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A Performance and Emission Characteristic of Ci Engine Fuelled with Hybrid Blends of an Edible Sunflower Oil and Non Edible Castor Oilbiodiesels

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***Abstract*---Energy is universal source for development. As increase at usage of fossil fuels, pollution increases. The fossil fuels are non-renewable nature cost more along with awareness increasing regards to environmental concern existing automobile engine fuel has to replace with another suitable alternate fuel without any modification was needed now a days. Biodiesel has become one of the best suitable promising replacements for the petroleum fuels. This work concentrated on extraction of the oil from seeds, biodiesel production from castor and sunflower oil. In this experimental study hybrid, blends of castor and sunflower with nearly 20% and 25% used for engine test. The engine performance and emission parameters on single cylinder 4-stroke water-cooled diesel engine at constant speed 1500rpm, at 220bar injection pressure carried out. The main performance and emission parameters like brake power (BP), brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), carbon monoxide emission(CO), hydrocarbon emissions (HC) and oxides of nitrogen emission (NO_X) are compared. From investigation observed that hybrid blends of castor and sunflower blends gave comparatively best result with diesel fuel so suggest that these fuels utilize for existing engines.**

I.INTRODUCTION

As development in the industrial sectors, population growth, increase in the technology and automobile development all these improving mainly depends on the limited source of energy i.e. majorly fossil fuels. These are depleting source, creates environmental pollution and cost is more. Therefore, there is urgent need of an alternative source for complete replacement of these fuels. Now a day's, researchers given more importance for to develop the best suitable renewable alternates for these depleting sources in order to reduce the dependence on this depleting source and based on the pollution free to meet the emission standards.

Several areas of study have been carried, but a promising development was not yet reached. However, out of this vegetable oil and their biodiesels has been selected as best alternative source for replacement of these fossil fuels. Since vegetable biodiesel is one of the most promising outcomes, because some favourable importance involves they are biodegradable, less pollutant emission, non-toxic, less emission of sulphur, renewable source, less particulate emission easy store, handle and transfer etc.

Since vegetable oil not used directly at the engine, they have to convert to the useful combustion properties of oil that means good properties of diesel fuel, these helps in good combustion, vaporisation, and atomisation at nozzle. There are mainly four different methodology can be used to reduce the viscosity of the oil they are as follows

1. Direct blending with diesel fuel
2. Thermal cracking technique
3. Micro emulsification
4. Transesterification with alcohols

Biodiesel is mainly obtained from animal fats, vegetable oils etc. Out of these, easier and good method was transesterification this one adopted for the production of the biodiesels. At transesterification, the vegetable oil is subject to chemical reaction during chemical reaction the vegetable oil is reacted in the presence of an acid or a base catalyst with alcohol methanol to give alkali esters of the free fatty acids mixture that found in the vegetable oil.

In this investigation volume blending technique volume, based blending technique is used for non-edible castor oil and edible sunflower oil, as hybrid fuel blends are prepared. This blend has been used at CI engine with compression ratio 16:5:1 at 1500 rpm with 220Bar pressure. The performance parameter and emission parameters studied for these prepared blends.

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II. MATERIALS AND EXTRACTION METHODS,

Raw Materials

Selection of raw material place important in production of oil, that oil has to used for production of the biodiesel. The seeds collected from the locally farms area and placed in free from fungus-attacked area. The collected seeds cleaned by hand picking, remove the waste unwanted foreign objects from the collected seeds, dehulling and winnowing carried out that separation of the shell from the nibs. A pestle and mortar has adopted to weaken the shell of seeds or rupture of the shells. These seeds dried well for remove the moisture content, next adopt the oil extraction.

Figure 1: Raw dried Castor and Sunflower seeds

Quality of the seeds

1. As much as maximum oil content in the seeds is preferred, it should not less than 32%.
2. Seeds are well cleaned, fungus attacked seeds are avoided in usage.
3. Moisture content in the seeds are should be kept minimum, that mean it should not exceed maximum 3.5 to 5%
4. The seeds are stored in well-dried place and care must take during while selecting these seeds.

Oil Extraction Methods

Once after selection raw castor seeds and sunflower seeds then the seeds material used for extraction of the oil. Several different techniques adopted for extraction of the oil. In this investigation, Conventional extraction method has been used. Conventional Extraction Methods (Rotary Crushing Method) is one of the traditional technique is adopted for extraction of the oil these are carried out in two way one is through rotary crushing type machines and second one is through expeller type of machines. The oil yield quality is better in expeller type of machines as compare to the rotary type of the machines.

Figure 2: Convention Extraction Setup and Seed Hopper

In this study, rotary type machines used because of small-scale production requirements. In rotary crushing, seeds crushed by rotary type crushing machines extract the oil from these seeds.In this investigation oil, extraction is carried out at "Shri Nataraj Oil Mills 1st Main Road New Mandipete Road Thumkur."

III. METHODOLOGY OF BIODIESEL PRODUCTION

Preparation of Biodiesel

After production of raw oil from different methodology of production, the oil is then going for the production of the biodiesel from those oils. Basic steps involve in the production of biodiesel is explained below step wisely. Two oils that used for in this study are shown below

Figure 3: Castor oil and Sunflower oil

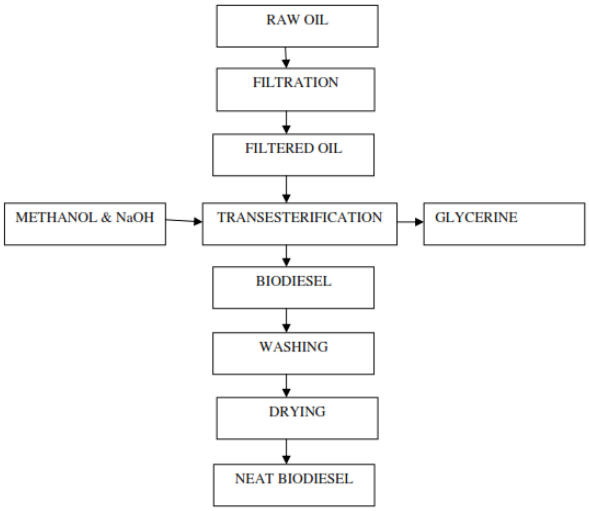

Figure 4: Steps of Biodiesel Production

Transesterification

The best and optimum method of biodiesel production is transesterification. Here in this process removes the fatty acid content that means breakdown the molecules of raw extracted castor or sunflower oil in the presence of alcohol and catalyst to produce the ethyl ester or methyl esters.

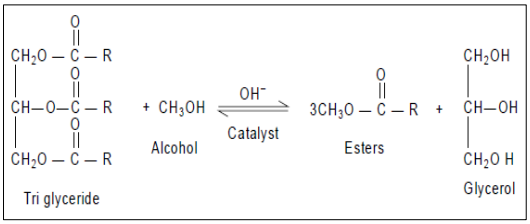

Figure 5: Transesterification Chemical Reaction [2]

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Chemicals Used

Table 1: Chemicals Used

SL No.	Chemical Name
1	Phenolphthalein indicator
2	NaOH
3	Methanol
4	Water

The selection of the catalyst in the process mainly depends on FFA percentage content in the oil.

If the FFA in the oil is greater than 4% then acid catalyzed transesterification is used and if less than 4% then alkaline transesterification is adopted. During esterification glycerine is major by-product obtained that is used in the production of soap

Free Fatty Acid (FFA) Calculation,

Calculation of FFA Content

Formula for calculation is

$$\text{FFA} = \frac{28.2 * (\text{N}) * (\text{Titration Value})}{(\text{Weight Of The Oil})}$$

N= Normality of NaOH

For Castor Seed Oil

$$\text{FFA} = \frac{28.2*0.1*0.9}{1} = 2.58\%.$$

For Sunflower Seed Oil

$$\text{FFA} = \frac{28.2 * 0.1 * 1}{1} = 2.82\%$$

Apparatus Used

Table 2: Apparatus used at Transesterification

SL.No.	Name
1	3 neck flask with magnetic stirrer
2	Reflex condenser
3	Beaker
4	Magnetic pellet
5	Thermometer
6	Separating funnel
7	Weighing balance
8	250 ml flask & collecting jar
9	Holding stand
10	Electric heater

The reaction is carried out in 3-neck flask with magnetic stirrer and reflex condenser as shown in Fig.5 Sunflower oil contains very less contents of FFA percentage so one-step transesterification processes is adopted to convert oil into biodiesel i.e. alkali catalyzed transesterification process. Sunflower oil reacts with methanol in the presence of NaOH catalyst to produce fatty acid ester and by-product glycerol. The methanol (300ml) and based on the FFA percentage NaOH were taken in a round bottomed flask, mixed well with these two which is helps to produce methoxide mixture. The prepared mixture solution mixed with sunflower oil (1000ml). The mixture heated to 63^0C with constant stirring for one and half an hour time duration. Next allow for cool these solution and passes to the separating flask chamber for 5hours so that glycerine is settled at bottom side of the separating chamber. The settled glycerine is removed by draining. Again, allow these separated biodiesel for some 1 hour and check any left out glycerine settles. Once after removing glycerine biodiesel get washed with pure warm water by using washing funnel around 400ml of warm water slowly spray into the biodiesel allow to settle for 10 to 20 minutes so that soap water get starts to form ,removed these soap water content by draining. Same step is repeat for 5 to 6 times to get clear biodiesel. At the end final step, the prepared biodiesel is heats up to 105 degree centigrade temperature with magnetic stirrer. Allow for cool and store in dry neat place.

Figure 6: Batch Reactor & Separating funnel

Biodiesel Properties

After biodiesel get ready, some important properties are studied before using at engine they are mainly flash point, density, calorific value, specific gravity, and kinematic viscosity are determined. Here pure diesel along with two blends 5C+15S+80D and 5C+20S+75D used in this investigation. The determined properties are shown in the below Table3

Table 3: Properties of diesel and blends

Properties	D100	5C+15S+80D	5C+20S+75D
Density (kg/m^3)	834	848	855
Calorific Value (kJ/Kg)	42850	42220	42094
Kinematic viscosity (cSt)	2.38	2.91	3.15
Specific Gravity	0.834	0.848	0.855
Flash Point (^{0}C)	60	65	67

IV. EXPERIMENTAL PROCEDURE

The experimental engine test rig held at Tontadarya College of engineering Gadag. The test rig is 4-stroke single cylinder engine it mainly consists of variable compression ratio setting unit, variable injection pressure setting unit, airflow-measuring unit. For varying load the load cell unit along with torque to measure eddy current dynamometer, speed-measuring unit, and extra setup for exhaust gas analysers unit, sensors included for temperature, water flow and fuel flow measurement. Data acquisition system enclosed for easy operation. In this well-established setup involved computerised data manipulation engine measurement software system for to give complete aspect of the engine running activity in complete profile. The engine test rig placed at study base frame. The dynamometer and test rig attached with

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standard coupling attachment. Several different sensors adopted in the system like combustions pressure gas sensor, temperature measurement sensor, fuel sensors provided in the test rig. To carryout emission parameter, extra fitting attached to the setup that called as exhaust gas, analyser system. To study balance sheet test rig during operation calorimeter attached included. The test rig is mainly for measuring performance well-established system is included.

Figure 7: Stroke Single Cylinder, Engine test rig

Table 4: Engine specifications of tested engine

Particular	Specifications
Engine	(Kirloskar AV1)
Bore	80mm
Speed	1400-1500RPM
Horse power	5HP
Starting	Crank start
Lubrication	Forced type
Capacity	553cc engine
Injection pressure	180 Bar
Compression ratio	16:5:1
Stroke	110 mm
Cooling	Water cooling system

In this present investigation, the engine attached with a multi gas analyzer MN-05 System that measures mainly CO, CO_2, HC, NO & NO_2 in the engine exhaust during combustion. The analyzer is very handy easy to analyze. In this investigation the specification used in analyzer mentioned below.

Table 5: Specification of Multi Gas analyzer MN-05

Analyzer Technical Specifications		
Parameters	Range	Specification
CO	O -9.99%	0.001% volume
NO_X	5000ppm	1ppm
CO_2	0-20%	0.01%volume
HC	15000ppm	1ppm
O_2	0-25%	0.1% volume

Figure 8: Multi gas analyzer MN-05

V. RESULTS AND DISCUSSION

The experiment were conducted on 4 stroke, water-cooled diesel engine at 220bar constant speed of 1500rpm,Comprssion ratio of 16:5:1 along with varying load on the engine (25%, 37.5%, 62.5%, 87.5% and 100% loads). Initially test carried out for pure diesel (D100) and next test carried out for blends 5C+15S+80D and 5C+20S+75D. The analysis of basic performance and emission parameters like BP, BSFC, BTE, CO, HC and NO_X are obtained and next observed values are compared with D100.

The comparative graphs are shown below from Figure 9 to Figure 14.

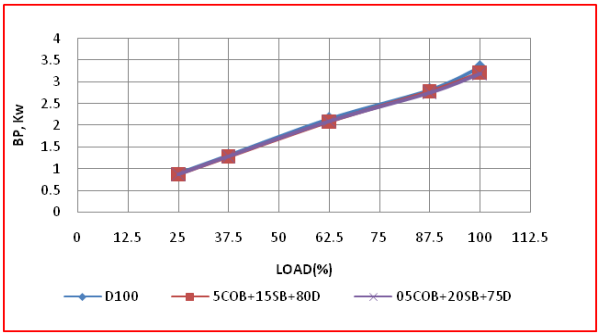

Figure 9: BP,kW v/s LOAD

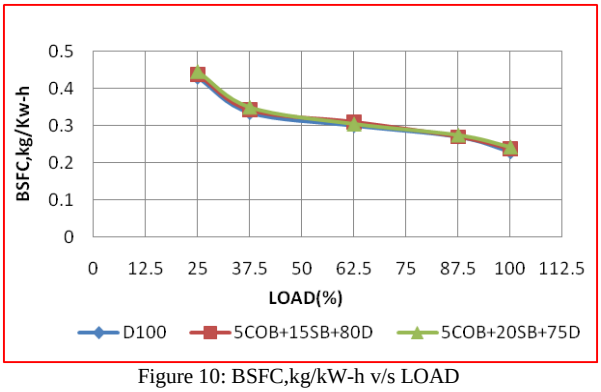

Figure 10: BSFC,kg/kW-h v/s LOAD

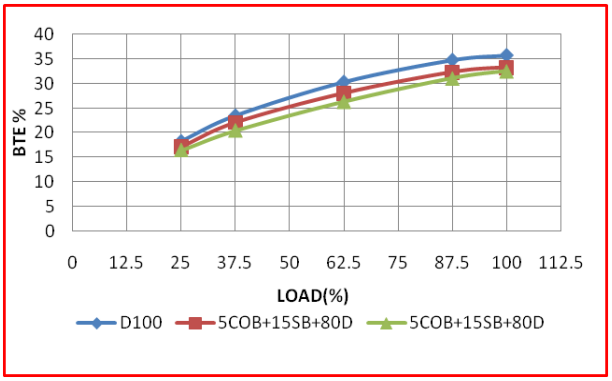

Figure 11: BTE % v/s LOAD

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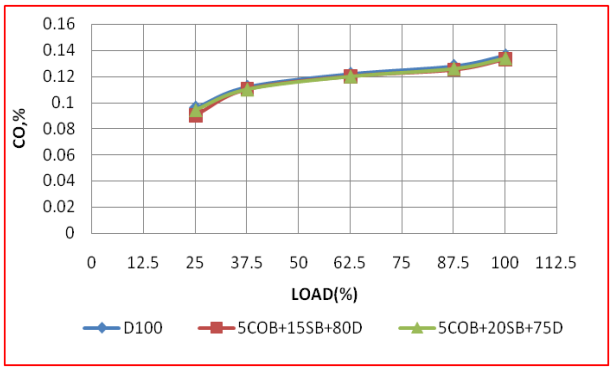

Figure 12: CO % v/s LOAD

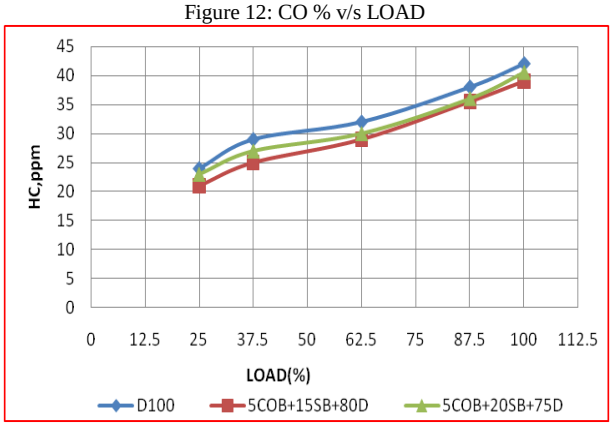

Figure 13: HC,ppm v/s LOAD

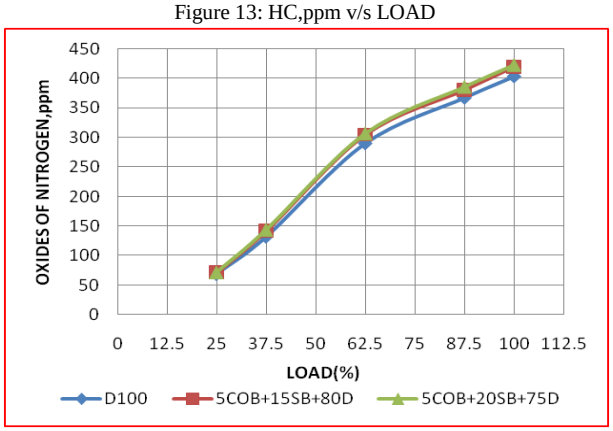

Figure 14: NO_X v/s LOAD

VI. CONCLUSION

From this experimental investigation biodiesel, production from sunflower and castor oil studied and hybrid blends of castor and sunflower used at engine the performance and emission parameters like BP, BSFC, BTE, CO, HC and NO_X are obtained and comparisons given with D100. From this study, a better nearest values of outputs came with hybrid biodiesels. Hence, conclude that castor and sunflower biodiesels can be used as alternative fuel for the CI engines.

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