. Therefore it is needed to improve properties of vegetable oil such that it may be used as substitute to diesel fuel. Several techniques are available to reduce the viscosity of vegetable oil such as blending, pyrolysis, transesterification. Waste turmeric oil obtained from leaf of turmeric crop. This oil filtered to remove the solid material and preheated at 110ºC for the 30 minute to remove the moisture and wax.

2.1 Transesterification.

Transesterification is reaction of oil (triglyceride)with primary alcohol to form ester and glycerol. The oil was stirred and heated up to 60ºc at which mixture of alcohol 10% and 0.5% NaOH added and reaction continued for 90 minute. After the confirmation of completion of methyl ester formation, the heating was stopped and product was cooled and transfer to separating funnel. Two layers were observed clearly whenever it allowed settling for 24 hours in separating funnel. Top layer was biodiesel and higher denser layer settle at bottom was glycerin.Once the glycerin and biodiesel phases were been separated. The biodiesel was washed with distilled water.

2.2. Fuel properties.

The properties of diesel fuel, waste turmeric oil, its blend are given in table 1. It is shown that viscosity of biodiesel higher than that pure biodiesel. The density of pure biodiesel is 0.860 which slightly higher than that diesel fuel 0.830. Heating value of biodiesel is lower than that diesel fuel. Fuel with flash point above 50ºc is considered safe. Thus biodiesel with high flash point 90ºc as an extremely safe to handle and storage.

Table.1. Properties of Diesel and Pure Biodiesel**.**

Properties	Ref. Std. Astm 6751	Unit	Diesel B00%	Pure Biodiesel B100%
Density	D1448	gm/cc	0.830	0.86
Calorific value	D6751	MJ/kg	42.50	38
Cetane no.	D613	-	49.00	51
Viscosity	D445	mm2/sec	2.7	4.2
Flash point	D93	ºC	64	91
Fire point	D93	ºC	71	106

3. Experimental Procedure.

The single cylinder variable compression ratio direct injection coupled with eddy current dynamometer engine use for experimentation with required instrumentation and with computer interface. Detailed specifications of engine given in table 2. Engine has provision to change the compression ration by tilting block arrangement. The tilting block arrangement consists of tilting block with six allen bolt, compression ratio adjusting lock nut and compression ratio indicator. For setting the selected compression ration allen bolt are loosened. Then lock nut on to be loosened and adjuster to be rotated to set chosen compression ration by observing the compression ratio indicator and to be locked by using lock nut. Finally all allen bolt tightened.

3.1 Test Procedure.

The fuel used in this study includes diesel fuel, biodiesel blend. The test were carried out by using neat diesel fuel(denoted as B00), 9% biodiesel + 91% diesel fuel(B9), 18% biodiesel + 82% diesel fuel(B18), 27% biodiesel + 73% diesel fuel(B27), 36% biodiesel + 64% diesel fuel(B36), 45% biodiesel + 55% diesel fuel(B45) at different compression ratio 16, 17, 18 with varying load such as zero, half, full. The engine is started using diesel fuel and run for few minute to reach the steady state condition. The test conducted at constant speed. In every test exhaust gas emission such as CO, HC, NO, CO2 and O2are measured. Also the performance parameter BP, BTE, Mechanical efficiency with respect to compression ratio and load for different blend are recorded. Sane procedure repeated for different blend of waste turmeric oil.

Table 2. Engine Specification.

Sr. no	Description	Specification
1	Model and make	Kirloskar and TV
2	No. Of cylinder	Single
3	Cycle	Four stoke
4	Bore and stoke	87.5mm and 110 mm
5	Rated power	3.5 kw at 1500 rpm
6	Compression ration	17.5, modified to work range of 12 to 18.
7	Dynamometer	Eddy current, water cooled with loading unit
8	Cubic capacity	0.661 liters
9	Software	EnginesoftLV

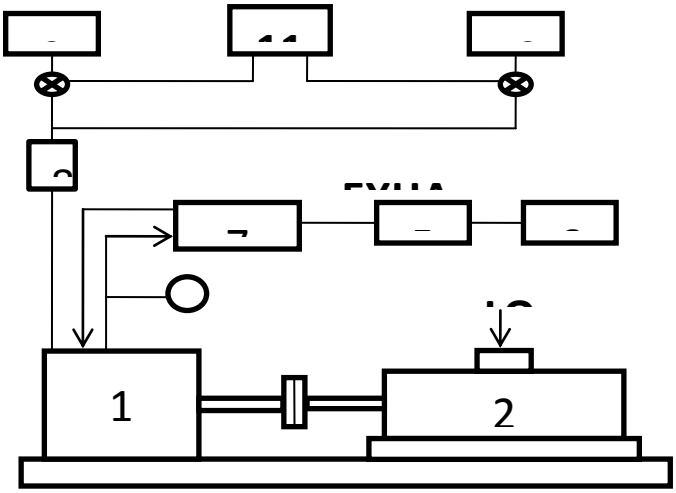

Fig:1 Engine set up.
1. Engine Test Rig, 2. Dynamometer, 3. Exhaust Gas Temp. 4. Test Bed, 5. Smoke Meter, 6. Exhaust Gas Analyser, 7. Calorimeter 8.Fuel Filter, 9. Oil,10. Diesel 11.Buretee

4.Result and Discussion.

4.1 Brake Power.

Fig. 2, 3 and 4shows that brake power with load for different blends and compression ratio. Graph indicate that the brake power increase with load. Brake power is lower at zero loads and high at full load condition. Brake power for all the blends are very close to pure diesel fuel for all compression ratios.

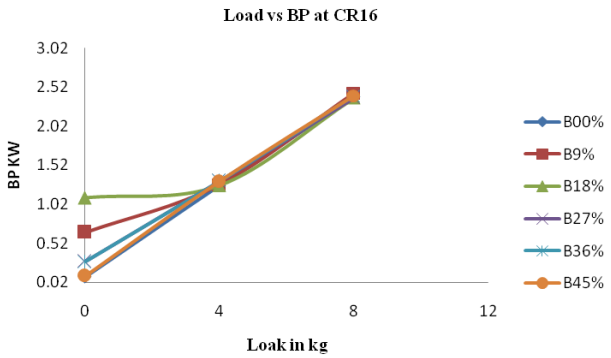

Fig: 2 Variation of brake power with load.

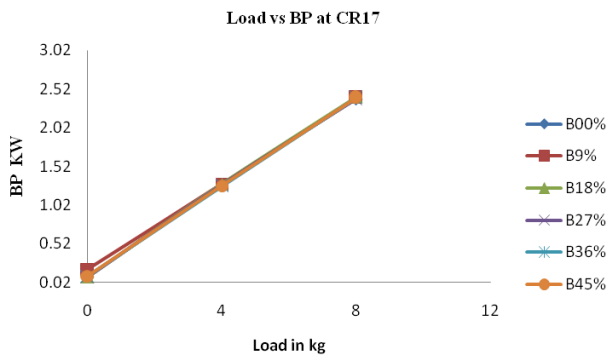

Fig:3 Variation of brake power with load.

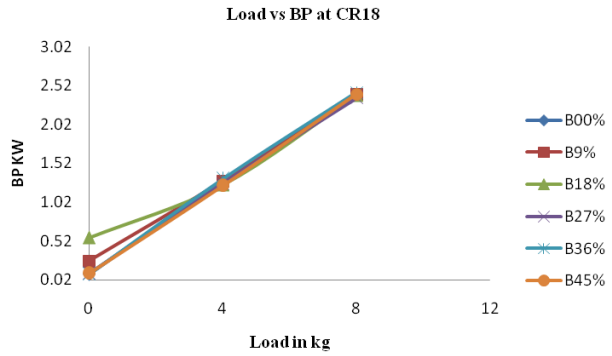

Fig:4 Variation of brake power with load.

4.2 Mechanical Efficiency.

Fig. 5, 6 and 7 show that variation of mechanical efficiency with load for different blends and compression ratio. It has been observed that there are increases in mechanical efficiency for all the blends as the load increase. Mechanical efficiency of the all blends is lower than that pure diesel. For high compression ratio mechanical efficiency of all blends close to pure diesel.

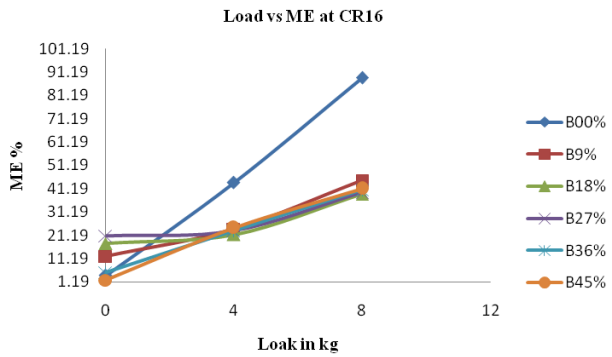

Fig:5 Variation of mechanical efficiency with load.

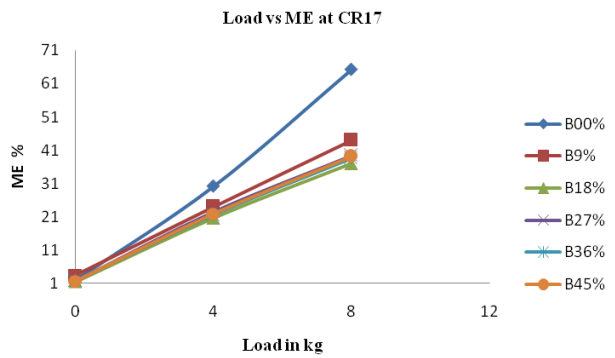

Fig: 6 Variation of mechanical efficiency with load.

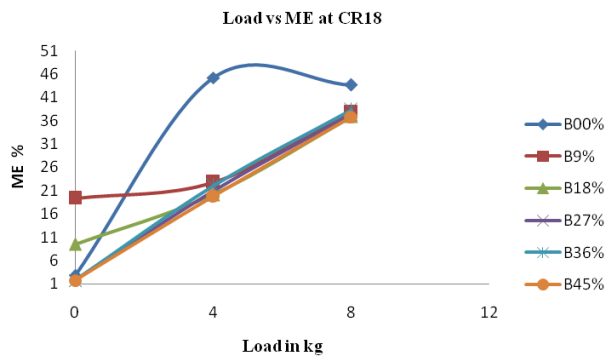

Fig:7 Variation of mechanical efficiency with load.

5. Emission Analysis.

5.1. Hydrocarbon emission.

Fig. 8, 9 and 10 shows variation of hydrocarbon emission with load for different blends and compression ratio. Graph indicates that hydrocarbon emission slightly increases with load for all blends and diesel. This due to the fuel rich mixture at higher load. There is reduction in HC emission for all blends as compare with diesel fuel.

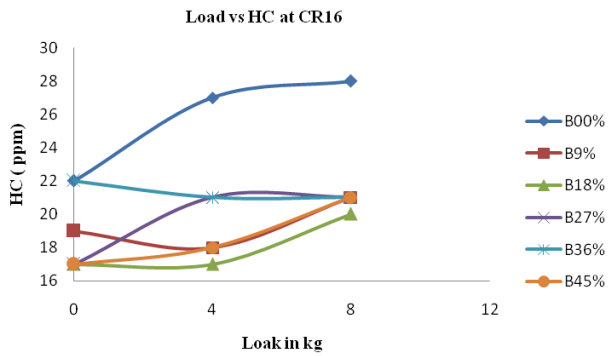

Fig:8 Variation of hydrocarbon emission with load.

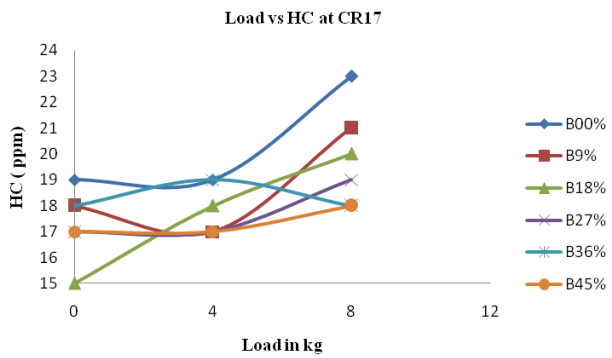

Fig: 9 Variation of hydrocarbon emission with load.

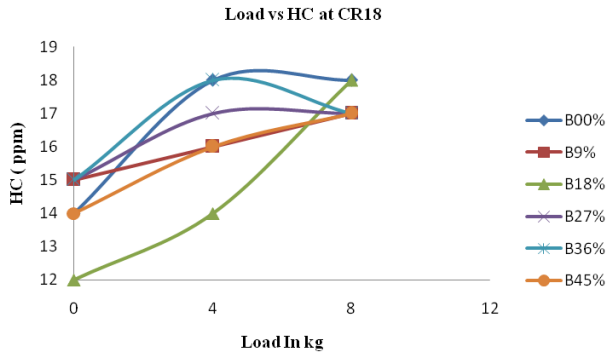

Fig: 10 Variation of hydrocarbon emission with load.

5.2 Carbon monoxide.

Fig. 11, 12 and 13 show that variation of carbon monoxide with load for different blends and compression ratio. Graph indicates that CO emission reduces with load. It can also observe that CO emission is lesser for all blends compared to diesel. This lower CO emission of biodiesel blends may be due to their more complete oxidation as compared to diesel. Some of CO produced during combustion of biodiesel might converted into carbon dioxide by taking up of extra oxygen in biodiesel and thus formation CO reduced.

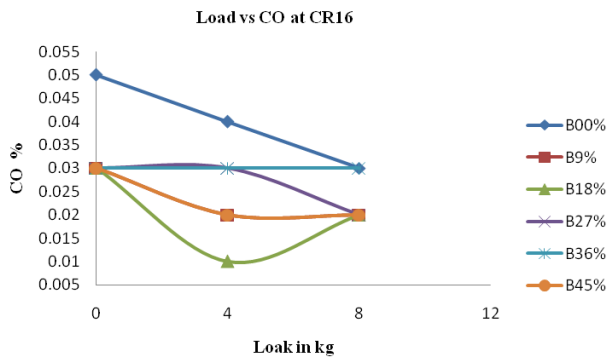

Fig: 11 Variation of carbon monoxide with load.

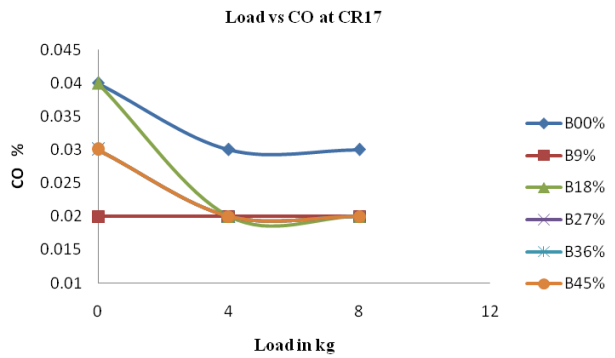

Fig:12 Variation of carbon monoxide with load.

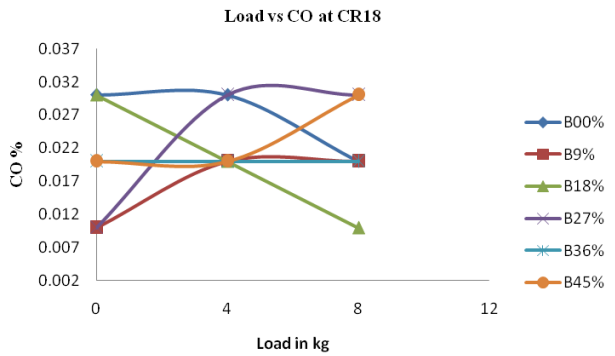

Fig:13 Variation of carbon monoxide with load.

5.3 Nitrogen Oxide.

Fig. 14, 15 and 16 show that variation of nitrogen oxide with load for different blends. NO emission for biodiesel blends is slightly lower than pure diesel fuel at higher load condition but it close at low load.

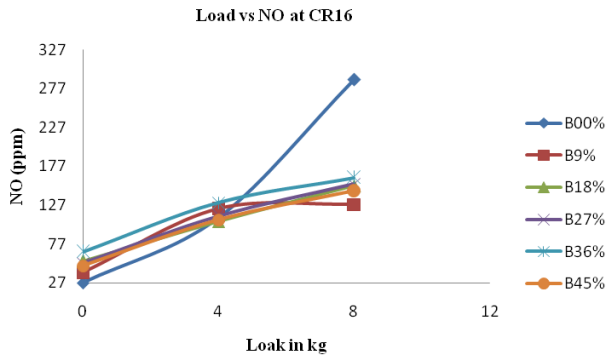

Fig: 14 Variation of nitrogen oxide with load.

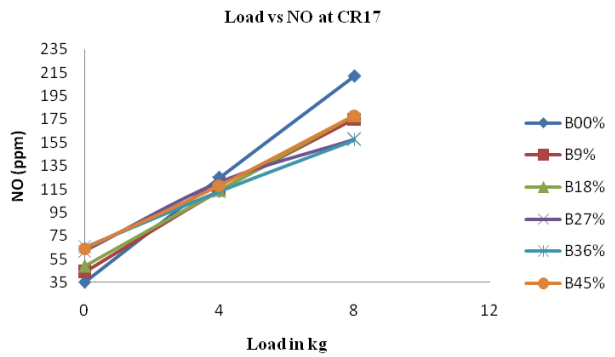

Fig: 15 Variation of nitrogen oxide with load.

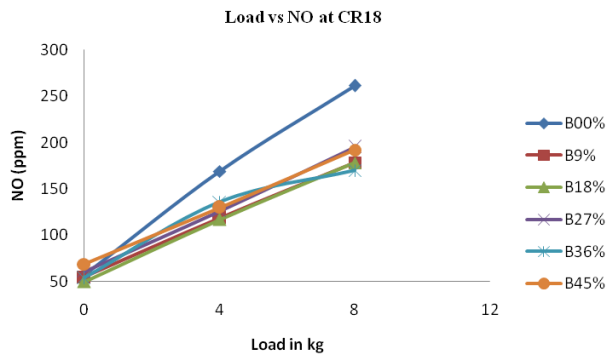

Fig: 16 Variation of nitrogen oxide with load.

Conclusion.

From the experimental result the following conclusions were made.

1. Brake power of waste turmeric oil is very close to standard diesel at all load condition.
2. With increases in load on engine, mechanical efficiency increases at all compression ratio.
3. There is reduction in hydrocarbon emission for all the blends of waste turmeric oil as compared with diesel fuel at all compression ratio and loads.
4. Carbon monoxide decreases for all the biodiesel blends than diesel fuel.
5. Nitrogen oxide emission for biodiesel blends close to diesel fuel but it increases with load.

From the above observation , it has been found that the waste turmeric oil blends show the better performance and emission characteristics compare to diesel fuel all compression ratio and full load condition.

References.

1. SukumarPuhan, N. Vedaraman, Boppana V.B. Ram, G. Sankarnarayanan, K. Jeychandran(2005) "Mahua oil (MadhucaIndica seed oil) methyl ester as biodiesel-preparation and emission characterstics" Biomass and Bioenergy 28 87–93.
2. Gaurav Paul, AmbarishDatta, Bijan Kumar Mandal (2014) "An Experimental and Numerical Investigation of the Performance,Combustion and Emission Characteristics of a Diesel Engine fueled with Jatropha Biodiesel" Energy Procedia 54 455 – 467.
3. H. Raheman, S.V. Ghadge (2007) "Performance of compression ignition engine with mahua (Madhucaindica) biodiesel" Fuel 86 2568–2573.
4. K. Muralidharana, D. Vasudevana, K.N. Sheeba(2011) "Performance, emission and

combustion characteristics of biodieselfuelledvariable compression ratio engine"Energy 36 5385-5393.

5. S. Nagaraja, K. Sooryaprakash, R. Sudhakaran (2015) "Investigate the Effect of Compression Ratio over the Performance and Emission Characteristics of Variable Compression Ratio Engine Fueled with Preheated Palm Oil -Diesel Blends" Procedia Earth and Planetary Science 11 393 – 401.
6. S V Channapattana,Kantharaj C,V S Shinde, Abhay A Paward, Prashant G Kamble(2015) "Emissions and Performance Evaluation of DI CI - VCR EnginFuelled with Honne oil Methyl Ester / Diesel Blends" Energy Procedia 74 281 – 288
7. J. Hemanandh, K.V. Narayanan(2015) "Emission and Performance analysis of hydrotreated refined sunflower oil as alternate fuel" Alexandria Engineering Journal 54, 389–393.
8. Ameya Vilas Malvadea, Sanjay T Satpute(2013) "Production of Palm fatty acid distillate biodiesel and effects of its blends on performance of single cylinder diesel engine"Procedia Engineering 64 1485 – 1494.
9. B De (2014) "an experimental study on performance and emission characteristics of vegetable oil blends with in direct injection variable compression ignition engine" Procedia engineering 90431-438.
10. BobadeS.N,Kumbhar R. R. Khyade V. B "Preperation of methyl ester (biodiesel) from jatrophacurcaslinn oil" ISSN 2320-6063, 2013