

Characterization of Mexicana Methyl Ester on Single Cylinder Four Stroke Diesel Engine

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ABSTRACT: In this research paper, our aim was to investigate new non-edible oil except Karanja, Jatropha, and Neem. Argemone Mexicana is a weed crop and its seeds oil biodiesel is extracted by Transesterification process with methanol. And tested on a single cylinder, four stroke diesel engines connected to eddy current dynamometer fuelled with argemone biodiesel and blend with diesel fuel under different load condition. The performance parameters like brake power (BP), brake specific fuel consumption (BSFC), brake thermal efficiency (BTHE), and emissions of CO and HC are compared and with diesel fuel. In this work 5%, 10%, 15%, 20%, 25%, 30% and 50% argemone mexicana blends are used.

KEYWORDS: Biodiesel, Transesterification, Argemone mexicana seed oil, Methyl ester, Emission, Molar ratio

I. INTRODUCTION

Because of increased demand for the energy supply of fossil fuels source such as petroleum, coal & natural gas. Due to urbanization and increased population, the usage of the number of automobiles increased and consumption of petroleum products are increasing. There is continuous demand increasing from year to year as a result reserves of petroleum products are depleting at a faster rate. Therefore it is necessary to find an alternative fuel to be used in an internal combustion engine to bridge this gap of increased consumption. By using less expensive feedstock containing fatty acids, the cost of biodiesel production is lowered by some extent. The availability & sustainability of sufficient supplies of less expensive feedstock will be a crucial determinant delivering a competitive biodiesel price. All those studies aimed to produce the high yield of biodiesel by optimized reaction conditions based on optimized parameters in terms of alcohol/oil molar ratio, catalyst concentration, reaction temperature, and time.

A biodiesel an alternative fuel has attracted considerable attention during past decade as a renewable, biodegradable and non-toxic fuel. It is derived from the different types of vegetable oil (edible and non-edible oil) and animal fats through Transesterification; it is also called alcoholysis. The commonly used alcohols for the transesterification include methanol, ethanol, Methanol particularly due to its low cost. It is safe alternative fuel to replace traditional petroleum diesel. It has high lubricity, is a cleanburning fuel and can be a fuel component for use in existing, unmodified diesel engines. Biodiesel produces less air pollution and it is a safer for the environment. There for the non-edible seed plant like Argemone mexicana has been found most suitable for this purpose.

Amexicana seeds contain 22–36% of pale yellow non-edible oil, called argemone oil. The oil from the seeds of weed plant like Argemone mexicana can easily available & can found on wasteland, roadside throughout India. The plant prefers sandy soils, requires well-drained soil and can grow in nutritionally poor soil. All parts of the plant, including the seed, contain toxic alkaloids, but it has much medicinal usage and can be applied in external part of the body. It contains alkaloids similar to those in the opium poppy and so can be used as a mild pain-killer. The fresh yellow,

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milky, acrid sap contains protein dissolving substances and has been used in the treatment of warts, cold sores, cutaneous affections, skin diseases, itches etc. The root is alterative and has been used in the treatment of chronic skin diseases.

II. LITERATURE SURVEY

Ashish Sithta, Ashwini Kumar, and S. K. Mahla, "Utilization of Argemone Oil Biodiesel in Commercial Di-Ci Engine" Its aim was to study or to investigate some new non-edible oil. Argemone Mexicana, a weed crop, and its seed oil methyl ester are tested on single cylinder direct injection diesel engine. In which, maximum brake thermal efficiency was obtained slightly higher than that of diesel fuel. The specific energy consumption for B20 was found closer to the diesel fuel. There is a significant decrease in the emission level with blends of Argemone oil biodiesel as compared to diesel operation. It was found that biodiesel obtained is of good quality and it is suitable for using in a diesel engine.

Nikhil Sutar and M.H. Attal doing research on, "Performance Evaluation of C.I. engine with the change in different engine variables and using methyl ester of Argemone Mexicana" In this research paper; the argemone oil methyl esters are used for the check and evaluate the performance of compression injection diesel engine. It is to investigate to look effect for compression ratio, fuel injection pressure, and load. On an average, the brake thermal efficiency increased as compression ratio increased from 16 to 18 whereas BSFC reduced. Thus higher compression ratio gives better engine performance. On an average, the CO₂ and NO_x emission increased and HC and CO emission decreased as compression ratio increased from 16 to 18.

Parmjit Singh, Sandeep Kumar Duran, Amanpreet Singh, "Optimization of biodiesel from argemone oil with different reaction parameters and performance analysis in CI engine" In this paper, the argemone mexicana oil is used for investigating the performance parameters like BP, BSFC etc. There are different reaction temperatures parameters for optimizing the biodiesel like kinematic viscosity, molar ratio, catalyst concentration. The production of biodiesel is obtained by transesterification of argemone oil with methanol in the presence sodium metal as a catalyst. The brake thermal efficiency and brake power were maximum for AB20 at full load conditions. The specific fuel consumption was decreased for AB20 at full load conditions even that of diesel fuel.

III. METHODOLOGY OF BIODIESEL PRODUCTION

A. Transesterification of oil:

Transesterification is the reaction of oil with an alcohol to form esters and glycerin. A catalyst is used to improve the reaction rate and yield. Among the alcohols, methanol and ethanol are used commercially because of their low cost and physical and chemical advantages. They quickly react with triglyceride and NaOH and are easily dissolved in them. To complete a transesterification process, 3:1 molar ratio of alcohol is needed. A mixture of vegetable oil and sodium hydroxide are heated and maintained at 65°C for 1 hour, while the solution is continuously stirred. Two distinct layers are formed, the lower layer is glycerin and the upper layer is the ester. The upper layer is separated and moisture is removed from the ester by using calcium chloride. It is observed that 90% ester can be obtained from vegetable oils. The graphical representation is shown in figure 1. (a)

Transesterification:

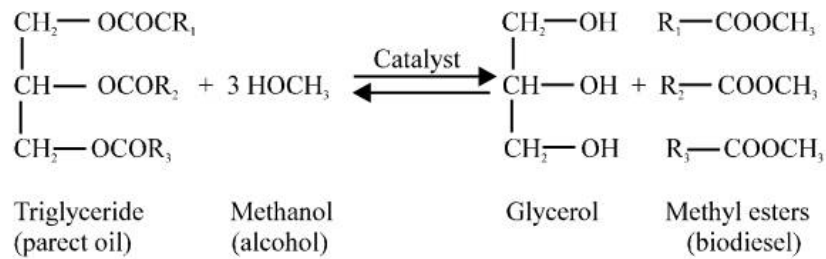


Fig1. (a) Transesterification reaction

The below Fig.2 (a) shows actual argemone mexicana plant,0.6-0.5 meter in height.It has bright yellow latex.It is tolerant of drought and poor soil and fig.(b) shows that seed of argemone mexicana,which is very small, round,blackish brown.The seeds counts per kg are 50000-80000.The seed collection period is from sept-Oct. And fig.(c) shows the pure diesel fuel and different biodiesel blends of argemone mexicana i.e B5,B10,B15,B20,B25,B30 and B50 respectively.It is extracted using transesterification process at baramati,Pune.

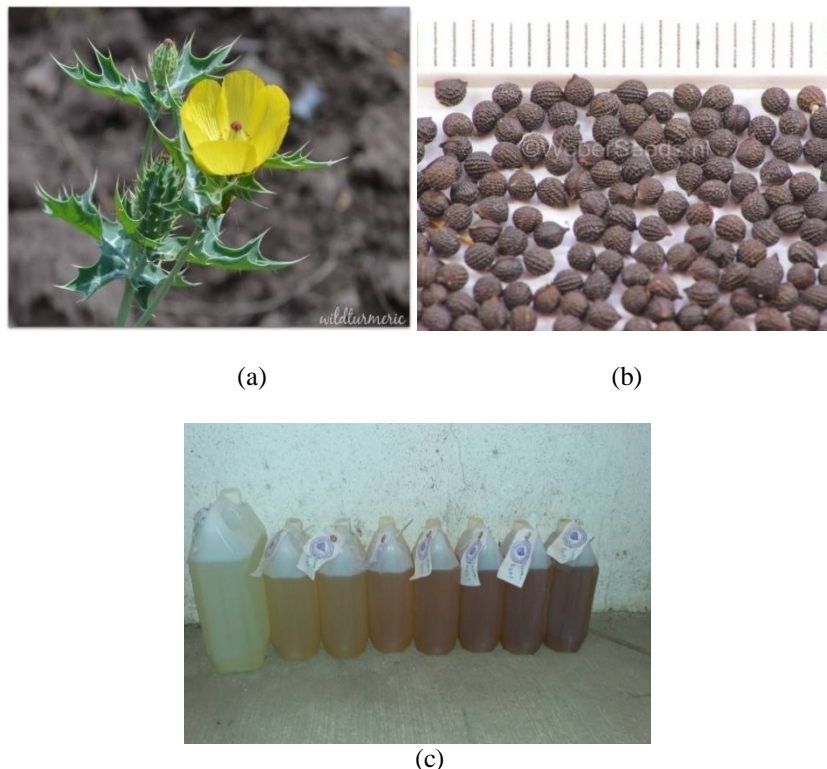


Figure 2. (a) Mexicanana Plant (b)Mexicana plant seeds (c) Argemone Biodiesel Blends

B. Physiochemical Analysis:

Physio-chemical properties of biodiesel were evaluated in accordance with Bureau of Indian standards (BIS) in Indian Biodiesel Corporation, a certified laboratory at Baramati, Dist.pune, and Maharashtra. In this table, the properties of diesel

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and blends of argemone mexicana are easily understood. The properties like density, calorific value, cetane no., viscosity, moisture, flash point, pour point etc. It is shown in table 1.

Table 1. Physio-chemical properties

S r . N o	Test Descr-- ption	Ref.. Std. ASTM 6751	Reference		Diesel	Mexicana Biodiesel Blends						
			Unit	Limit	B00 %	B5 %	B10 %	B15 %	B20 %	B25 %	B30 %	B50 %
1	Density	D1448	gm/cc	0.800 - 0.900	0.830	0.834	0.836	0.838	0.839	0.841	0.844	0.859
2	Calorific Value	D6751	MJ/Kg	34-45	42.50	42.33	42.11	42.01	41.90	41.66	41.50	41.03
3	CetaneNo.	D613	-	3-6	49.00	49.25	49.55	49.89	49.99	50.13	50.45	50.77
4	Viscosity	D445	mm ² / sec	0.05 %	2.700	-	-	-	2.70	-	-	3.50
5	Moisture	D2709	%	-	NA	NA	NA	NA	NA	NA	NA	NA
6	Flash Point	D93	°C	-	64	-	-	-	97.0	-	-	-
7	Fire Point	D93	°C	-	71	-	-	-	105	-	-	-
8	Cloud Point	D2500	°C	-	-4	-	-	-	2.0	-	-	-
9	Pour Point	D2500	°C	-	-9	-	-	-	-0	-	-	-
10	Ash	D4812	%	-	0.05	-	-	-	0.1	-	-	-

IV. EXPERIMENTAL SETUP

The test rig is used for the experiment is a single cylinder, four strokes, diesel engine connected to eddy current dynamometer fuelled with argemone mexicana biodiesel with different blends for loading. The setup having provision is made for airflow, fuel flow, temperatures & load measurement. The engine stands panel box consisting air box, fuel tanks, manometer, fuel measuring unit, engine speed indicator. The rotameters are provided for measuring cooling water & calorimeter water flow. It is used to study the brake power, indicated power, frictional power, brake thermal efficiency, specific fuel consumption, and mechanical efficiency. And Exhaust gas analyser is used for measurement of CO and HC level. In this research investigation seven blends were prepared 5% (v/v) argemone biodiesel with 95% (v/v) diesel fuel denoted by B5 (argemone biodiesel blend). The experiment was conducted using diesel and biodiesel blend with diesel B10, B15, B20, B25, B30, B50 under different load and speeds.

The engine was started by hand cranking. The engine speed runs up to 1500 rpm. The engine is attached to the eddy current type dynamometer at one end and other with a drive shaft coupling flange for loading. A throttle is used to control and increase the speed of the engine as the control variable. The dynamometer and engine are cooled by a continuous supply of water to dissipate the generated heat. The other end of the dynamometer is hooked up to the digital readout system which contains the digital RPM meter and loading unit that experimental readings can be obtained. The graphical representation is shown in fig.3

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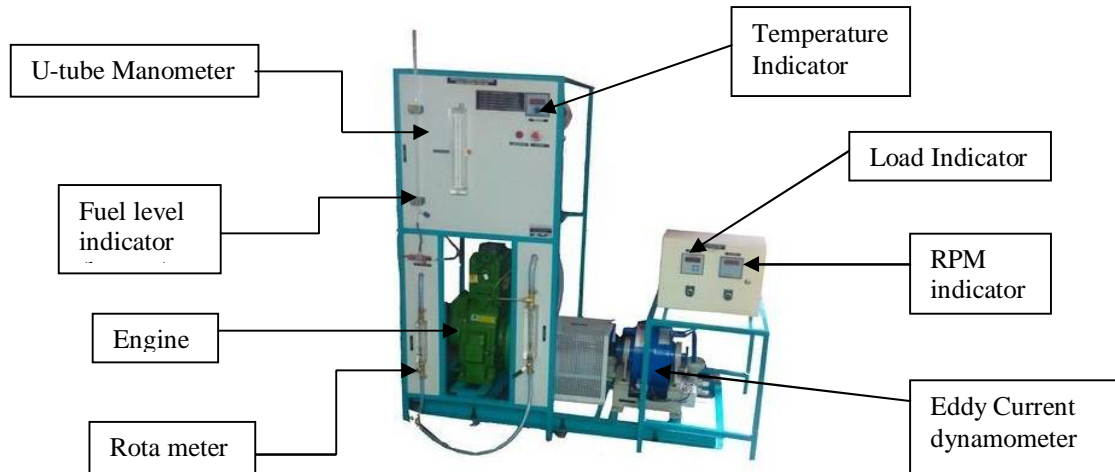


Fig 3. Experimental setup

The single cylinder, four stroke diesel engine having following specifications. This diesel engine is vertical water cooled and it is manufactured by Kirloskar Company and AV1 type model. This engine is used to carry out experiments on diesel and biodiesel blends and compared. It is shown in table 2.

Table 2. Diesel Engine specifications

Engine	Kirloskar engine AV1 model 1 cylinder,4 stroke
Power rating	3.7 KW
Engine speed	1500 rpm
Cylinder Bore	80 mm
Stroke Length	110 mm
Swept Volume	661.45 cc
Cooled Type	Water cooled 1200LPH, Calorimeter 250 LPH
Compression Ratio	17.5
Dynamometer	Eddy current type
Load Indicator	Digital, supply 230 AC
Rotameter	Engine Cooling
Governing	Class 'B1'

V. EXPERIMENTAL RESULTS

The experiment is performed on single cylinder, four stroke diesel engines at different engine speeds, at no load condition, and at different load conditions. Initially, the experiment is performed for diesel fuel and thereafter with the help of blends of argemone biodiesel i.e. at B5, B10, B15, B20, B25, B30, and B50. The performance parameters like brake power, mechanical efficiency, brake thermal efficiency, brake specific fuel consumption, and emissions parameters like HC and CO are presented and then compared with petroleum diesel. They are discussed in this section.

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Performance and Emission Characterization:

1. Effect on Brake Power: Brake power for diesel and all argemone biodiesel blends are calculated and compared with diesel. It is observed that the power increased with increased in load. There are slight variations in brake power for diesel and all biodiesel blends. It is because of the calorific value of diesel is more than that of argemone biodiesel. The graphical representation is shown in fig.4 (a).

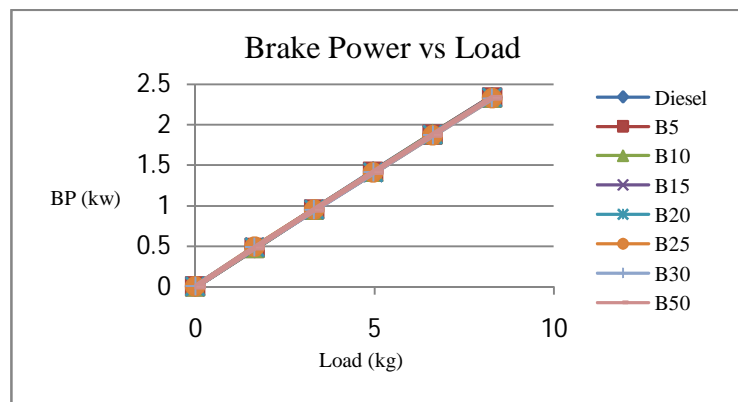


Fig.4 (a) Effect on brake power

2. Effect on Brake Specific Fuel Consumption: Specific fuel consumption is defined as the amount of fuel consumed per unit of power developed per hour. It is a clear indication of efficiency with which the engine develops power from fuel. It is observed that the brake specific fuel consumption decreases with increased in load. It is because of a higher percentage of brake power with load. And it is seen from the graph the bsfc of diesel is much higher than that biodiesel. The graphical representation is shown in fig.4 (b)

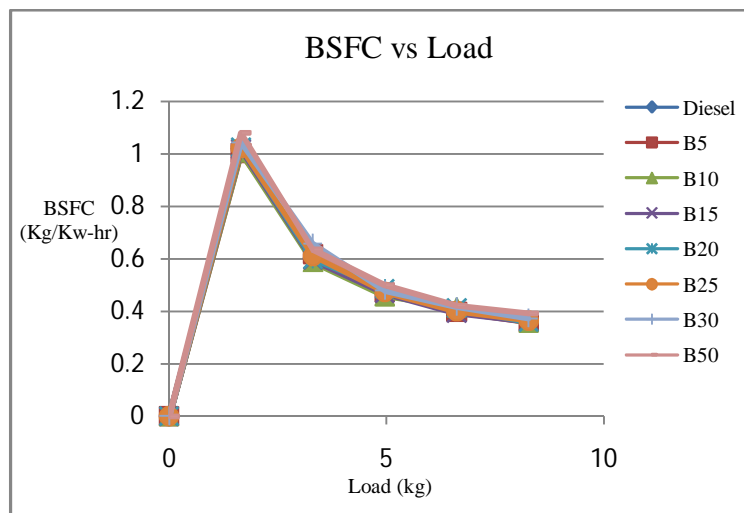


Fig.4(b) Effect on BSFC

3. Effect on Mechanical Efficiency: Mechanical efficiency measures the effectiveness of a machine. It is defined as the ratio of break power to indicated power. We have plotted the graph of Mechanical Efficiency for each blend at different

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loads. And we have observed that the mechanical efficiency increases with increase in load. The mechanical efficiency of diesel fuel is higher than B25, B30, and B50. Graphical representation of load vs. mechanical efficiency is shown in fig.4 (c)

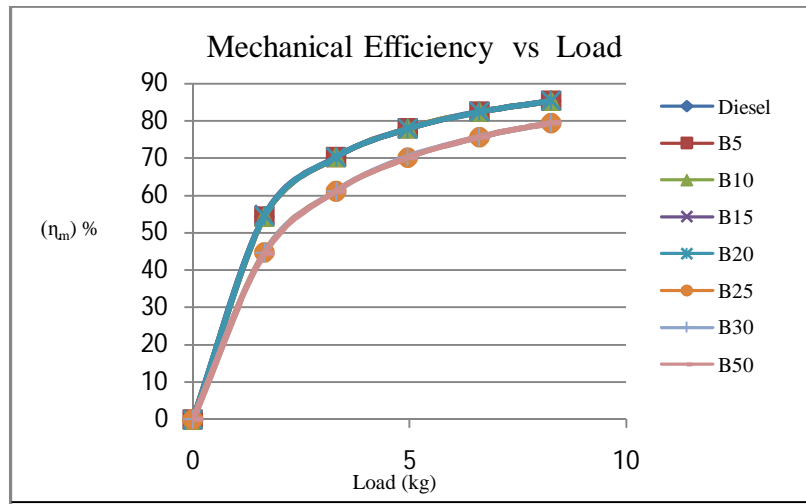


Fig.4(c) Effect on mechanical efficiency

4. Effect on Brake Thermal Efficiency: Thermal efficiency of an engine is defined as the ratio of the output to that of the chemical energy input in the form of fuel supply. The results were obtained that thermal efficiency is gradually increasing both for diesel and biodiesel. It is observed that thermal efficiency up to B20 is equal to diesel fuel, beyond that it is increased significantly. The graphical representation is shown in fig.4 (d)

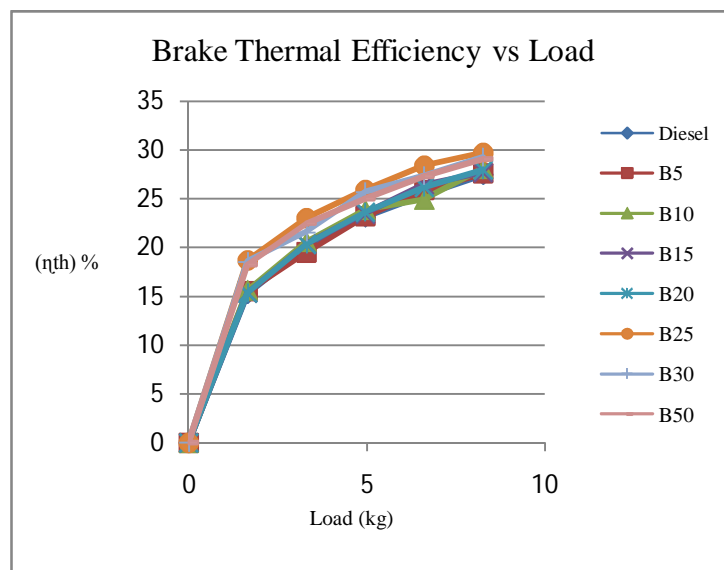


Fig.4 (d) Effect on thermal efficiency

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5. Effect on Carbon Monoxide (CO) Emissions: It is colorless, odorless and tasteless, but highly toxic gas. The variation of CO emissions with engine loading for different biodiesel blends are compared with diesel. It is seen that CO emissions for diesel are higher than that of blends of argemone biodiesel. The CO emissions for argemone biodiesel are reduced because of complete oxidation as compared with diesel. This may be due to the oxygen content and less C/H ratio of biodiesel that causes complete combustion. The graphical representation is shown in fig.4 (e).

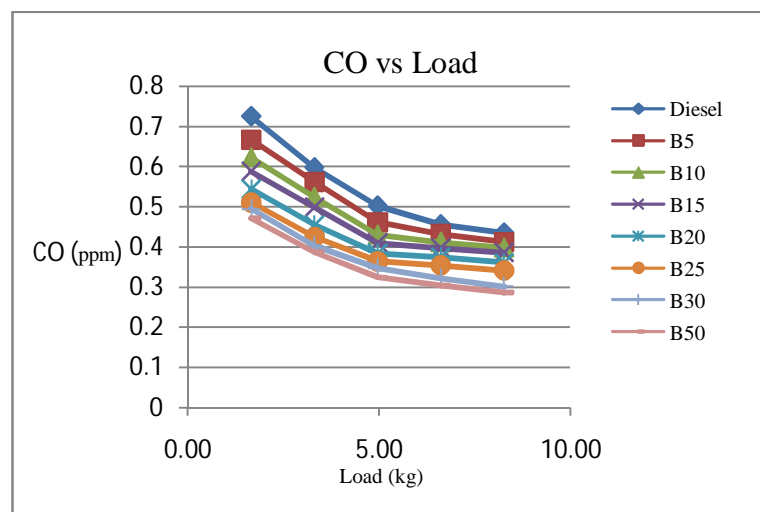


Fig.4 (e) Effect on CO

6. Effect on Hydro Carbon (HC) Emission: Hydrocarbon (HC) pollutants are formed when the fuel is not completely burned. The variation of HC emissions with engine loading for different biodiesel blends are compared with diesel. It is seen that HC emissions for diesel are higher than that of blends of argemone biodiesel. The HC exhaust emissions indicate complete combustion of fuels and thus HC level significantly decreases. The graphical representation is shown in fig.4 (f).

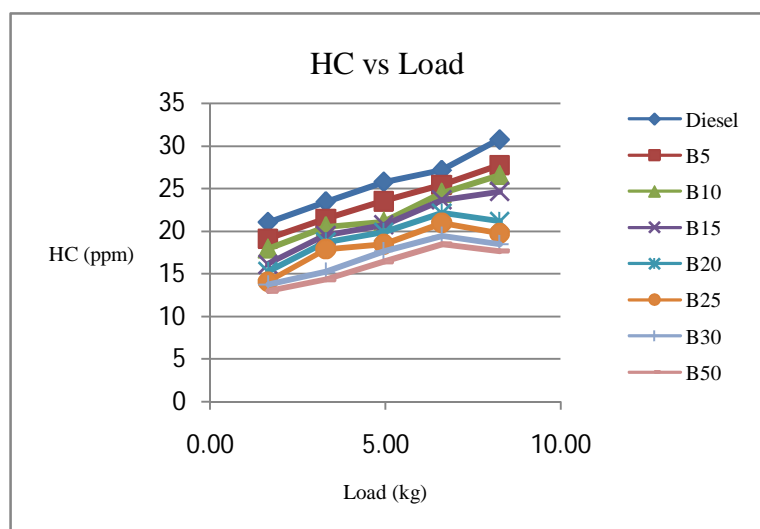


Fig.4 (f) Effect on HC

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VI. CONCLUSION

In this study, the argemone mexicana oil has a potential to become an alternative fuel in next few decades due to depleting fossil fuels at a faster rate all over the world. In this study we are found out some conclusions, they are as following:

1. The maximum brake thermal efficiency is obtained to be for B25, B30; B50 is high as compared to diesel. Due to a high amount of oxygen content are present in the fuel, they lead to proper combustion and better atomization of the fuel.
2. The mechanical efficiency is obtained equal for B5, B10, B15, and B20 as compared diesel fuel & the brake fuel specific consumption was decreased at different speed & load conditions as compared to diesel as a fuel.
3. There is significantly decreasing in HC & CO emissions levels as compared to pure diesel.
4. The kinematic viscosity and density of argemone biodiesel are higher as compared with diesel as a fuel & calorific value of biodiesel is lower as compared with diesel fuel.

Hence from the above conclusions, we are concluding that the argemone oil was used in compression-ignition (CI) engines without any modification.

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