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STUDY ON BIODIESEL PRODUCTION FROM CASTOR OIL BY TRANSESTERIFICATION METHOD AND TESTING ON FOUR STROKE KIRLOSKAR ENGINE.

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ABSTRACT

Today increasing oil consumption and demising the storage of fossil petroleum so requirement for renewable and domestic alternative fuel is now the prime necessity for survived daily life .

Today engine modification and developed is heavily controlled by increasing emission digitation, leading to rapid improvements.

The alternative fuel must meet the following factor like

- Technical acceptability
- Economically competitive
- Environmentally friendly

Hybrid electric vehicles is also a alternative fuel.
Alternative fuels are preferred to reduce waste, particulate matter carbon monoxide, unburned hydrocarbon, Sulphur dioxide. This is the reason why united nations and environmental at organization. Working all over the world are advocating alternative fuels.
We used castor oil which control the emission, castor oil blended in the diesel in various proportion like B-20(20% biodiesel, 80%diesel) , B-20 and B-30 has been used by different load condition in 4 stroke kirloskar engine. Physical properties of castor oil like density, viscosity and calorific value have been determined before engine testing. Hence suitable blend are saluted for blending with castor oil in the diesel engine.

Keywords: Biodiesel, C.I. Engine, performance testing, Blend B-20, B-30

Introduction

Self-sufficiency in energy requirement is critical to the success of any developing economy. With the depletion of oil resources and the negative environment impact associated with the use of fossil fuels, there is a renewed interest in alternate energy

sources. Apart from the search for alternatives, there is a need to achieve energy independence, directing much focus on biofuels.

Biofuels are renewable fuels that are produced predominantly from domestic biomass feedstock, or as a by-product from the industrial processing of agricultural or food products, or from the recovery and reprocessing of products such as cooking and vegetable oil. Bio-ethanol and biodiesel are the most widely recognized biofuel sources for the transport sector. Biofuel does not contain petroleum, but it can be blended in any proportion with petroleum fuel to create a biofuel blend. It can be used in conventional heating equipment or diesel engines with no major modifications.[1]

The World Energy Scenario

The present energy scenario has stimulated active research interest in non-petroleum, renewable, and non-polluting fuels. The world reserves of primary energy and raw materials are, obviously, limited. According to an estimate, the reserves will last another 218 years for coal, 41 years for oil, and 63 years for natural gas, under a business as usual scenario (Agarwal, 2007). Oil has no equal as an energy source for its intrinsic qualities of extractability, transportability, versatility, and cost. Being the product of the burial and transformation of biomass over the last 200 million years Reserves of petrol or gasoline, which is a complex mixture of hundreds of different hydrocarbons, are finite. The NOx, SO2, CO2, and particulate matter that cause pollution are emissions from engines using gasoline.

The growth in demand for oil and gas is rising exponentially. The combined world production of oil and gas in equivalent units rose by around 1.50% per annum from 1990 to 2000, But from 1999 to 2000, it rose by 4%. As the reserves approach exhaustion, demand is accelerating, bringing the emptying of reserves ever nearer.

Over the last five years Thus, biofuels from feedstock are apparently the only foreseeable alternative sources of energy that can efficiently replace petroleum-based fuels in the long term.[2]

Preparation of Biofuel from Castor Seed

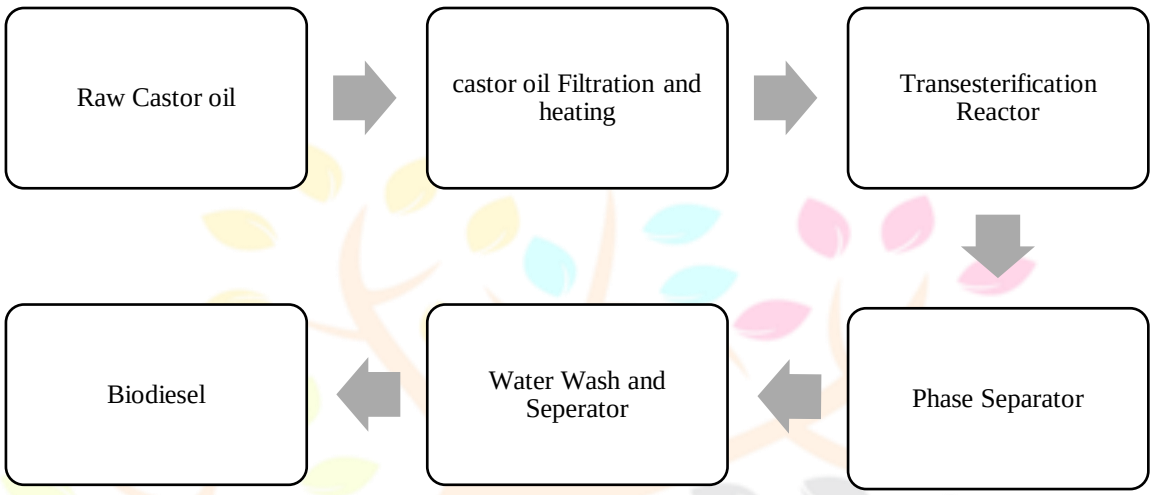
Biodiesel can be produced from various type of vegetable oil. One of it is castor oil which extracted from castor bean. Ricinus communis L. or famously known as castor bean plant is a type of plant that belong to Euphorbiacceae family. This plant originally found in Africa but also could be found wild in the tropical and subtropical countries all around the world. For producing biodiesel, transesterification process is one of the most suitable method to be used because castor oil has high viscosity relatively to vegetable oils. Gerpen and Knothe (2005) wrote that there are possible four methods to reduce the high viscosity of vegetable oils to enable their use in common diesel engines without having any operational problems. The four methods are blending with petrodiesel, pyrolysis, microemulsification and transesterification. We are focusing on transesterification process because it was found that up to 85% of ester could be obtained (Chakrabarti andAhmad, 2008). In the transesterification process, triglyceride component inside the castor oil will react with alcohol with presence of catalyst, then will produced glycerol and methyl ester. Castor oil is a product obtained from the extraction of castor bean or also known as castor seed. Scientifically, castor bean named as Ricinus communis L. is a type of plant that belong to Euphorbiacceae family. Castor oil is a type of vegetable oil gained from planted crop and currently widely planted at some countries. The advantages of using vegetable oil as sources of fuel are ready availability, renewability and nature-portability. Despite of the advantages, there are also disadvantages such as higher viscosity, there activity of the unsaturated carbon chained and lower value of volatility. These disadvantages can be overcome with several methods during the process of producing the biodiesel itself. The oil contain in this bean is approximately 35 - 55%. This percentage of oil can be consider as high value in number as the oil is extracted from bean itself, depending on the environment the seed being planted. [1]

Fiure:1 Castor seed

Biodiesel production

Castor oil containing 0.66 wt % FFA was collected from Dal bazar Gwalior (M.P). Methanol (CH3OH) and potassium hydroxide (KOH) were used as reacting agent and catalyst respectively during the transesterification process.

Methanol & Raw castor oil



Biodiesel manufacturing Flow sheet from Castor oil

Filtration and heating of Raw Castor oil

Non-oil components of the Castor oil were removed by separation using filter and moisture was removed by heating the oil at about 120°C for 30 to 45 minutes. Heating with electric heater is usually the easiest way to bring the oil up to required temperature.

Determination of FFA

In order to determine the percentage of FFA in the oil, a process called titration is used. The vegetable oil is first mixed with methanol. Next, a mixture of Sodium Hydroxide (NaOH) and water is added until all of the FFA has been reacted.

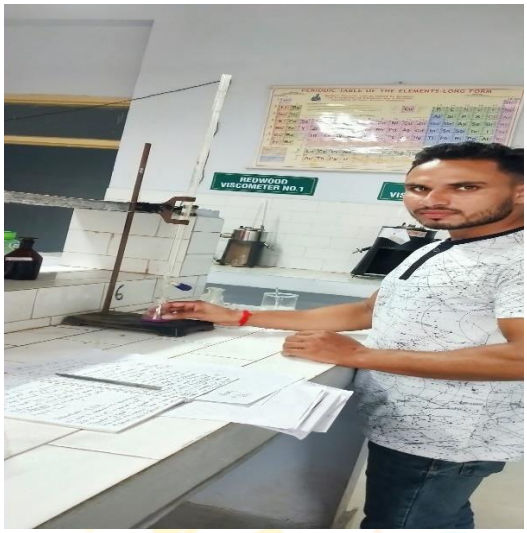


Figure:2 Determination of FFA

162 mg of NaOH was dissolved in 162 ml of distilled water solution. Phenolphthalein solution was used to get the end point. In a smaller beaker, 3ml of castor oil is dissolved in 30 ml of methanol (CH3OH). The mixture was stirred gently until all the oil dissolves in the alcohol and the mixture turns clear. Two to three drops of phenolphthalein solution were added. Using a burette, NaOH solution was added drop by drop to the oil alcohol phenolphthalein solution, stirring all the time, until the solution stays pink. The number of mg of NaOH solution gives the amount of NaOH to be used per litre of oil and FFA percentage.

CALCULATION

FFA%= (v-b) X N X 28.2/w,v is the volume of the titrant, b is the blank volume, N is the normality usually .25 N,

V is the volume of the titrant, b is the blank volume, N is the normality usually .25 N,

B is the blank volume , (titration without mixing with oil)

N is the normality usually .25 N,

28.2 is the molecular weight weight of oleic acid (282) divided by 10,

W is the weight of the oil used.

(v-b)*N*56.1/W [3]

Acid value

The acid value of an oil is determined by titrating a solution of the oil in diethyl ether with an alcoholic solution of sodium or potassium hydroxide. It is expressed as the amount of KOH (in mg) to neutralize 1 g of oil. [4]
Often, the acid value is converted to an FFA content by multiplying the acid value with a factor that equals the molecular weight of the fatty acid concerned (usually oleic acid, MW = 282.4) divided by ten times the molecular weight of the potassium hydroxide (56.1). This factor ten stems from the fact that the acid value is expressed as mg/g, whereas the FFA content is expressed as a percentage. When the FFA content is expressed as 'wt% oleic acid,' this factor therefore equals 0.50

CALCULATION OF FFA%

Calculation of normality of NaoH
Weight of NaoH = 162mg (0.162 gm NaoH)
Volume of disttled water =162 ml
Equivalent weight of NaoH =40

$$\text{Normality} = \frac{\text{weight of NaoH in gm} \times 1000}{volume\ of\ disttled\ water\ in\ ml \times equivalent\ weight\ of\ NaoH}$$

$$N = \frac{0.162\ gm \times 1000}{162 \times 40}$$

N = 0.025

Titration

$$FFA\% = \frac{V \times N \times 28.2}{\text{weight of oil}}$$

V = titrant value (volume of 0.025 N NaoH used to neutralize acid of oil)

Weight of oil = 1 ml / 10 ml CH3OH

$$FFA\ \% = \frac{3.2 \times 0.025 \times 28.2}{1}$$

FFA % = 2.256

ACID NUMBER

$$\text{Acid no.} = \frac{V \times N \times \text{EQUIVALENT WEIGHT OF NaoH}}{\text{weight of oil}}$$

$$= \frac{3.2 \times 0.025 \times 40}{1}$$

= 3.2 mg/NaoH

Table :1 FFA information

ml titration	% FFA	NAOH (mg)
10	2.256	162

Mixing of Methanol and Catalyst

The purpose of mixing methanol and the catalyst (NaOH) is to react the two substance to form methoxide. The amount of methanol used should be 20% of the volume of the oil. Methanol and KOH are dangerous chemicals by themselves, with Methoxide even more so. None of these substances should ever touch skin. Vapours should not be inhaled. Gloves and ventilation are required at all times when working with these substances.[5]

Transesterification (Biodiesel reaction)

The methanol in excess is added to the oil in a beaker serving as a batch reactor. The mixture is then agitated for about 60 to 90 minutes and then left overnight for phase separation to take place due to gravity. [5]

Draining of Glycerol

After the transesterification reaction, one must wait for the glycerol to settle to the bottom of the container. This happens because glycerol is heavier then biodiesel. The settling will begin immediately, but the mixture should be left for minimum of 8 hours to 12 hours.

Washing of Biodiesel

The purpose of washing is to wash out the remnants of the catalyst and other impurities. Generally water washing is preferred in which lukewarm water (about one third of raw biodiesel) is added to raw biodiesel, stirred for a short duration and then impurities are allowed to settle down at bottom with water. .[5]

Biodiesel Production technologies

This section contains the details of biodiesel production methodologies which are used in the present work like mechanical stirring, transesterification method and results of these methods are relatively compared. [5]

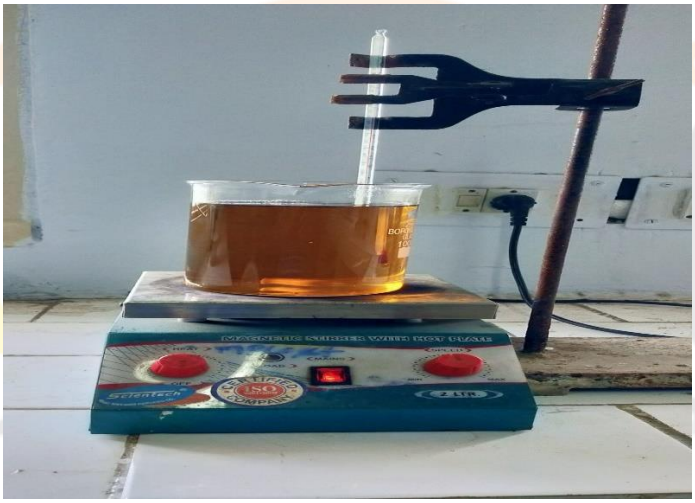


Figure:3 magnetic Stirrer

Reagents and materials used for experiment

1. Castor oil for preparing biodiesel.

2. Methyl alcohol (CH3OH)

3. Base catalyst (KOH) for accelerating the reaction mixture.

Experiments Performed

This experiment has been performed to evaluate performance of mechanical stirring method of biodiesel production in terms of yield (%).

Experiment has been performed with the following steps:

1. Castor oil is filtered and then heated to 120°C and kept at this temperature for about 05 minutes to remove impurities and moisture. This reduces the probability of soap formation during the transesterification reaction. The sample is then cooled to room temperature.
2. Methyl alcohol (CH3OH) is taken with a molar ratio of (1:6) and Catalyst (KOH) is taken as (1% by wt of oil). The mixture of methyl alcohol and KOH is stirred until KOH dissolve in methyl alcohol.
3. Now the castor oil and mixture of methanol and catalyst are put together into the tank ad mechanical stirring is applied for about 90 min.
4. During the reaction the temperature of mixture is kept in between 60-65°C.
5. Samples are then allowed for phase separation of methyl ester and glycerol in separating flasks. Fatty acid has higher specific weight therefore it will settle at bottom. Separation of methyl ester and glycerol will take 8 to 12 hours duration.
6. After complete separation, bio-diesel (methyl Ester) is visible in the upper layer and glycerol at the bottom.
7. Bio-diesel is then separated.
8. To remove impurities and catalyst, water at around 40°C is mixed with the methyl ester and left for settling down. Water due to its higher specific gravity collected at bottom.
9. The washed sample was dried by placing it on a hot plate and excess water still in the biodiesel was removed.
10. Purifying of biodiesel.

Table.2 Specification & properties of castor oil

Properties	**Castor oil**
FFA (%)	**2.256**
Density (kg/m3)	**962.8**
Fire point (°C)	**335**
Flash point (°C)	**298**
Specific gravity	**0.9628**
Calorific value (kJ/kg)	**35684.5**
Kinematic viscosity (mm2/s)	**109.53**

PERFORMANCE PARAMETERS

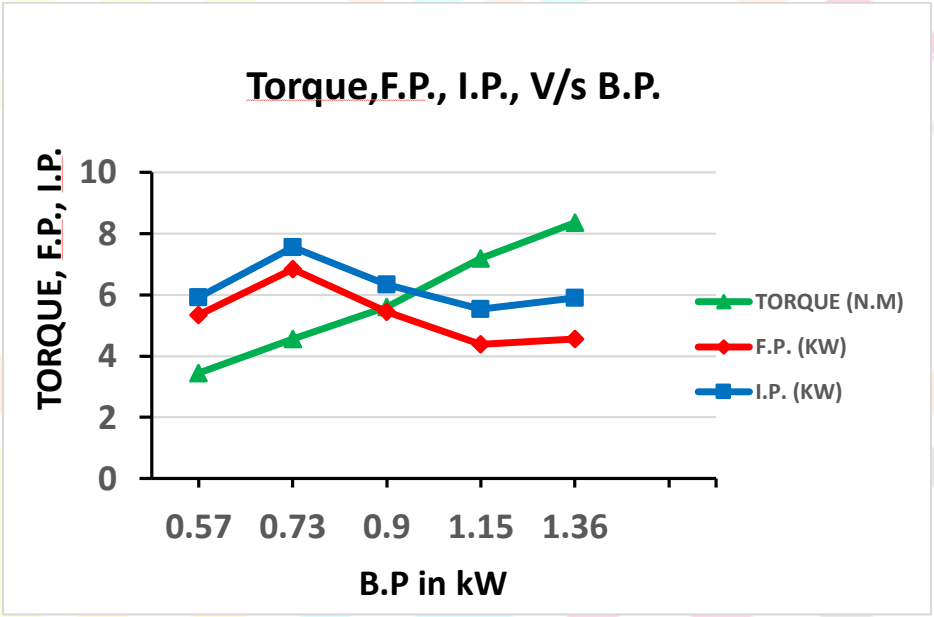
TORQUE: in this case of torque the maximum value in diesel is 8.36 when load is 2.4 kg and rpm is 1518. In case of B20 the maximum value of torque is 7.27 when load on engine is 2.4 kg and rpm is 1518 at that time. In B30 case get the maximum value of torque is 10.97 Nm when load is 2.4 kg and rpm is 1518. So all of three case we get the maximum value in B30 case , which show that the biodiesel is fine alternative diesel fuel

BRAKE POWER: in case of brake power the maximum value of 1.36 In diesel, 1.16 in B20, and 1.72 in B30. All these value the brake is also higher as compare to diesel engine. These results show that the biodiesel is reliable fuel.

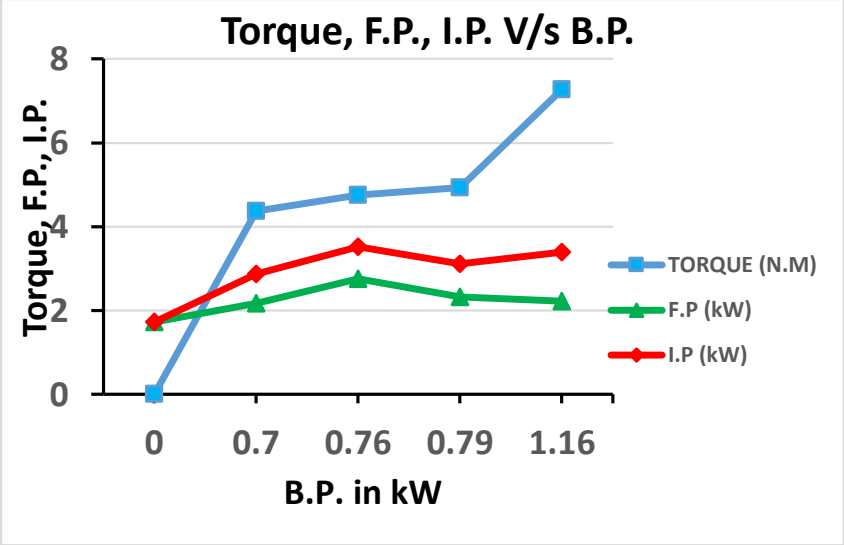
BRAKE THERMAL EFFICIENCY: the value of brake thermal efficiency is also increases, when use the biodiesel blends in diesel engine. The maximum value of BTHE is 25.9 in diesel, 13.97 in case of blends of B20 is use to diesel engine and B30 case we get the maximum value of all of these case which value is 23.97 .

MECHANICAL EFFICIENCY: the value of mechanical efficiency is as higher as possible in diesel engine. The higher value of this efficiency is give better performance and low emission of diesel engine. The maximum value of mechanical efficiency is 22.99% in diesel, 34.20% in case of B20 and 44.37% in B30 case.

GRAPH FOR DIESEL



GRAPH FOR B20



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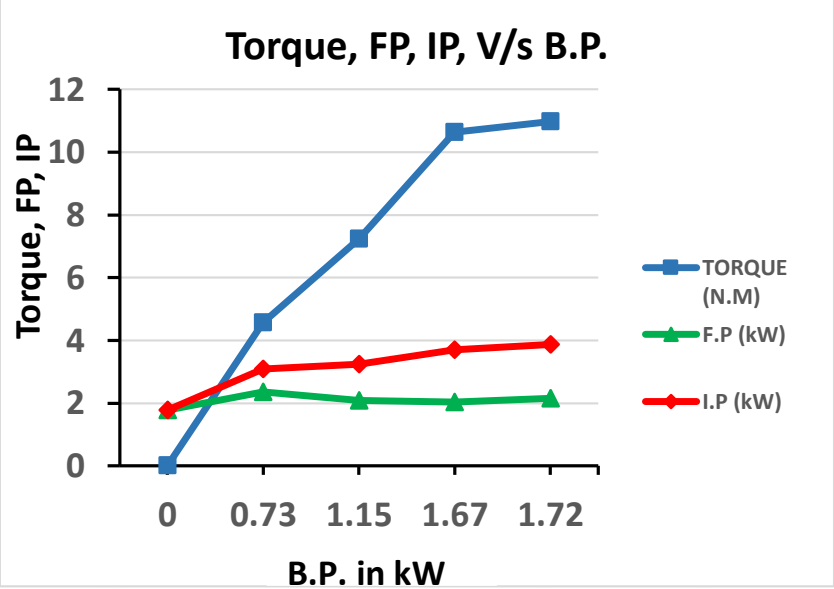

COMPARISON BETWEEN PURE DIESEL,B20 AND B30

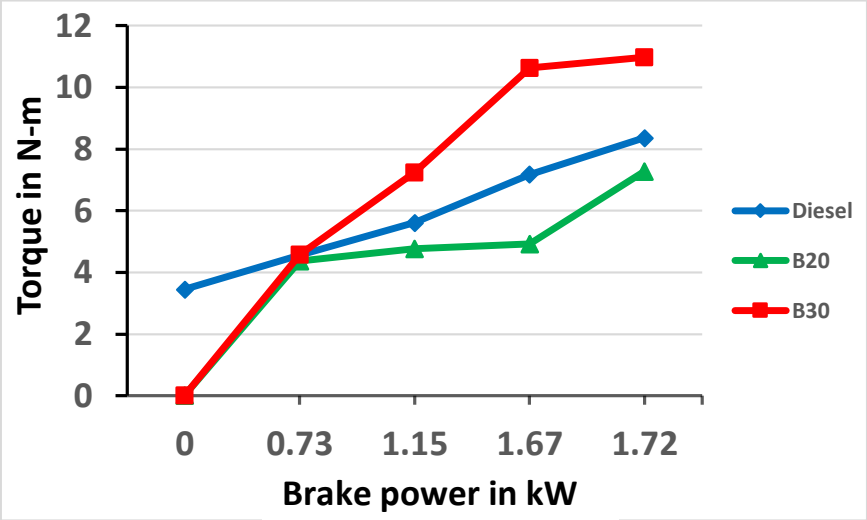

Table 3: DISCUSSION ON PERFORMANCE PARAMETER

	DIESEL	B20	B30
MAX. TORQUE	8.36	7.27	**10.97**
MAX. BRAKE POWER	1.36	1.16	**1.72**
MAX. BTHE	**25.9**	13.97	23.97
MAX. MECH.EFF.	22.99	34.20	**44.37**
LOAD	2.4 kg	2.4 kg	2.4 kg
RPM	1518	1518	1518

Emission characteristics of biodiesel (castor oil)

- Emission characteristics of biodiesel (castor oil) is less as compare to pure diesel.
- Emission rate of biodiesel is considered from previous research papers, I have studied so many papers about emission rate of castor oil is less.
- The test conducted on the Diesel engine using different castor blends B25, B50, B75, B100 at rated load ,the neat castor oil emissions CO, UHC, smoke are 56.41%, 21.27%,31.32% higher and NOX are 44% lower compared to the diesel.CO emission for castor B25blend is found to be 2.12% with respect to the value 1.95% for the diesel.[21]

Table 4: Emission comparison between diesel and biodiesel blends

Sr. no.	Types of emission	B100	B20
1	Hydro carbon (HC)	-67%	-20%
2	CO	-48%	-12%
3	Particulate matter (PM)	-47%	-2%
4	NOx	+10	+2
5	SO2	-100	-20
6	PAH	-80	-13

CONCLUSION

- Biodiesel obtained from castor oil has very low cloud and pour points which makes this biodiesel a good alternative in winter conditions. Castor oil biodiesel could be used as petroleum diesel additive for improving both environment and flow behavior of the mineral fuel.
- Maximum yield up to 70 % is obtained by using castor oil by transesterification process technique.
- The presence of oxygen in the molecular structure of biodiesel intensifies the complete combustion phenomenon.
- The smoke emission of biodiesel blends are considerable less as compare to diesel due to sufficient proportion of oxygen are present so complete combustion of the fuel. The results confirm the potential of these blends have in reducing the over burdening imports of diesel fuel.

FUTURE SCOPE

The present research can be extended by future researchers

In following ways-

- Comparative analysis on crankshaft.
- Different engines can be carried out.
- Analysis with variation in fuel supply pressure can be carried out.
- Different cooling system.

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