

Production of Biodiesel from Simarouba Seeds and Performance Test on Single Cylinder Compression Ignition Engine with Variable Injection Pressure

Somashetty S S, Dr. Mohamed Khaiser, B.S.Mahesh

Abstract— biodiesel is one of the most promising alternative for diesel needs. Biodiesel is a biodegradable, clean-burning combustible fuel derived from new or used vegetable oils or animal fats. Biodiesel meets American Society for Testing and Materials (ASTM) specifications D6751. Biodiesel can be used in any internal combustion diesel engine in either its pure form, which is referred to as “neat” biodiesel or it can be mixed in any concentration with regular petroleum diesel without any major modification of the engine. The objective of this paper is production of from simarouba oil methyl ester by using transesterification process and performance test conduct on the single cylinder compression ignition engine with different blend of biodiesel(SOME) with diesel (B20,B40,B60,B80,and B100) at constant speed of 1540 rpm and varying the injection pressure 80 bar,120 bar and 150 bar. The result are compared with diesel. Brake thermal efficiency, brake specific fuel consumption and mechanical efficiency are studied in comparison with conventional diesel. The result shows a better performance at B60 and injection pressure of 80 bar.

Index Terms— biodiesel, brake thermal efficiency, injection pressure, mechanical efficiency, transesterification

I. INTRODUCTION

The world demand for energy is rapidly increasing. We need energy to cook our meals, to travel and communicate, and to power our factories. The amount of energy available to us determines not only our standard of living, but also how long we live. One of the main energy sources is oil and the rate of production is expected to peak in the next few years. There are still plentiful supplies of coal, the other principal energy source, but it is even more because to meet our requirement. Nonrenewable fuel (fossil fuel) emits more hydrocarbons, oxides of nitrogen, sulfur, and carbon mono-oxides, leading to acid rain and climate change. This combination of increasing need and diminishing supply constitutes the energy crisis. The world urgently needs a clean energy source that is able to meet world energy needs. This is without doubt the most serious problem facing mankind. India has the potential to be a leading world producer of biodiesel, as biodiesel can be harvested and sourced from non edible oils like jatropha curcus, honge, neem, mahua, simarouba, cotton seed and tobacco seed etc.

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II. PRODUCTION OF BIODIESEL (SIMAROUBA OIL METHYL ESTER)

Simarouba is commonly known as paradise tree. It is also known as simab, maruba, laksmitaru, aceituno, dysentery bark, pitomba etc. in different part of the country. It is an evergreen multiutility tree that grows up to 15 meters height with tap root system and cylindrical stem. It is native being promoted in the country as the latest wonder tree which is a source of edible oil that has wide utility. At the village level the plant is cost effective as its farming is nearly zero budget and completely organic, yielding good harvest for almost 70 years the average life sun of a full grown tree.

BOTANICAL FEATURES



Fig- 1. Simarouba tree

Simarouba belongs to family simaroubaceae the medium sized tree with 7-15 meter in height possess cylindrical stem of maximum trunk diameter of approximately 20 inches, the young shoot smooth and reddish brown or green in colour. It turns brown with the subsequent growth and attains cylindrical shape as it grows. The radical begins to grow rapidly into tap root system with secondary and tertiary roots. The leaves are alternate estipulate, pulvinate, petiolate, with oblong leaflets uptoin number.

A. OIL EXTRACTION FROM SIMAROUBASEEDS

Following steps are using the extraction of oil from simarouba seeds.

1) PRE-PROCESSING

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a) CLEANING AND GRADING:

The ripen fruit let contain foreign material like sand dust, stones, mud ball, stick, leaves and sometimes tramp iron. Cleaning is required for removal of the above undesired materials. Tramp iron may cause damage to the expeller worms if not remove prior to oil extraction. Presence of foreign materials not only absorbs oil during oil extraction and thereby leads to oil loss but also deteriorate the quality of the extracted fat. Cleaning is usually done by means of revolving screen or reels and by using a devise consist of vibrating screen shaker having permanent electro magnet called cleaner cum grader



Fig-2: Mechanical expeller

b) DE-PULPING:

Pulp constitutes about 60% of the fresh fruit let. The freshly collected ripe berries fruits are dipped in water in a tank or in a pond after packing in a gunny bags. The freshly pulp and mucilaginous substances are scraped away by rubbing with waste gunny bags or sand. De pulping may also be done by using mechanical de pulper de pulped seed has got longer shelf life and resulting in extraction of good quality fat

c) DRYING:

The de pulped seed is dried in shade for seed purpose and by using sunlight on RCC drying floor. Drying may also be done by using hand operated dryer/ mechanical drier by using external fuel

d) DECORTICATION:

Simarouba seeds comprising of 60% shell and 40% kernel are preferably decorticated before oil extraction. If not decorticated, the presence of shell absorbs a substantial quantity of the oil during extraction and thereby causes oil loss as well as deteriorate the quality of the extracted fat.

2) PROCESSING

a) HEAT TREATMENT OF SIMAROUBA SEEDS

Cooking is applied to decorticated simarouba seeds prior to pressing. It is done to coagulate the proteins in the walls of the fat containing cells. Heating causes coalescence of oil droplets. It makes the walls permeable to the flow of oil and decrease the affinity of the oil for the solid surface of the seed. The heat treatment also decrease the viscosity of the oil and facilitates the coming out of oil from seed cell. Heat treatments given to the pre processed seed by using stoat hot water for protein coagulation. Proper cooking determines the quality of oil and cake. Steam is generated by using a steam kettle cooker. The oil expeller must be Attached with a steam kettle cooker along with mini boiler arrangement.

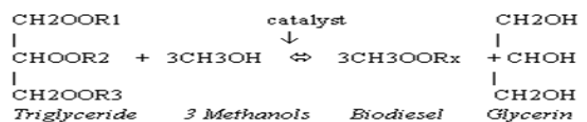
1.1. MECHANICAL EXPELLER

After decortications oil is extracted from the kernels by using conventional oil expellers having cooking arrangement. Always a mixture of shell (10-20%) and kernel (80-90%) is fed in expeller hoper for maximum recovery of oil. Feeding of only kernel reduces the oil yield. In fact, oil extracted at low pressure found suitable for edible grade fat while subsequent pressure on expeller worms generate heat result release of alkaloids presence in the cake from the oil rendering unsuitable it for edible use.

B. EXTRACTION OF BIODIESEL BY USING TRANSESTERIFICATION PROCESS

1) THEORY:

We used alkaline catalyzed transesterification to produce biodiesel. The raw simarouba seed oil was extracted by mechanical expeller in which small traces of organic matter, water and other impurities were present. Transesterification is a most common and well established chemical reaction in which alcohol reacts with triglycerides of fatty acids (vegetable oil) in presence of catalyst to form glycerol and esters. The reaction is shown in following figure.



R1, R2, and R3 are fatty acid alkyl groups (could be different, or the same), and depend on the type of oil. The fatty acids involved determine the final properties of the biodiesel

2) PROCEDURE:

1. Take 500ml of oil in a round bottom flask.
2. Take 100ml of methanol in a beaker, add KOH and dissolve by stirring.
3. Measure the calculated amount of KOH into a petridish
4. Add methanol and KOH mixture to round bottomed flask containing oil.
5. Keep the flask on the magnetic stirrer (fig -3) and using magnetic bit stir the mixture for 30min without heating.
6. Then switch on the heater and heat the mixture for 60minutes with temperature maintaining between 50-60°C.
7. Pour the mixture into the separating funnel. (Fig-4).

8. The mixture is allowed to settle by gravity in a separating funnel over night.
9. Separate the Glycerol and Collect the methyl ester from the funnel.
10. Heat the collected methyl ester up to 90°C to evaporate methanol if present
11. Filter the heated methyl ester using filter paper.
12. Finally collect the filtered simarouba oil methyl ester in a bottle.

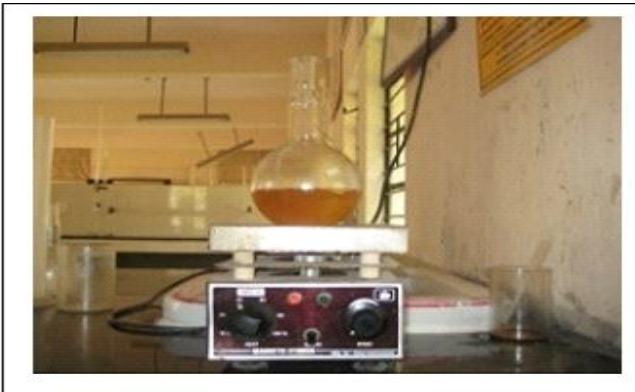


Fig-3 magnetic stirrer with electric heater



Fig-4 separation funnel

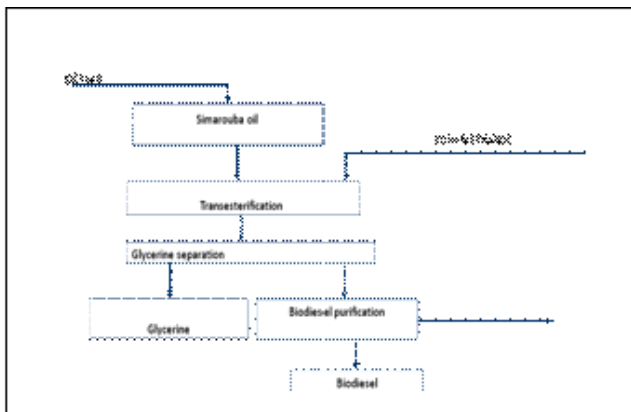


Fig : 5 Bio Diesel Flow Chart

III. PROPERTIES OF SOME OIL

The fuel properties of diesel, raw and simarouba oil methyl ester (SOME) were measured in the laboratories. The properties of these oils are shown in Table [1].

IV. EXPERIMENTAL SETUP

CHARACTERSTICS	SOME	ASTM STANDARD BIODIESEL	DIESEL
Kinematic viscosity at 40 °c (mm ² /s)	4.7	1.9-6	2.54
Specific gravity	0.865	0.87-0.90	0.82
Flash point in °c	160	>110	54
Density in kg/m ³	865	870-900	820
Calorific value in kJ/kg	37933	37000-42500	43500



Fig- 6 Single Cylinder 4-Stroke Diesel Engine

The experimental set up consists of stationary engine of following specifications

- Made- Kirloskar
- Cycle's used-Diesel
- Number of strokes-4
- Number of cylinder-1
- Bore diameter-80mm
- Stroke – 100mm
- Cooling system -water cooled
- Lubrication-forced method
- Out put-3.675kw at 1500rpm
- Dynamometer-D.C. generator
- Armature-shut
- Voltage-220volts

V. RESULT & DISCUSSION

The experiment were conducted on a directed injection compression ignition engine for various brake power and various blends (B20, B40, B60, B80,B100) of bio diesel at variable injection pressure of 80bar, 120bar and 150 bar. Analysis of performance brake specific fuel consumption, brake thermal efficiency and mechanical efficiency.

A. PERFORMANCE CHARACTERISTICS FOR 80 BAR

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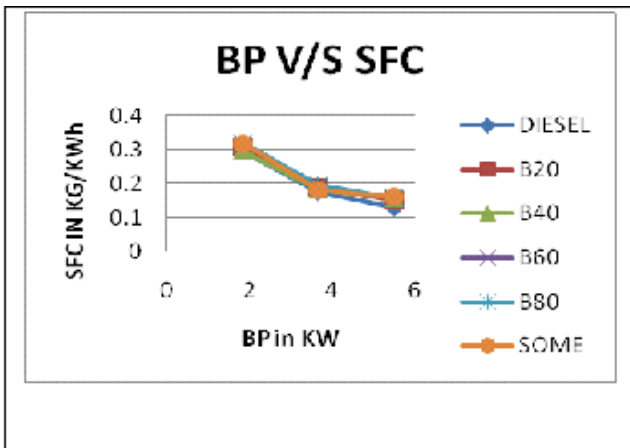


Fig -7 brake power v/s sfc

B. PERFORMANCE CHARACTERISTICS FOR 120 BAR

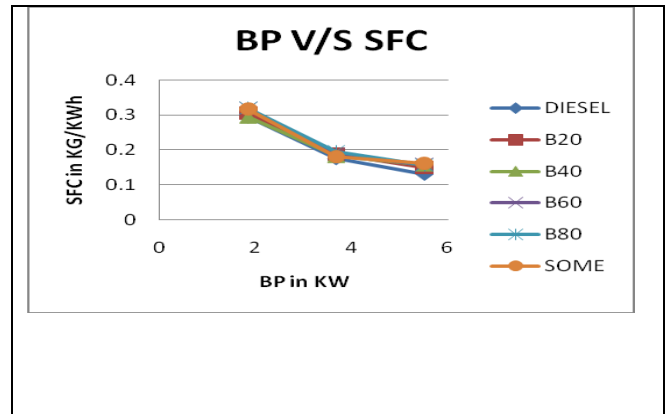


Fig -10 brake power v/s sfc

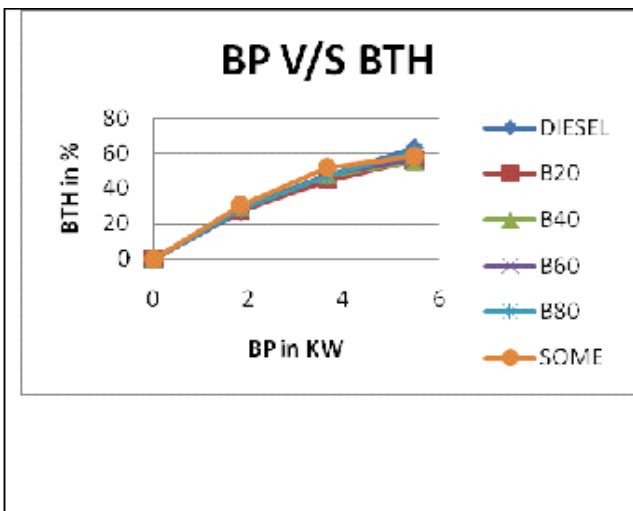


Fig-8 brake power v/s brake thermal efficiency

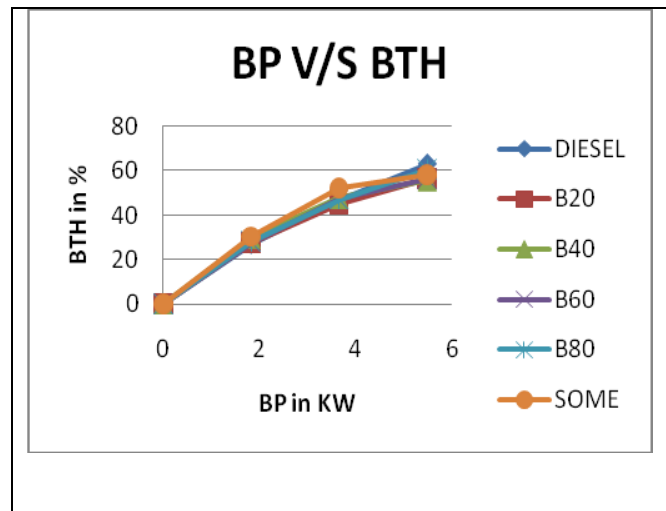


Fig-11 brake power v/s brake thermal efficiency.

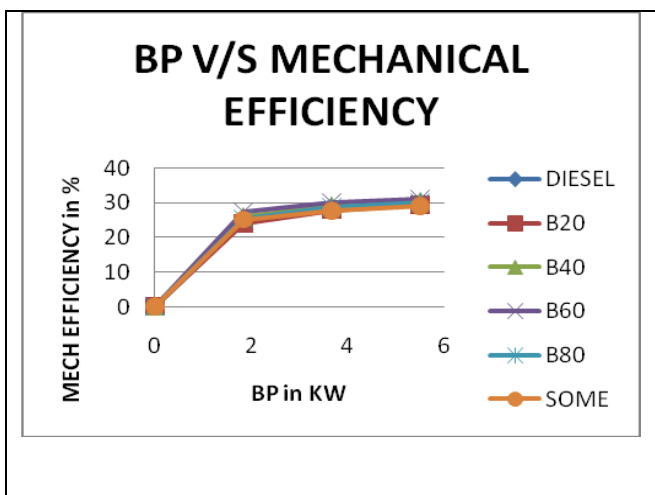


Fig-9 brake power v/s mechanical efficiency

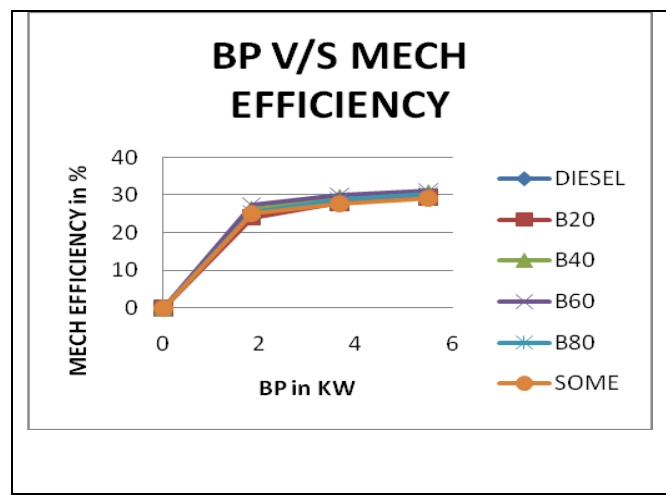


Fig-12 brake power v/s mechanical efficiency

The graph show that brake power v/s sfc, brake power v/s brake thermal efficiency and brake power v/s mechanical efficiency. The result show specific fuel consumption is minimum and better brake thermal efficiency at B60 at 80 bar. And B20,B40 is similar to diesel performance

The graph show that brake power v/s sfc, brake power v/s brake thermal efficiency and brake power v/s mechanical efficiency. The result show specific fuel consumption is minimum and better brake thermal efficiency at B60 at 120 bar. And B20,B40 is similar to diesel

performance .and B80 ,B100 is more fuel consumption for same performance

B. PERFORMANCE CHARACTERISTICS FOR B60 WITH VARYING THE INJECTION PRESSURE

A.PERFORMANCE CHARACTERISTICS FOR 150 BAR

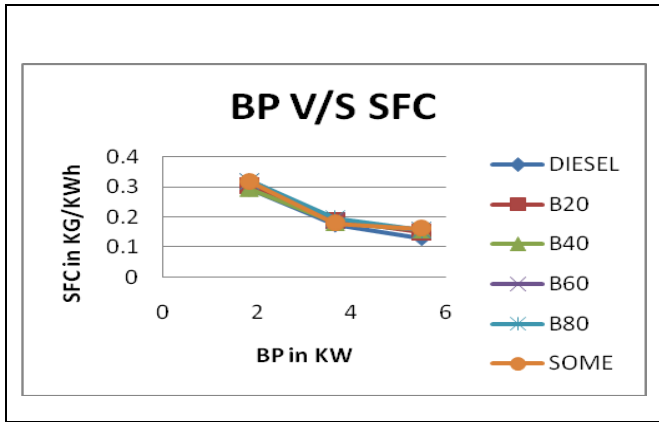


Fig -13 brake power v/s sfc

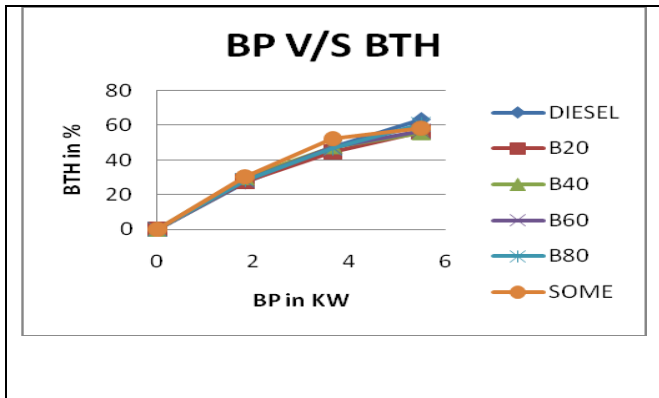


Fig-14 brake power v/s brake thermal efficiency

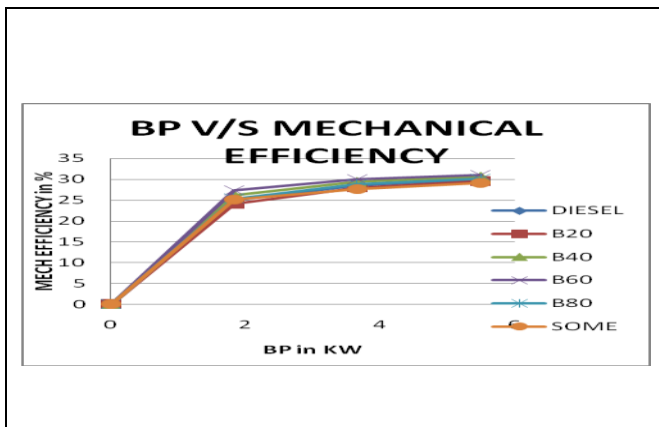


Fig-15 brake power v/s mechanical efficiency

The graph show that brake power v/s sfc, brake power v/s brake thermal efficiency and brake power v/s mechanical efficiency. The result show specific fuel consumption is minimum and better brake thermal efficiency at B60 at 150bar. And B20,B40 is similar to diesel performance .and B80 ,B100 is more fuel consumption for same performance

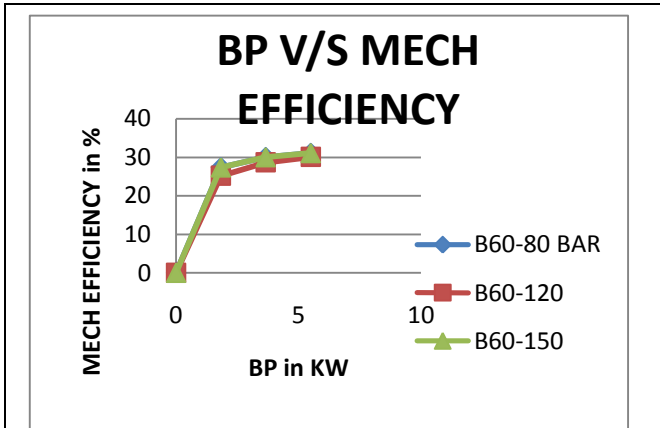


Fig-17 brake power v/ s brake thermal efficienc

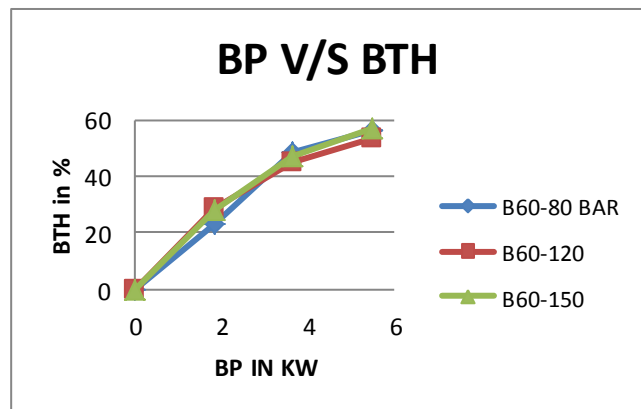
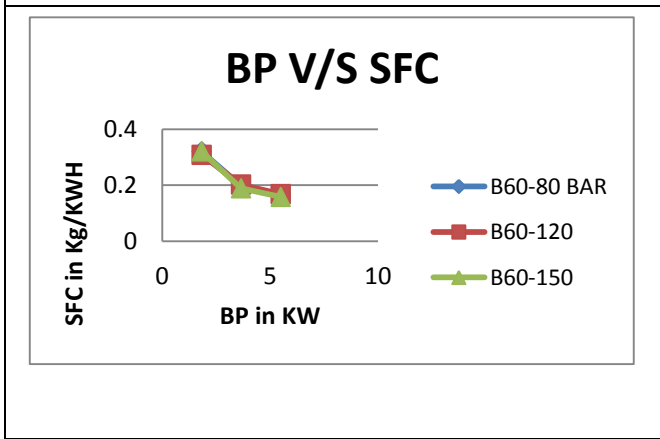


Fig.18: BP vs BTH

The graph show that brake power v/s sfc, brake power v/s brake thermal efficiency and brake power v/s mechanical efficiency. The result show specific fuel consumption is minimum and better brake thermal efficiency at B60 at 80 bar.

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VI. CONCLUSION

- The diesel engine performed satisfactorily on bio-diesel without any engine hard ware modification.
- Transesterification is an effective way to reduce the viscosity and improves the fuel properties of SOME seed oil.
- It can be seen that pure diesel has higher performance at 80 bar . From the blending of 60% has the higher Brake Thermal efficiency and lower BSFC at a pressure of 150bar . 80% blend has higher performance at 80 bar. So it can be concluded that 60% blend has higher performance at 150bar.
- Based on the experimental investigation it can be proved that bio-diesel is good substitute fuel for diesel engine and it can be adopted as an alternative fuel.
- Bio-diesel reduces the environment impacts of transportation, reduce the dependence on crude oil imports from Gulf countries and offer business possibility to agricultural enterprises for periods of excess agricultural production.
- Bio-diesel is found to be a potential alternative fuel to diesel oil. Since its physical properties are close to those of diesel fuel and hence form a renewable source of energy.
- Due to use of SOME seed oil the economic condition of farmers can also be improved.

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