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Research Article

JATROPHA AND KARANJA BIO-DIESELPERFORMANCEONA DIESEL ENGINE

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ABSTRACT

The bio-diesel was produced from non-edible oils by using bio-diesel processor and the diesel engine performance for water lifting was tested on bio-diesel and bio-diesel blended with diesel. The newly developed bio-diesel processor was capable of preparing the oil esters sufficient in quantity for running the commonly used farm engines. The fuel properties of bio-diesel such as kinematic viscosity and specific gravity were found within limited of BIS standard. Operational efficiency of diesel pump set for various blends of bio-diesel was found nearer to the expected efficiency of 20 percent. Bio-diesel can be used as an alternative and non-conventional fuel to run all type of C.I. engine.

INTRODUCTION

Fast depletion of the fossil fuels and sometimes shortage during crisis period directs us to search for some alternative fuel which can reduce our dependence on fossil fuels. The agriculture sector of the country is completely dependent on diesel for its motive power and to some extent for stationary power application. Increased farm mechanization in agriculture thus, further increase requirement of this depleting fuel source. Many alternative fuels like biogas, methanol, ethanol and vegetable oils have been evaluated as a partial or complete substitute for diesel fuel. The vegetable oil directly can be used in a diesel engine as a fuel, because their calorific value is almost 90-95 percent of the diesel. The technology of production, the collection, extraction of vegetable oil from oil seed crop and oil seed bearing trees is well known and very simple. The development in this respect also provides much ecological balance. Due to pressure on edible oils like groundnut, rapeseed, mustard and soybean etc. non-edible oil of Jatropha curcas and (Pongamia Pinnata) are evaluated as diesel fuel extender. The oil is extracted from the seeds and converted into methyl esters by the transesterification process. The methyl ester obtained from this process is known as bio diesel. Biodiesel is a renewable source of energy which can be produced locally by our farmers by growing oilseed producing plants on their wastelands, barren land which is eco-friendly also. In order to propagate and promote the use of bio-diesel as an alternate source of energy in the rural sector, the bio-diesel was produced from non-edible oils by using bio-diesel processor and the diesel engine performance for water lifting was tested on bio-diesel and bio-diesel blended with diesel.

MATERIALS AND METHODS

Considering the availability of Karanja, Jathropha and other vegetable oils in the local areas bio-diesel processor based on the trans-esterification process was designed and fabricated at Shivamoga, Karnataka State, India.

Process Requirements

1) Revolutions of stirrer: 500-700 rpm
2) Temperature of reaction: 55-60 ^{0}C
3) Thermostat setting: 52 +2 ^{0}C
4) Oil sample: 15 kg
5) Methanol used: 200 ml/kg of vegetable oil
6) KOH / NaOH: 0.5-1.0 gm/litre of vegetable oil
7) Time required: 1.0-1.5 hours
8) Sulphuric acid: 1.0 ml/litre of vegetable oil (pre-treatment)

Almost all bio-diesel is produced by using base catalysed transesterification process, as it is the simple process and requiring only low temperature. The trans-esterification process is the reaction of a tri-glyceride (fat/oil) with an alcohol to form esters and glycerol. The alcohol reacts with the fatty acids to form the mono-alkyl ester or bio-diesel and crude glycerol. In bio-diesel production process, the main reaction is transesterification of vegetable oil. The important factor that affects the transesterification reaction is the amount of methanol and sodium or potassium hydroxide, reaction temperature and reaction time. A molar ratio of 6:1 is normally used in industrial processes to obtain methyl ester yields higher than 98% by weight because lower molar ratio required more

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reaction time. With higher molar ratios conversion increased but recovery decreased due to poor separation of glycerol.

Most researchers have used 0.5 to 0.1% NaOH/KOH by weight of oil for bio-diesel production. If the acid value is greater than 1, more alkali is required to neutralize free fatty acids. The methyl ester conversion rate increases with the reaction time. Different researchers have reported different reaction times for the transesterification process. The reaction mixture was stirred for 90 min during transesterification process.

Vegetable oil + Methanol Methyl + Glycerine (Trans fatty acids) + Sodium Hydroxide Ester & Soap (Bio-diesel

CH_2 – OCOR CH_2 – OH

CH – OCOR + 3 CH_3OH KOH / NaOH 3 $RCOOCH_3$ + CH – OH

CH_2 – OCOR CH_2 – OH

Products of the reaction are the bio-diesel and glycerol. The mixture was then allowed to settle. The glycerine phase is much denser than a bio-diesel phase. The bio-diesel and glycerine can be gravity separated with glycerine simply drawn off from the bottom of the settling vessel. The bio-diesel is then purified by washing gently with warm water to remove residual catalyst or soap, dried, and sent to storage. This is normally the end of the production process resulting in a clear liquid with viscosity near to petrodiesel.

Bio-diesel processor was fabricated as per the design consideration and need to produce bio-diesel on farm level. This processor has been used for the preparation of methyl esters from raw Karanja oil and Jatropha oil.

Jatropha and Karanja seeds were collected from the local area. The chemical analysis of the seed sample was carried out. The oil was extracted using screw expeller in the local market. The oil recovery percentage of Jathropha and Karanja by using local oil expeller was calculated.

Oil was pre-heated to remove water contents at about 100^0C for 10 min. in a cylindrical stainless steel tank. Potassium methoxide was prepared by mixing methanol and potassium hydroxide. The methanol was 99.6% and sodium hydroxide was 86% pure. For the preparation of 1 litre of bio-diesel, 200ml methanol and 10gm of potassium hydroxide used. Methanol and potassium hydroxide were mixed to form potassium methoxide.

CH3 – OH + NaOH CH_3 – O – Na + H_2O

Methanol Sodium Sodium Water Hydroxide Methoxide

Engine Specification

Make: Field marshal

Horse Power: 5 HP, 5.7 KW The potassium methoxide was added to the pre-heated oil of Karanja and Jatropha. The mixture was stirred at 550 rpm for one hour. The temperature of the reaction was maintained at 55^0C. The batch wise mixture of Karanja and Jatropha methyl esters were allowed to settle for 8 hours in the setting flask. Glycerine was heavier as compared to oil so it settles down while oil floats up. After 8 hours glycerine settles down while methyl ester floats at top. The Crude bio-diesel obtained from Karanja and Jatropha had some impurities which were then separated by using bubble washing method. The bio-diesel was again heated to remove moisture at about 100-110^0C temperature.

Jatropha, Karanja bio-diesel blends were used in diesel engine coupled water pump. The specification of the diesel engine used during the test run was as under:

R. P. M.: 1500

Specific fuel consumption: 236 gm/Kw-h

Cooling system: Water cooled

The bio-diesel prepared from Karanja, Jatropha and its blends with diesel as B_{20}, B_{40}, B_{60}, B_{80} and B_{100} by volume were used as a fuel to run a diesel engine. This engine was run for water pumping from the sump well. Fuel consumption, engine rpm, water discharge /water output were measured for each blend. The standard instrumentation was used to measure the fuel consumption, engine rpm, and water output. The operational efficiency of pumping system was determined as the ratio of the power output to power input. The water horsepower or output was calculated as

WHP = Q x H / 75.8

Where, Q = Discharge (litre per second)

H = Total head (meter)

The discharge was measured volumetrically during the specific time for specific blends of karanja and Jatropha bio-diesel with petroleum diesel in t proportion of B_{20}, B_{40}, B_{60}, B_{80} and $B_{100.}$ Water Horse Power was calculated after considering suction delivery head and frictional losses for each blend of bio-diesel for water discharge. Input horsepower was measured for each test run on the basis of consumption of fuel in specific time duration and on basis of Water Horse Power and 1 Horse Power, operational efficiency for each test run was calculated. Combustion of bio-diesel fuel in the engine since bio-diesel is called as an oxygenated fuel and it contains approximately 1% oxygen.

During water pumping test with 100 percent bio-diesel of Karanja and Jatropha, water discharge was found to be 3.175 lps and 3.046 lps against 4.8 lps with diesel fuelled engine. Water discharge of pump operated on Karanja and Jatropha bio-diesel were 66.15 and 63.46 percent respectively of diesel fuelled engine. Reduction in water discharge was observed to be 24-33 percent due to less fuel consumption. Engine test was carried out on Karanja and Jatropha biodiesel blending proportion of B_{20}, B_{40}, B_{60}, B_{80} and B_{100}. The observed values of engine rpm, fuel consumption, and water discharge through pump are summarised in the Tables 5 and 6. The results showed that bio-diesel blends B_{20} and B_{40} gave comparatively better water discharge.

Water horsepower, input horsepower and operational efficiency of the engine were determined for specified blends of Karanja and Jatropha are presented in (Tables 5 and 6). The pump set efficiency was evaluated on the engine run in diesel fuel and found to be 12.93%. Operational efficiency on 100 percent bio-diesel fuel was calculated for Karanja and Jatropha bio-diesel as 12.86 and 9.88 percent compared with 12.93 percent on diesel. The operational efficiency of diesel pump set run on Karnaja bio-diesel was found to be more than Jatropha bio-diesel and slightly less with engine run on 100 percent diesel (12.93%). In the case of Karanja blends, operational efficiency for B_{20} and B_{40} were found to be maximum 15.8% and 14.2 % respectively than values calculated for B_{60}, B_{80} and B_{100}. Maximum efficiency was due to the less IHP correlated with less fuel consumption. The maximum WHP was due to the more water discharge for B20 and B40 blends as compared to B60, B80 and B100 blends. The maximum operational efficiency in Jatropha biodiesel blends of B_{60} and B_{80} were found to be 10.7 % and 11.2 % respectively. The maximum operational efficiency was due to the less fuel consumption and IHP. The expected pump efficiency was about 20 per cent. The efficiency of pump set evaluated under field condition ranged from 5.32 to 12.81 percent as reported. The efficiency of pump set using specified blends of bio-diesel was found in the range of 8.0 to 17.56 %. The maximum operational efficiency was found on B_{20} and B_{40} blends in Karanja and for B_{80} Jatropha blends (11.2 %).

Table-1 Performance of diesel engine for water pumping on Karanja bio-diesel.

Blending proportion	Engine R.P.M.	Fuel consumption (kg/hr)	Water Discharge (lps)
B20	1345	0.594	4.08
B40	1340	0.561	3.63
B60	1342	0.615	3.38
B80	1340	0.686	3.445
B 100	1340	0.543	3.175
B 0	**1352**	**1.09**	**4.8**

Table-2 Performance of diesel engine for water pumping on Jatropha bio-diesel.

Blending proportion	Engine R.P.M.	Fuel consumption (kg/hr)	Water Discharge (lps)
B20	1342	0.705	**3.389**
B40	1340	0.684	3.338
B60	1341	0.684	3.442
B80	1340	0.648	3.3389
B 100	1340	0.684	3.046
B 0	**1352**	**1.09**	**4.8**

CONCLUSIONS

- Bio-diesel processor is capable of producing bio-diesel from edible and non-edible oils by using base catalysed transesterification process.
- The fuel properties of bio-diesel such as kinematic viscosity and specific gravity were found within limited of BIS standard.
- Operational efficiency of diesel pump set for various blends of bio-diesel was found nearer to the expected efficiency of 20 percent.
- Bio-diesel can be used as an alternative and non-conventional fuel to run all types of C.I. engines.
- Bio-diesel gives high efficiency and the compression ratio can also increase.
- The blending of biodiesel with diesel it increases its fuel properties.
- The blending ratio can acts the main role in bio-diesel formation and preparation of fuel.

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