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Diesel Engine Operated with Various Blends of Argemone Biodiesel

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ABSTRACT

An experimental analysis of the performance and emission characteristics of compression ignition engines running on various Argemone biodiesel blends was done for the current study. The 5.2 kW, 4-stroke, single-cylinder, 1500 rpm, water-cooled, direct injection, Kirloskar engine was used for the experiments, and the injection timing and pressure were kept constant throughout the trial at 23° BTDC and 210 bar, respectively. The B0, B25, B50, B75 and B100 are just a few of the biodiesel blends that have been developed to study performance and emission characteristics. The test findings showed that, among the several blends, B25 blend performed nearly as well as plain diesel.

KEYWORDS:Biodiesel, Blends, Emissions, Engine, Transesterification.

1. INTRODUCTION

The biggest detrimental effects of modern civilisation are environmental pollution and global warming. We are also making our world unsafe for future generations due to our growing industrial and urbanisation. The number of vehicles on the planet is rising quickly [1]. According to a recent analysis, vegetable oil methyl ester offers greater thermal efficiency and lower smoke levels than plain vegetable oils. Globally extensive research is being done to find a suitable diesel replacement. Vegetable oils have won the lead in this competition amongst alternatives because certain of their physical, chemical, and combustion-related characteristics are quite comparable to those of diesel fuel [2]. Because of their high viscosity, raw vegetable oils cannot be used in diesel engines directly. The viscosity can clog gasoline filters and lines, and it also leads to poorly atomized fuel entering the combustion chamber. Transesterification process must be carried out in order to lower the high viscosity of raw oil [3]. Among various biodiesel blends the B20 blend is accepted all over the world [4-8]. When an engine is fuelled by different biodiesel mixes, advanced injection time outperforms retarded injection timing among the many investigated injection timings [9-16].

2. ARGEMONE BIODIESEL

Argemone species are plants that can withstand cold temperatures and droughts and are adapted to semi-warm, semi-dry, and temperate regions from the sea up to 2750 metres above sea level. They are linked with arid zones and low deciduous forests, and they grow on roadsides, in agricultural regions, or on abandoned farmland. Some species have also been found in xerophytic scrub, pine, mixed pine-oak, juniper, and deciduous and evergreen tropical forests. The leaves are arranged alternately and have serrated edges that finish in spines. The many bud shapes include lobed, elliptical, spherical, and obovate. According to Ownbey, the number of sepals varies from 2 to 6, with 3 being the typical amount. The apex of each sepal has a corniculate appendage, and the shape of the horns on each one can be used to distinguish between different species. Argemone species have actinomorphic flowers with six or, less frequently, nine petals. The petals of A. ochroleuca are six elliptical to obovate or bcuneiform, but those of A. albiflora, A. munita, and A. gracilenta are obovate or suborbicular. The flower's hues range from yellow to white and include lavender. Flowers have both sexes. The stamens in the various species are numerous; the number varies depending on the species; Karnawat and Malik mention that A. mexicana has between 30 and 50 stamens while A. ochroleuca has between 20-75. The anthers are linear and comprised of two dehiscent cells. The pistils are made up of a stigma and a short style. The several Argemone species produce dry, dehiscent fruits or capsules that contain many seeds and have between three and six carpels. The capsules could have an ovate, lanceolate, or narrowly elliptical-oblong shape. Argemone seeds range in size from 1 to 2.5 mm and are subspherical or slightly conical. The micropyle develops a thin, frequently noticeable peak, and the testa reticulate exhibits surface depressions. Seeds cannot be distinguished visually, and the size and colour ranges of the depressions do not have any taxonomic significance. The tap roots of the Argemone species are robust and slenderly branching. While other species generate lateral roots, the primary root of A. polyanthemos can reach depths of up to 60 cm. Due to their molecular makeup, the isoquinoline alkaloids found in argemone seeds exhibit the characteristics of auto-fluorescence. The molecular structure that sanguinarine acquires when it is dissolved in solution is what causes its absorptions and emissions. While the non-ionic form of sanguinarine exhibits a maximum peak at 450 nm, the ionic form as a quaternary ammonium salt has a maximum emission of about 580 nm [17].

3. TRANSESTERIFICATION REACTION

It is the most popular and effective method for lowering vegetable oil’s viscosity. In this procedure, a catalyst is used to help a triglyceride react with three alcohol molecules to produce a combination of fatty acids, alkyl esters, and glycerol. Esterification is the process of completely removing all of the glycerol and fatty acids from the vegetable oil while using a catalyst. The variables that influence the transesterification of raw oil, such as temperature, molar ratio, and catalyst concentration, were originally tuned. The 2 L capacity, round bottom flask with three necks that is part of the transesterification setup is submerged in water to heat the oil. The flask with a spherical bottom contained a heater with a temperature control. For thorough mixing of the oil, a high speed motor with a magnetic stirrer was employed. Triglycerides from raw oil react with methyl alcohol in the transesterification process in the presence of a catalyst (NaOH) to generate a fatty acid ester and glycerol. In this procedure, a round bottom flask was filled with 1000 g of raw oil, 230 g of methanol, and 8 g of sodium hydroxide pellets. In order to encourage ester formation, the mixture was heated to 70°C and vigorously agitated for an hour. After that, the mixture was poured into a separate funnel and let to settle naturally overnight. In the separation funnel, the ester is in the upper layer, and the eliminated glycerol is in the lower layer. 250 g of boiling water were added to the separated ester and it was then given 24 hours to settle naturally. Remaining fatty acids and catalyst are separated by water washing and then eliminated using a separating funnel. Finally, silica gel crystals were used to extract the moisture from the ester.

4. PROPERTIES OF FUELS

Table-1. Properties of fuels

Properties	B0	B25	B50	B75	B100
Density (kg/m^3)	827	841	852	864	876
Kinematic Viscosity at 40°C (cSt)	3.51	4.11	4.68	5.26	5.84
Flash point (°C)	52	83	112	142	171
Fire point (°C)	59	93	127	161	194
Calorific value (MJ/kg)	42.21	41.31	40.38	39.46	38.54

5. EXPERIMENTAL SETUP

The experimental investigation makes use of a single-cylinder, direct-injection, four-stroke, water-cooled, compression-ignition (CI) engine. Fig-1 shows line diagram of experimental setup. Table-2 contains the engine's technical specifications. The time it took to consume a known amount of fuel (10cc) from a burette was recorded in order to calculate the fuel flow rate. A red wood viscometer was used to measure the viscosity of raw and esterified oil, a hydrometer to assess density, a bomb calorimeter to measure calorific value, and an open cup to measure flash and fire point. HC, CO, and NOx emissions from exhaust tailpipes were measured using an exhaust gas analyzer. The engine was first made to run in perfect conditions as a warm-up phase before the experimental tests began, and then the experiments were carried out. After starting, the engine was given around 10 minutes to warm up.

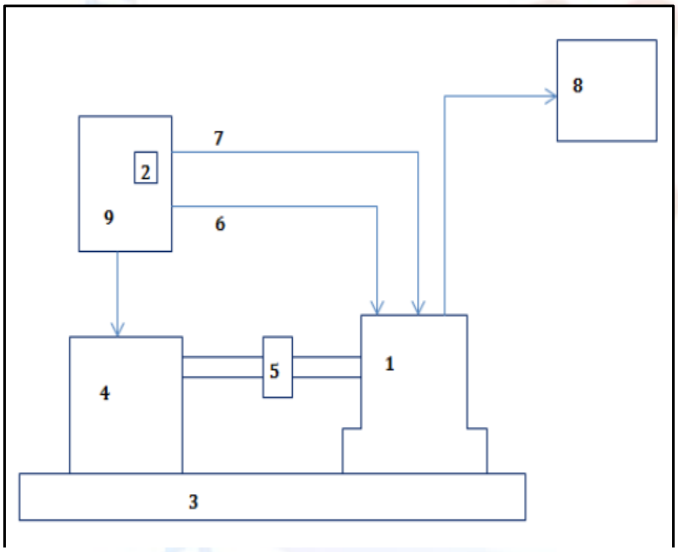

Fig. 1. Line diagram of experimental setup

1-Diesel engine, 2-Burette for fuel measurement, 3-Base, 4-Dynamometer, 5-Coupling, 6-Air supply line, 7-Fuel supply line, 8-Exhaust gas analyser, 9-Control panel

Table-2.Test engine specifications

Engine Type	Kirloskar
No. of Strokes	4
No. of Cylinders	1
Type of Cooling	Water Cooling
Type of Injection	Direct Injection
Bore	87.5 mm
Stroke	110 mm
Compression Ratio	17.5:1
Rated Power	5.2 kW
Rated Speed	1500 rpm
Injection Pressure	210 bar
Injection Timing	23° bTDC

6. RESULTS AND DISCUSSION

6.1. Brake thermal efficiency (BTE)

Figure 2 depicts the fluctuation of BTE with load for various biodiesel mixes. The BTE rises with increasing load for all of the evaluated fuels. This is caused by a decrease in heat loss and an increase in power as load increases. At both power outputs, it was discovered that biodiesel blends had worse BTE than diesel. The lower calorific value, higher viscosity, and higher density of biodiesel cause it to atomize poorly compared to diesel, increasing the BTE of biodiesel blends. Because the power generated by the engine is less than the amount of fuel needed to generate that power at 100% load condition, all tested fuels exhibit higher BTE at 80% load condition.

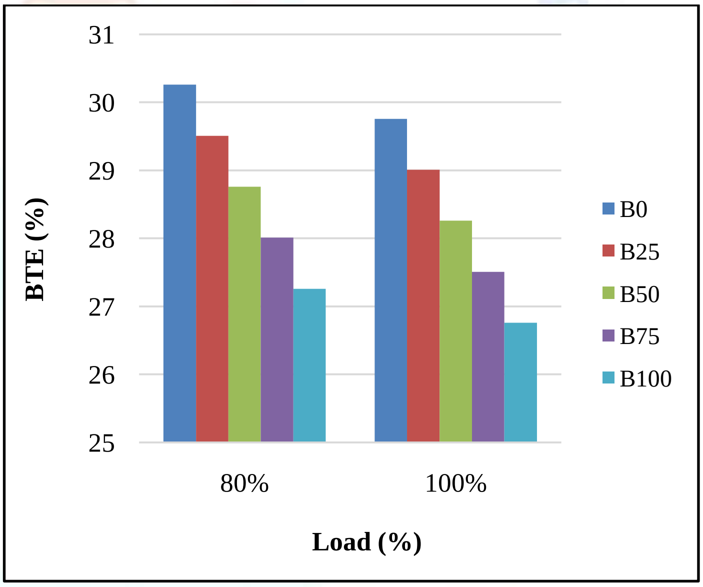

Fig. 2. Variation of BTE with load

6.2. Hydrocarbon (HC) and carbon monoxide (CO) emissions

Figure 3 and 4 depicts the fluctuation of HC and CO emissions with load for various biodiesel blends. Compared to biodiesel mixes, plain diesel emits fewer HC and CO emissions into the atmosphere. This is mostly caused by the increased viscosity of biodiesel mixes, which causes incomplete combustion due to poor fuel and air mixing.

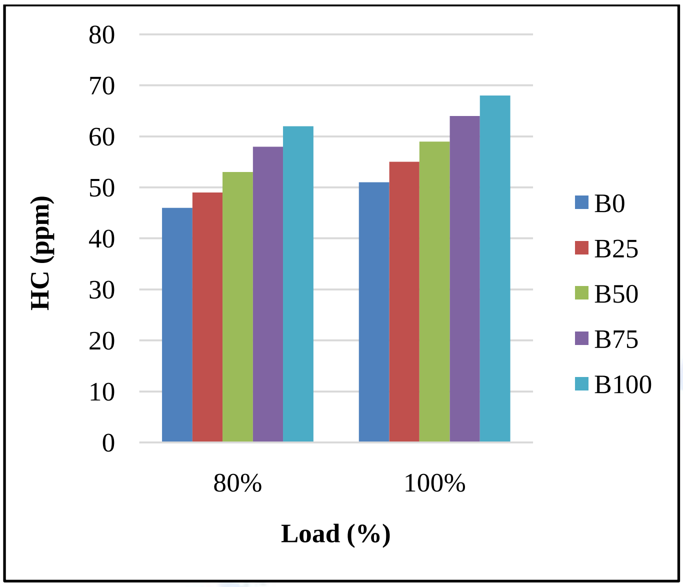

Fig. 3. Variation of HC emissions with load

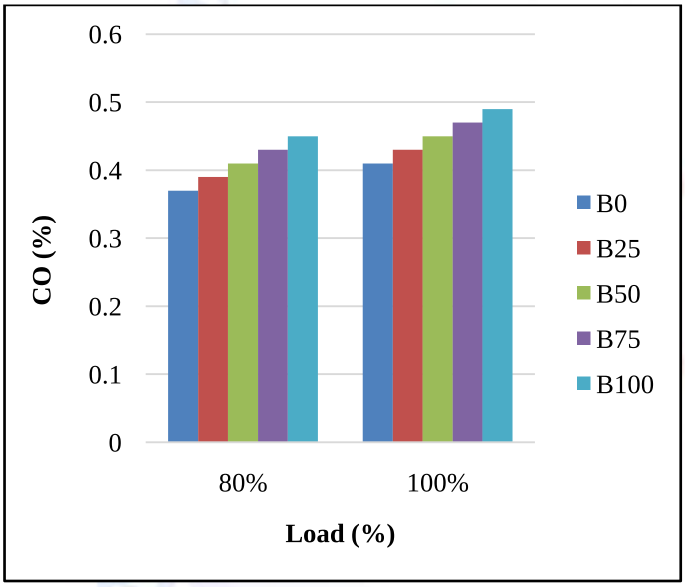

Fig. 4. Variation of CO emissions with load

6.3. Oxides of nitrogen (NOx) emissions

Figure 5 illustrates NOx emissions change as a function of load for various biodiesel blends. Compared to biodiesel mixes, plain diesel emits a higher level of NOx. Diesel has a larger calorific value and lower viscosity than biodiesel mixes, which is mostly to blame for this. This leads to improved fuel and air mixing, which promotes complete fuel combustion. In comparison to biodiesel blends, full combustion of the fuel results in higher peak pressure rise rates and exhaust gas temperatures as well as increased NOx emissions.

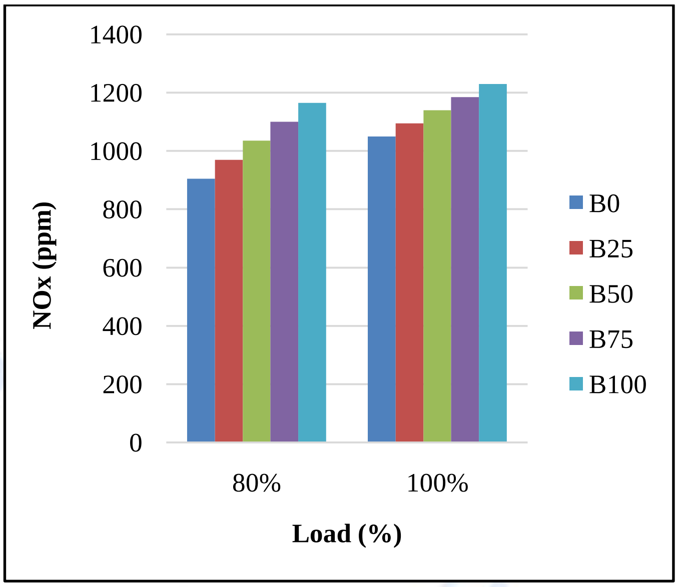

Fig. 5. Variation of NOx emissions with load

7. CONCLUSIONS

At all power outputs, it was discovered that biodiesel blends had worse BTE than diesel. Compared to biodiesel mixes, plain diesel emits fewer HC into the atmosphere. Compared to biodiesel blends, plain diesel produces less CO emissions. Compared to biodiesel mixes, plain diesel emits a higher level of NOx. The B25 demonstrated the best performance with the lowest emissions out of the evaluated biodiesel blends. The engine's BTE operates closer to diesel operating at 80% power output when using a B25 mix. In light of this, B25 blend is advised for older diesel engines.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Harari P.A., Akshatha D.S., Manavendra G., Simarouba biodiesel as an alternative fuel for CI engine: review, International Journal of Innovative Research in Science, Engineering and Technology, 4(3), 2015, 1059-1063.

[2] Harari P.A., Mahua biodiesel as an alternative fuel for CI engine: review, International Journal of Modern Engineering Research, 5(4), 2015, 24-31.

[3] Harari P.A., Akshatha D.S., Manavendra G., Effect of injection pressure and nozzle hole diameter on combustion parameters of CI engine fuelled with B20 neem blend, International Journal of Innovative Research in Science, Engineering and Technology, 4(5), 2015, 2857-2870.

[4] Chavan M., Sutar A., Bhatkande R., Gurav R., Mulla M., Deokar A., Harari P., Experimental studies on production of biodiesel from thevetiaperuviana feedstock, International Journal of Engineering and Management Research, 8(2), 2018, 46-49.

[5] Harari P.A., Yaliwal V.S. Banapurmath N.R., Experimental investigation on the effect of gaseous fuels energy share on reactivity controlled compression ignition mode of combustion operated with gaseous fuels and liquid fuels, Materials Today Proceedings, 2021, https://doi.org/10.1016/j.matpr.2021.11.006.

[6] Harari P.A., Banapurmath N.R., Yaliwal V.S., Soudagar M.E.M., Khan T.M.Y., Mujtaba M.A., Safaei M.R., Akram N., Goodarzi M., Elfasakhany A., Seesy A.I., Experimental investigation on compression ignition engine powered with pentanol and thevetiaperuviana methyl ester under reactivity controlled compression ignition mode of operation, Case Studies in Thermal Engineering, 25, 2021, 100921, https://doi.org/10.1016/j.csite.2021.100921.

[7] Harari P.A., Yaliwal V.S., Banapurmath N.R., Effect of CNG and CBG as low reactivity fuels along with diesel and TPME as high reactivity fuels in RCCI mode of combustion by varying different loads, Materials Today Proceedings, 47(10), 2021, 2491-2494, https://doi.org/10.1016/j.matpr.2021.04.557.

[8] Harari P.A., Banapurmath N.R., Yaliwal V.S., Khan T.M.Y., Soudagar M.E.M., Sajjan A.M., Experimental studies on performance and emission characteristics of reactivity controlled compression ignition (RCCI) engine operated with gasoline and ThevetiaPeruviana biodiesel, Renewable Energy, 160, 2020, 865-875, https://doi.org/10.1016/j.renene.2020.07.009.

[9] Pushparaj M., Vishal J., Harari P.A., Pattanashetti A., Jagatap S., Bhuimbar S., Meti V., Performance parameters of B20 neem blend in CI engine by varying injection timing and nozzle hole diameter, 5(2), 2016, 1434-1442.

[10] Harari P.A., Pattanashetti A., Experimental investigation on the effect of injection timing, carburetor type and exhaust gas recirculation on compression ignition engine fuelled with diesel–compressed biogas and rice bran oil methyl ester–compressed biogas, Integrated Research Advances, 4(2), 2017, 29-36.

[11] Harari P.A., Effect of injection timing on the performance and emissions of dual fuel engine operated with compressed biogas and calophylluminophyllum methyl ester, International Journal of Research in Advent Technology, 7(4), 2019, 1-8.

[12] Harari P.A., Deokar A.J., Jadhav S.D., Narvekar R.P., Nimbalkar P.Y., Kamble V.A., Effect of injection timing on compression ignition engine fuelled with thevetiaperuviana biodiesel, 8(5), 2019, 5744-5754.

[13] Harari P.A., Banapurmath N.R., Yaliwal V.S., Khan T.M.Y., Badruddin I.A., Kamangar S., Mahlia T.M.I., Effect of injection timing and injection duration of manifold injected fuels in reactivity controlled compression ignition engine operated with renewable fuels, Energies, 2021, 14, 4621, https://doi.org/10.3390/en14154621.

[14] Karthik T., Banapurmath N.R., Basavarajappa D.N., Ganachari S.V., Kulkarni P.S., Harari P.A., Effect of injection timing on the performance of dual fuel engine fueled with algae nano-biodiesel blends and biogas, Materials Today Proceedings, 2021, https://doi.org/10.1016/j.matpr.2021.11.156.

[15] Gaddigoudar P.S., Banapurmath N.R., Basavarajappa Y.H., Yaliwal V.S., Harari P.A., Nataraja K.M., Effect of injection timing on the performance of CeibaPentandra biodiesel powered dual fuel engine, Materials Today Proceedings, 2021, https://doi.org/10.1016/j.matpr.2021.08.009.

[16] Deokar A.J., Harari P.A., Effect of injection pressure, injection timing and nozzle geometry on performance and emission characteristics of diesel engine operated with thevetiaperuviana biodiesel, Materials Today Proceedings, 47(10), 2021, 2622-2626, https://doi.org/10.1016/j.matpr.2021.05.198.

[17] Delgado A.A.M., Anda J., Morales J.M.L., Díaz J.C.M., Mora A.G., Nava J.J.C., Argemonespecies: Potential source of biofuel and high-value biological active compounds, Environ. Eng. Res. 2022; 27(2): 200619, https://doi.org/10.4491/eer.2020.619.