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Utilization of Argemone Oil Biodiesel in Commercial Di-Ci Engine

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Abstract: In this research paper, our aim was to investigate some new non edible oil except Jatropha, Karanja, and Neem etc. Argemone Mexicana, a weed crop and its seed oil methyl ester have not been tested for performance potential for diesel engine. An experimental study was conducted to determine the performance and exhaust emissions characteristics of a single cylinder direct-injection diesel engine operated on diesel-biodiesel blends. The maximum brake thermal efficiency was obtained to be 28.56% for B20, which was slightly higher than that of diesel. The specific energy consumption for B20 was also observed closer to the diesel. There is a significant decrease in the emission level with blends of Argemone oil biodiesel as compared to diesel operation. It was observed that biodiesel obtained is of good quality and is suitable for using in diesel engine.

Keywords: Non-edible oil, Trans- esterification, Methyl ester, Diesel engine.

I. INTRODUCTION

From last three decades, thousands of researchers has been working on biodiesel and it is emerged as a successful alternative fuels that fulfill environmental and energy security needs without sacrificing operating performanceThe extensive consumption rate of liquid petroleum products especially of diesel fuel has grown up significantly due to expansion of all sectors of economy especially transport and industrial sectors. In turn, the petroleum reserves have been exploited at an accelerated rate causing their rapid rate of depletion. Ester may be a better substitute for petroleum diesel, which is extracted as methyl or ethyl ester from vegetative oil. But there is no possibility to diverting the edible oil for production of ester because of edible oil demand is higher than its production. There for the non-edible seed plant like Argemone mexicana has been found most suitable for this purpose. This plant found everywhere as weed. The plant prefers light (sandy) soils, requires well-drained soil and can grow in nutritionally poor soil. All parts of the plant, including the seed, contain toxic alkaloids [1] but it has many medicinal usage and can be apply in external part of body .The whole plant is analgesic, antispasmodic, possibly hallucinogenic and sedative [2–5]. It contains alkaloids similar to those in the opium poppy (Papaver somniferous) and so can be used as a mild pain-killer [3]. The fresh yellow, milky, acrid sap contains protein-dissolving substances and has been used in the treatment of warts, cold sores, cutaneous affections, skin diseases, itches etc [5–7]. It has also been used to treat cataracts [4]. The root is alterative and has been used in the treatment of chronic skin diseases [8].The flowers are expectorant and have been used in the treatment of coughs and other chest complaints [6].The fatty acids present in A. mexicana seed oil are Myristic acid, Palmitic acid, Stearic acid, Oleic acid, Linoleic acid and Arachidic acid [9].This study was undertaken to determine whether A. mexicana seed oil and its methyl ester are desirable as alternative diesel fuel.

II. METHOD

A. Transesterification of oil

Transesterification has been done in single steps due to the low F.F.A. value. To start with the process about 2.3g of Potassium hydroxide (KOH) is dissolve in 25ml methanol and stirred vigorously for 20 min in the covered container until the alkali is dissolve completely, forming Potassium methoxide. 100ml of Argemone oil was preheated on hot plate up to 55°C and then alcohol - catalyst mixture is then transferred into it. The reactor is switched on with constant speed that causes triglyceride transport into methanol phase where it is rapidly converted into FAME (Fatty Acid Methyl Ester) and glycerol. Stirring of mixture is continued for 1 h at a temperature between 55°C and 60°C.. The mixture is taken out and poured into a separating funnel soon the glycerol component of the mixture started settling at the bottom. Without disturbing the funnel the bottom layer is separated out which is glycerol. The upper layer is pure methyl ester is separated and washed minimum of 8 times with water.

III. PHYSICO-CHEMICAL ANALYSIS

The different Physico-chemical properties of biodiesel were evaluated in accordance with Bureau of Indian standards (BIS) in Bali Laboratories (Regd.), a government approved test house and an ISO 9001-2000 certified laboratory at Ludhiana.

Table. 1

Fuel properties	**Argemone oil**	**Argemone oil methyl ester**	**Diesel**
Density@40° C (kgm^{-3})	0.910	0.862	0.880
Viscosity@40°C (cSt)	29.6	4.4	3.42
Flash point(°C)	270	193	56
Gross calorific value(kJ^{-1})	37.72	41.50	43.20
Sulphated ash	-	0.01%	Nil
Total sulphur,ppm	-	0.1%	1.2%
Copper strip corrosion	-	Passed	-
Acid value	3.94	0.2	Nil

IV. EXPERIMENTAL

A. Experimental Test Rig

An experimental study was conducted on vertical, single cylinder; water cooled, direct injection, compression ignition, four stroke cycles, constant speed diesel engine. The engine was coupled to the dynamometer with the help of T9 rubber coupling. Since the level of crankshaft is in line, so the dynamometer was properly aligned to the engine. The specifications of the engine and genset are demonstrated in table 2 and 3. The engine was periodically maintained to operate on various diesel biodiesel blends.

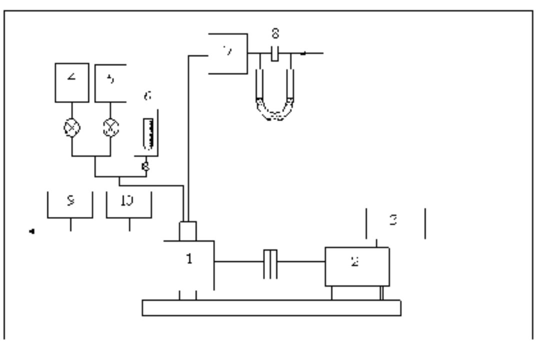

Fig. 1. Block Diagram of Experimental Test Rig
1.Diesel engine; 2. Electrical generator 3. Electrical load cell; 4. Diesel fuel tank; 5. Biodiesel fuel tank; 6. Burette; 7. Surge tank; 8. Orifice plate; 9. Gas analyzer; 10. Smoke analyzer.

Table. 2

Make:	**Atul Pvt. Ltd. Agra**
Type	Diesel 4 stroke water cooled
Type of injection	Direct into piston
K.W./H.P.	4.8/6.5
RPM:	1500
Bore and stroke (mm)	85X110
S.F.C.(gm/kw/hr)	242
Injection Timing	24° before TDC
Compression pressure	16.5:1

Table. 3

Model no.	AG-2
K.W,	4
Volts	240
AMPS	17.4
Winding used	Copper

B. Experimental Procedure

The series of exhaustive engine tests was carried out on compression ignition diesel engine under different loading condition using diesel and Argemone oil biodiesel blends. Performance and emission tests were conducted on various biodiesel blends in order to optimize the blends concentration for long-term usage in CI engines. To achieve this, several blends of varying concentration were prepared ranging from 0 percent (Neat diesel oil) to 80 percent through 10 percent, 20 percent, 40 percent 60 percent and 80 percent by volume. The performance data was then analyzed from the graphs recording power output, fuel consumption, specific fuel consumption, thermal efficiency for all blends of biodiesel. The optimum blend was found out from the graphs based on maximum thermal efficiency. The major pollutants appearing in the exhaust of a diesel engine are carbon monoxide, hydrocarbon and smoke density. For measuring exhaust emissions, Neptune Multi-gas analyser and OPAX 2000 II/ DX 200 P smoke meter were used.

V. RESULTS AND DISCUSSION

A. Effect of Diesel Biodiesel Blends on Engine Performance

Effect on Brake Thermal Efficiency. The variation of brake thermal efficiency with load for different fuels is presented in fig. 2. In all cases, efficiency has increased with an increase in percent load. This was due to a reduction in heat loss and increase in power with increase in percent load. The maximum brake thermal efficiency was obtained to be 28.56 for B20, which was slightly higher than that of diesel (27.81%).. The maximum brake thermal efficiencies obtained for B40, B60, B80 and B100 were 24.82%, 22.26%, 20.1% and 20.72%, respectively. This lower brake thermal efficiency obtained for B40–B100 could be due to a reduction in the calorific value and an increase in fuel consumption as compared to B20 and diesel fuel.

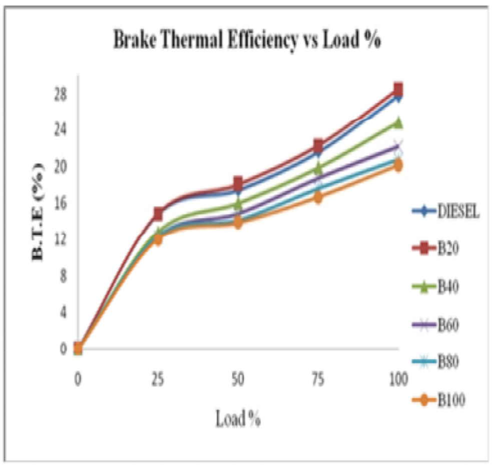

Fig. 2. Effect on Brake Thermal Efficiency.

B. Effect on Brake Specific Fuel Consumption

The variation of brake-specific fuel consumption with load for different fuels is presented in fig. 3. For all fuels tested, brake-specific fuel consumption decreased with increase in load. One possible explanation for this reduction could be due to the higher percentage of increase in brake power with load as compared to fuel consumption. At higher loads, the brake-specific fuel consumption for B20 and B40 was close to the diesel. In case of B60–B100, the brake-specific fuel consumption was approximately 12–45% higher than that of diesel. This reverse trend was observed due to the lower calorific value with an increase in biodiesel percentage in the blends.

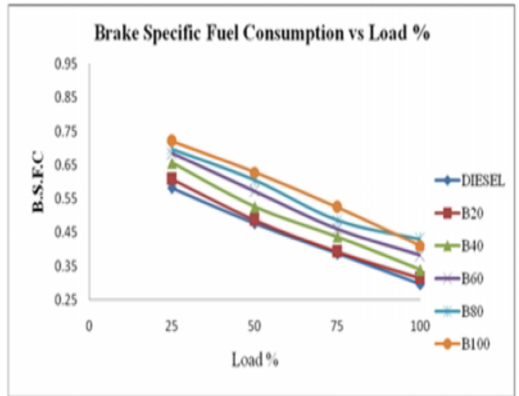

Fig. 3. Effect on Brake Specific Fuel Consumption.

C. Effect on Brake Specific Energy Consumption

The variation in BSEC with load for all fuels is presented in fig. 4. In all cases, it decreased with increase in percentage load for all fuels. The main reason for this could be that percent increase in fuel required to operate the engine is less than the percent increase in brake power due to relatively less portion of the heat losses at higher loads. The BSEC for B20 was observed closer to the diesel. In case of B40, B60, B80 and B100, the BSEC was higher than that of diesel. This reverse trend was observed due to lower calorific value with increase in biodiesel percentage in the blends.

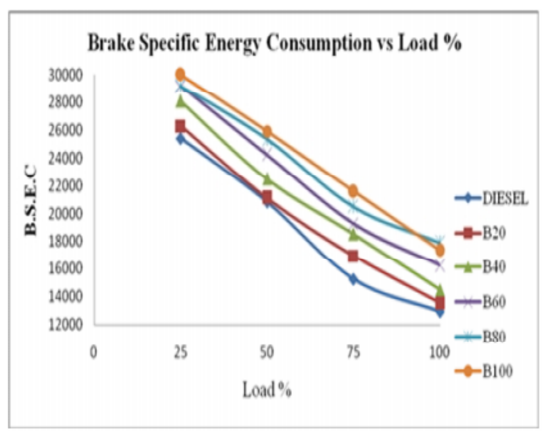

Fig. 4. Effect on Brake Specific Energy Consumption.

D. Effect of Biodiesel on Engine Emission

Effect on Carbon Monoxide. Variation of CO emissions with engine loading for different diesel biodiesel blends is compared in fig.5. The minimum and maximum CO produced was 0.015–0.05 % for B100.

These lower CO emissions of biodiesel blends may be due to their more complete oxidation as compared to diesel. Some of the CO produced during combustion of biodiesel might have converted into CO_2 by taking up the extra oxygen molecule present in the biodiesel chain and thus reduced CO formation. It can be observed from the fig.5.6 that the CO initially remain linear with load and latter increased sharply up to full load. This trend was observed for all the fuel blends tested.

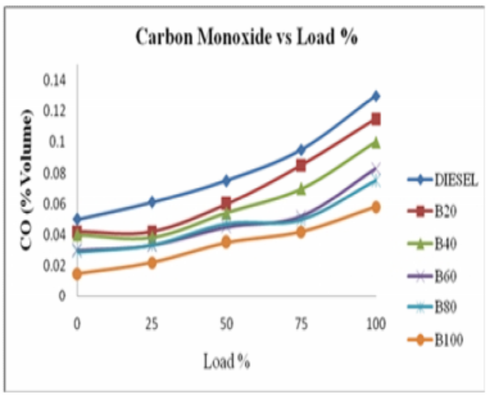

Fig. 5. Effect on Carbon Monoxide.

Effect on Hydrocarbons. Variation of hydrocarbon emissions with engine loading for different diesel biodiesel blends is compared in fig.6. It is seen in the graph that there is a significant decrease in the HC emission level with blends of methyl ester of Argemone oil as compared to pure diesel operation. There is a reduction from 70 ppm to 42 ppm at the maximum power output. These reductions indicate that more complete combustion of the fuels and thus, HC level decreases significantly. The reduction in HC was linear with the addition of biodiesel for the blends.

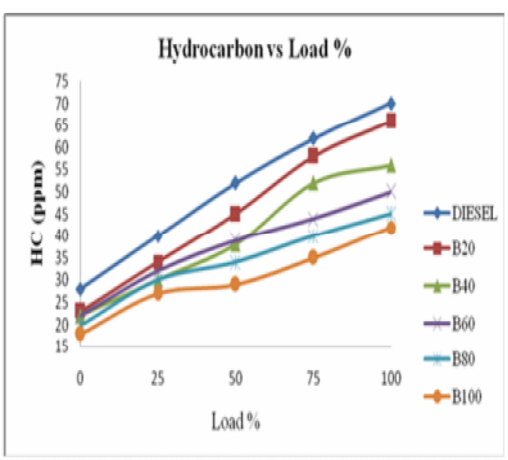

Fig. 6. Effect on Hydrocarbons.

Effect on Smoke Opacity. The variation of smoke opacity with respect to different fuels is considered, depicted in the diesel oil. Higher thermal efficiency indicates better and complete combustion of fuel. That is, lesser amount of unburnt hydrocarbons present in the engine exhaust emission. So, lower smoke density values are achieved with biodiesel blends as compared to that of the diesel. B40 blends gave smoke density of 28% as compared to 50% in the case of diesel.

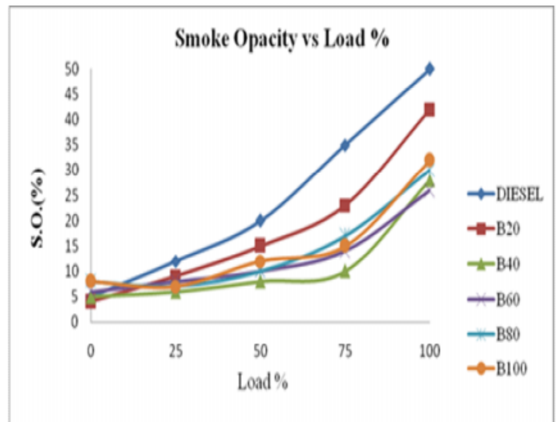

Fig. 7. Effect on Smoke Opacity.

CONCLUSIONS

In our research it has become clear that non-edible oil called Argemone Mexicana oil, a weed crop, has a potential to become a suitable alternative fuel for ever depleting fossil fuels. Following are the conclusion made on the basis of results

1) Due to low free fatty acid value, Alkaline Trans esterification was results into 80% yield.
2) B20 and B40 have viscosity values 3.62 and 3.72 c St respectively, which is close to that of diesel fuel value.
3) Gross Calorific value of Argemone Mexicana methyl ester is close petroleum diesel and flash point of oil and its ester were very high as compared to diesel.
4) The maximum brake thermal efficiency was obtained to be 28.56 for B20, which was slightly higher than that of diesel (27.81%).
5) The BSEC for B20 was observed closer to the diesel. In case of B40, B60, B80 and B100, the BSFC and BSEC were higher than that of diesel.
6) There is a significant decrease in the CO and HC emission levels with blends of methyl ester of Argemone oil as compared to pure diesel operation.
7) B40 blends gave smoke density of 28% as compared to 50% in the case of diesel.

Finally it can be concluded that no problem was faced at the time of starting the compression ignition engine and the engine ran smoothly with Argemone oil methyl ester and its various blends with diesel fuel. B20 can be used in C.I engine without any modification and without any adverse effect.

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