ARTICLE IN PRESS

Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Studies on CI engine characteristics with waste cooking oil as biomaterial

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ARTICLE INFO

Article history:
Received 17 May 2020
Accepted 22 May 2020
Available online xxxx

Keywords:
Diesel
Engine
Biodiesel
Performance
Pressure
Emission

ABSTRACT

Global Community anxiety about ecological pollution and the price of gasoline have enforced the progress of substitute for automobiles. This work targets to explore the feasibility of utilizing waste cooking oil an alternate to diesel. The fuels were examined on a single-cylinder diesel engine. The tailpipe pollutants were reduced owing to reduction in viscosity of WCO. Adequate thermal efficiencies were attained with biodiesel. From the trial outcomes it has been found that WCO biodiesel can be replaced for diesel with no engine alteration and warming the fuels.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Newer Trends and Innovation in Mechanical Engineering: Materials Science.

1. Introduction

The world is currently challenged with the crises of ecological degradation. The quest for substitute fuels, which promise an energy management, effectiveness and ecological preservation, has become significant today. Biodiesel is a substitute fuel resulting from the *trans*-esterification of plant oils or waste cooking oils with spirits to give the consistent methyl esters [1–2]. The practice and study of biodiesel as a standby for CI engine happening because of the increase in global warming. CI engines produce huge volume of CO, UBHC and oxides of nitrogen. Release of harmful gases may effect in air pollution, greenhouse effect and will cause various diseases such as lung cancer and breathing problem [3–7]. Different nations look for dissimilar plant oils as alternates for diesel depends on their climate and soil environments. Biodiesel resultant from plant oils and waste cooking oil are gifted alternate to diesel since biodiesel have abundant benefits equated to fossil fuels as they are biodegradable, renewable, delivers energy safety and addressing ecological anxieties [8–10]. Fig. 3.1.Fig. 4.1.Fig. 4.2.Fig. 4.3.Fig. 4.4.Fig. 4.5.Fig. 4.6.Table 3.1.

2. Waste cooking oil biodiesel

The WCO was collected from dissimilar local cafeterias and cleaned to eliminate residues by twin layer of cloth. To the warmed mix of waste cooking oil and methanol, KOH were added. The quantity of KOH required was 7.7gm/ltr by titration with WCO. 200 ml methanol is added with 1000 ml of waste cooking oil. This mixture was stirred for 15 min at 600 rpm and the glycerin was permitted to settle down for a day. The ester was parted from glycerol through an extrication funnel. In the extrication funnel, the ester was washed with hot water, till the washes were neutral and the ester was filtered.

3. Materials and methods

The engine performance and pollutant levels are evaluated by examining WCO biodiesel blends 20% and 80% of diesel (B20) at dissimilar compression ratios like 16.5, 17.5, 18.5 and 19.5:1 in the diesel engine. The diesel engine was attached to an Electric dynamometer for loading the engine. The facts collected for a specified cycle, exhibited, and kept on the computer linked to the unit. The engine load changed as 1/4th, 1/2, 3/4th and full load and the performance were assessed such as Power, SFC and thermal efficiency. The pollutant comprised smoke, UBHC, CO and oxides of nitrogen. The smoke was measured by AVL 437 smoke-meter.

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https://doi.org/10.1016/j.matpr.2020.05.589
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the International Conference on Newer Trends and Innovation in Mechanical Engineering: Materials Science.

Please cite this article as: L. Karikalan, M. Chandrasekaran and S. Baskar, Studies on CI engine characteristics with waste cooking oil as biomaterial, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.05.589

Fig. 3.1. Experimental Setup.

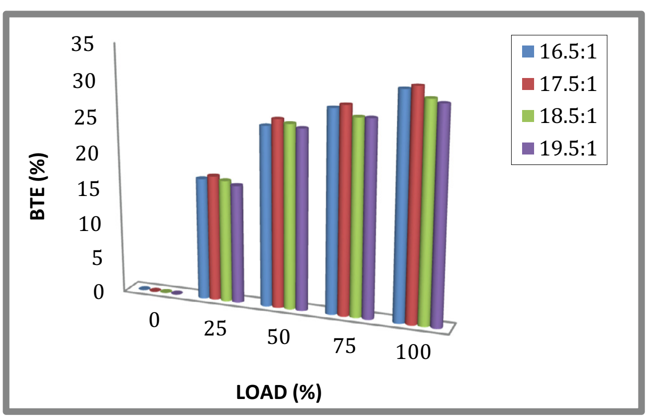

Fig. 4.1. BTE vs. LOAD.

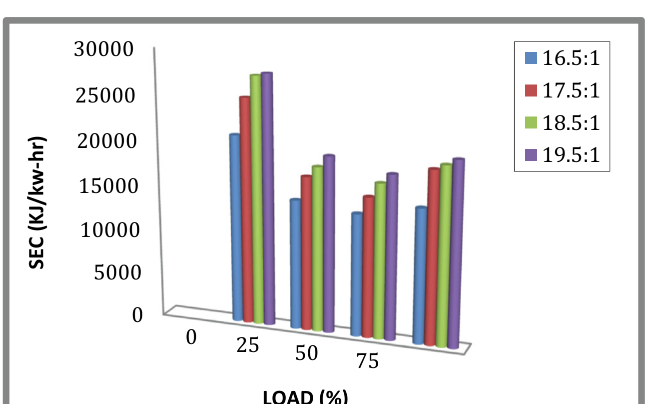

Fig. 4.2. SEC vs. LOAD.

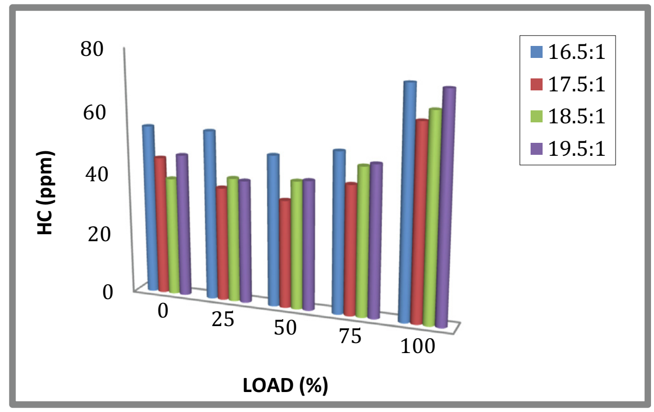

Fig. 4.3. HC vs. LOAD.

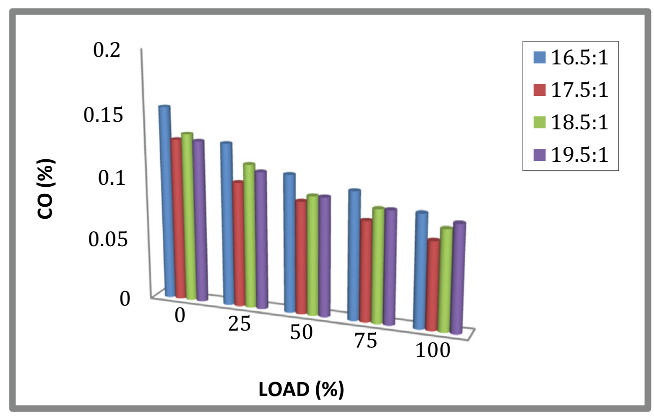

Fig. 4.4. CO vs. LOAD.

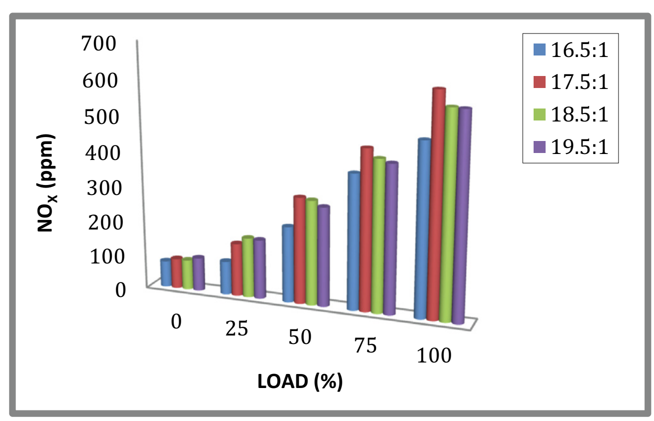

Fig. 4.5. NO_X vs. LOAD.

Exhaust gas configuration was measured by AVL 444DiGas analyzer. Table.1 displays the engine terms and Fig.1 exhibits the set-up of experiment.

4. Result and discussion

4.1. Brake thermal efficiency (BTE)

Trial results specify that BTE rises with load for diesel as well as biodiesel mixtures. For a C.R of 18.5, the thermal efficiency for B20

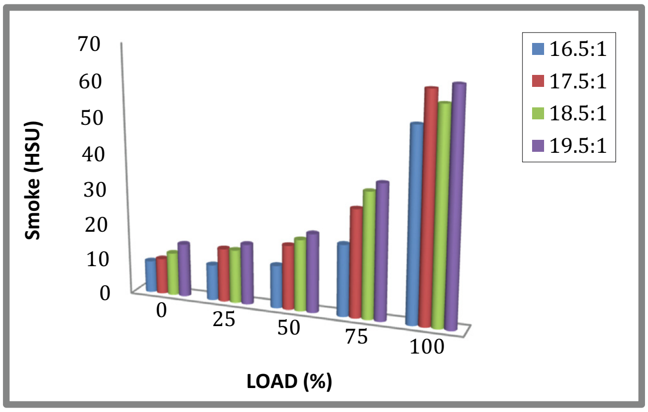

Fig. 4.6. SMOKE vs. LOAD.

Table 3.1
Detail of Engine.

Make & model	KIRLOSKAR - TAF1
General	Single Cylinder, Direct Injection, 4 Stroke and Air Cooled
Bore & Stroke	80 mm × 110 mm
Compression Ratio	16.5
Output Power	4.4 kW
Engine speed	1500 rpm
Injection Rate	200 bar

is highest amongst all the blends and is 1.4% lesser than diesel at 100% load. Henceforth B20 is considered to be the optimal blend. As the % of biodiesel in diesel is enlarged from the value the BTE value declines. The test results show that the BTE falls when C.R is backward and rises when C.R is advanced. For biodiesel at 19.5:1, at 3/4th of load the greater BTE was achieved when compared to other C.R at 3/4th of load. It could be owing to improved mingling of the air–fuel inside burning chamber which consequences improved burning.

4.2. Specific energy consumption

Trial outcomes reveal that SEC declines as the engine load bigger and were least at 100% load. For blend at 3/4th load, the lesser SEC was accomplished when compared to other compression ratios. It might be due to the proper vaporization of biodiesel, which effects in better burning.

4.3. Hydrocarbon emission

The trial results display that the HC rises when C.R is backward and drops when C.R is advanced. For all C.R, HC drops in the part load and then rises. For biodiesel at 17.5:1, at 100% load the reduced HC was achieved when equaled to other C.R at 100% load. This could be due to the uniformity of air–fuel combination which consequences in improved combustion.

4.4. Carbon monoxide emission

The test outcomes exhibit that the CO rises when C.R is backwards and drops when C.R is advances. For all the C.R, CO drops with rise in engine power. For blend at 17.5:1, at 100% load the reduced CO was accomplished when compared to other C.R at 100% load. It can be owing to the possibility of proper combustion at this compression ratio. The CO is significantly reliant on the A/F ratio as well as the fuel burning in the cylinder.

4.5. Nox emission

The trial results show that the NOx declines when C.R is backward and rises when C.R is progressive. For all the C.R, NOx increases with rise in engine power. For blend at 16.5:1, at 100% load the lower NO_X was achieved when compared to other C.R at 100% load. NOx for the biodiesel is greater than diesel, since the biodiesel contains the inbuilt O_2 in their molecular arrangement.

4.6. Smoke

The test outcome shows the Smoke rises when C.R is backwards and drops when C.R is advances. For all the C.R, Smoke rises with rise in engine power. At 100% load the lesser Smoke was attained at 16.5:1 when equated to other C.R at 100% load. It might be owing to the increase of O_2 in blend provides sufficient oxidation in richer areas, clue to a notable fall in smoke releases.

5. Conclusion

The subsequent outcomes are attained by varying compression ratio from 16.5 to 19.5:1 in a single-cylinder diesel engine with WCO B20 blend. At 3/4th of load, the maximum BTE was attained and the lesser SEC was attained at higher compression ratio. For blend at 17.5:1 at 100% load the reduced HC was achieved when compared to other ratios. For biodiesel at 18.5:1 at 100% load the reduced CO was achieved when compared to other ratios. At 100% load the reduced Smoke was achieved at 16.5:1 when compared to other compression ratio. It is clear that the WCO B20 biodiesel shows better pollution features at high compression ratio with 100% load.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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