ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.6

Performance and Emission Test on Castor And Cottonseed Oil Blended With Diesel As an Alternative Fuel In Diesel Engine

R. Parthiban[1], Mr.P.Sankarlal M.E.,(Ph.D).,(SEG)
M.E Student (Thermal Engineering)[1], Professor[2]
Department of Mechanical Engineering
J.J. College of Engineering and Technology, Trichy, India

Abstract:
India's growing demand for petroleum-based fuel has created challenges for the country's energy security, as almost 90% of its crude oil requirement is imported from oil producing countries. Out of industrial, agricultural & domestic sectors, the transport sector consumes almost 80% of total energy being currently derived from fossil fuels. Non-edible vegetable oils such as castor and Cottonseed oil, produced by seed-bearing shrubs, can provide an alternative and do not have competing food uses. Biodiesel was prepared from the non-edible oil of castor and Cottonseed by transesterification of the crude oil with methanol in the presence of NaOH as catalyst. The experimental treatments of a 200ml methanol to oil, addition of 5wt% catalyst, 65-70^{0}C reaction temperature using low quality crude castor and Cottonseed oil separately resulted in optimum yield in which the biodiesel content exceeded 95% at 2 hours. The resulting 50% castor oil and 50% Cottonseed oil is blended with diesel in different percentage. Performance and emission tests were carried out for 25%, 50%, and 75% castor and Cottonseed oil diesel blends. Results confirm that the performance and emission of the engine fuelled castor and Cottonseed oil biodiesel and their blend with diesel fuel is by and large comparable with pure diesel.

Keywords: castor oil, cottonseed oil, Biodiesel, transesterification, Performance, Emission Test

1. INTRODUCTION

Diesel engines are considered as the efficient prime movers which are used in various fields such as the transportation sector, power plant and agricultural sectors due to its higher fuel efficiency. But these engines tend to emit toxic emissions to the atmosphere. There is also a risk of quicker depletion of all the fossil fuels. In order to protect the environment from these toxic emissions, increasing cost and fast exhausting of petroleum reserves and to provide a sufficient and continuous supply of energy fuel, it became a necessity to develop alternative fuels such as vegetable oil, alcohol and biomass. Vegetable oils have comparable energy density, cetane number and heat of vapourization. Also, they are non-toxic and biodegradable with lesser toxic emissions. But they are extremely viscous when compared to the petroleum-based diesel which leads to inadequate fuel atomization and incomplete combustion. The vegetable oils can be modified by blending with petroleum-based diesel in order to reduce the viscosity of the fuel. There are various techniques to reduce the viscosity of vegetable oils such as direct blending, preheating and micro emulsion and transesterification process to convert biodiesel. Martin et al [1-3] reduced the viscosity of vegetable oil by blending it in different proportions with diesel, and analyzed its viscosity at various temperatures and used it as a fuel in a Compression Ignition (CI) engine. They reported that a remarkable improvement in the performance of the engine was noticed. There is a reduction in smoke, CO and HC emissions were also noticed for 60% of cottonseed oil diesel blend.

1.1 VEGETABLE OILS

In the last few years interest & activity has grown up around the globe to find a substitute of fossil fuel.. According to Indian scenario the demand of petroleum product like diesel is increasing day by day hence there is a need to find a solution. The use of edible oil to produce biodiesel in India is not feasible in view of big gap in demand and supply of such oil. Under Indian condition only non-edible oil can be used as biodiesel which are produced in appreciable quantity and can be grown in large scale on non-cropped marginal lands and waste lands. Non-edible oils like jatropa, karanja and mahua contain 30% or more oil in their seed, fruit or nut. India has more than 300 species of trees, which produce oil bearing seeds Around 75 plant species which have 30% or more oil in their seeds/kernel, have been identified and listed. Traditionally the collection and selling of tree based oil seeds were generally carried out by poor people for use as fuel for lightning. Biodiesel has become more attractive because of its environmental benefits and fact that it is made up of renewable resources. Although short term test using vegetable oil showed promising results, longer tests led to injector coking, more engine deposits, ring sticking and thickening of the engine lubricant .

1.2 CASTOR OIL

Castor oil has long been used commercially as a highly renewable resource for the chemical industry. It is a vegetable oil obtained by pressing the seeds of the castor oil plant (*Ricinus communis* L.) that is mainly cultivated in Africa, South America, and India. Major castor oil-producing countries include Brazil, China, and India. This oil is known to have been domesticated in Eastern Africa and was introduced to China from India approximately 1,400 years ago. India is a net exporter of castor oil, accounting for over 90% of castor oil exports, while the United States, European Union, and China are the major importers, accounting for 84% of imported castor oil.India is known as the world leader in castor seed and oil production and leads the international castor oil trade. Castor oil production in this country usually fluctuates between 250,000 and 350,000 tons per year. Approximately 86% of castor seed production in India is concentrated in Gujarat, followed by Andhra Pradesh and Rajasthan. Specifically, the regions of Mehsana, Banaskantha, and Saurashtra/Kutch in Gujarat and the districts of Nalgonda and Mahboobnagar of Andhra Pradesh are the major areas of castor oil production in India.7 The economic success of castor crops in Gujarat in the 1980s and thereafter can be attributed to a combination of a good breeding program, a good extension model, coupled with access to well-developed national and international markets. Castor is one of the oldest cultivated crops; however, it contributes to only 0.15% of the vegetable oil produced in the world. The oil produced from this crop is considered to be of importance to the global specialty chemical industry because it is the only commercial source of a hydroxylated fatty acid. Even though castor oil accounts for only 0.15% of the world production of vegetable oils, worldwide consumption of this commodity has increased more than 50% during the past 25 years, rising from approximately 400,000 tons in 1985 to 610,000 tons in 2010. On average, worldwide consumption of castor oil increased at a rate of 7.32 thousand tons per year. In general, the current rate of castor oil production is not considered sufficient to meet the anticipated increase in demand. There are various challenges that make castor crop cultivation difficult to pursue. Climate adaptability is one of the challenges restricting castor plantation in the U.S. The plant also contains a toxic protein known as ricin, providing a challenge from being produced in the U.S. It also requires a labor-intensive harvesting process, which makes it almost impossible for the U.S. and other developed countries to pursue castor plantation.Castor plant grows optimally in tropical summer rainfall areas. It grows well from the wet tropics to the subtropical dry regions with an optimum temperature of 20°C–25°C. The high content of the oil in the seeds can be attributed to the warm climate conditions, but temperatures over 38°C can lead to poor seed setting. Additionally, temperatures low enough to induce the formation of frost is known to kill the plant. As of 2008, three countries (India, China, and Brazil) produced 93% of the world's supply of castor oil. Because production is concentrated mainly in these three countries, total castor production varies widely from year to year due to fluctuations in rainfall and the size of the areas utilized for planting. As a consequence, this concentration has led to cyclic castor production. Thus, diversification of castor production regions and production under irrigation would hopefully reduce the climatic impact on castor supplies.

Figure 1.1 Castor Tree and Castor Seed

1.3 COTTONSEED OIL

The use of biodiesel is rapidly expanding around the world, making it imperative to fully understand the impacts of biodiesel on the diesel engine combustion process and pollutant formation. Biodiesel is known as the mono-alkyl-esters of long chain fatty acids derived from renewable feedstocks, such as, vegetable oils or animal fats, for use in compression ignition engines.

Different parameters for the optimization of biodiesel production were investigated in the first phase of this study, while in the next phase of the study performance test of a diesel engine with neat diesel fuel and biodiesel mixtures were carried out. Biodiesel was made by the well known transesterification process. Cottonseed oil (CSO) was selected for biodiesel production. Cottonseed is non-edible oil, thus food versus fuel conflict will not arise if this is used for biodiesel production. The transesterification results showed that with the variation of catalyst, methanol or ethanol, variation of biodiesel production was realized. However, the optimum conditions for biodiesel production are suggested in this paper. A maximum of 77% biodiesel was produced with 20% methanol in presence of 0.5% sodium hydroxide. The engine experimental results showed that exhaust emissions including carbon monoxide (CO) particulate matter (PM) and smoke emissions were reduced for all biodiesel mixtures. However, a slight increase in oxides of nitrogen (NO_x) emission was experienced for biodiesel mixtures.

Figure 1.2 Cottonseed Plant and Cottonseed Seed

2. PROBLEM DESCRIPTION

In today's world, alternative fuels are needed more than ever. Conventional fuels, such as coal, natural gas, and fossil fuel, are constantly being depleted; however, the world's dependency on these fuels is still growing. Additionally, the price on foreign fuels is ever increasing. For these reasons, the US and the world are pursuing alternative fuel sources to lessen the dependency on conventional fuels. One alternative fuel is biodiesel; biodiesel can be produced from vegetable oil or animal fat and thus can be used to alleviate the foreign fuel dependency. In order for biodiesel to be a viable alternative fuel source, an industrial-scale biodiesel production process needs to be improved. Compared to current designs and fossil fuel, the process must be cost competitive. The purpose of this project is to develop an industrial process to create biodiesel from oil extracted from non edible seeds.

3. EXPERIMENTATION

3.1 EXTRACTION OF OIL

Biodiesel is a clean-burning diesel fuel produced from vegetable oils, animal fats, or grease. Its chemical structure is that of fatty acid alkyl esters (FAAE). Biodiesel as a fuel gives much lower toxic air emissions than fossil diesel. In addition, it gives cleaner burning and has less sulfur content, and thus reducing emissions. Because of its origin from renewable resources, it is more likely that it competes with petroleum products in the future. To use biodiesel as a fuel, it should be mixedwith petroleum diesel fuel to create a biodiesel-blended fuel. Biodie- sel refers to the pure fuel before blending. Commercially, biodiesel is produced by transes- terification of triglycerides which are the main ingredients of biological origin oils in the presence of an alcohol (e.g. methanol,

ethanol) and a catalyst (e.g. alkali, acid, enzyme) with glycerine as a major by-product. After the reaction, the glycerine is separated by settling or centrifuging and the layer obtained is purified prior to using it for its traditional applications (pharmaceutical, cosmetics and food industries) or for the recently developed applications (animal feed, carbon feedstock in fermentations, pol- ymers, surfactants, intermediates and lubricants). However, one of the most serious obstacles to use biodiesel as an alternative fuel is the com- plicated and costly purification processes involved in its production. Therefore, biodiesel must be purified before being used as a fuel in order to fulfil the EN 14214 and ASTM D6751 standard specifications listed. otherwise the methyl esters formed cannot be clas- sified as biodiesel.

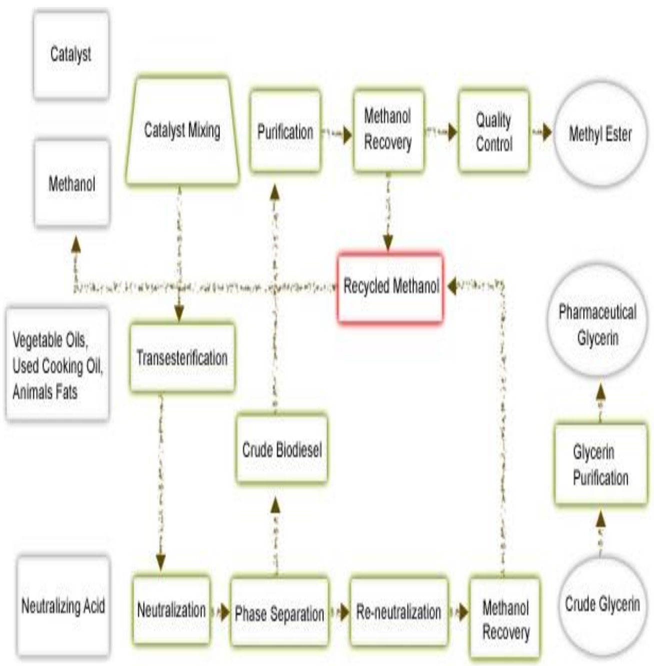


Figure 3.1 Bio diesel extraction process

Removing glycerine from biodiesel is important since the glycerine con- tent is one of the most significant precursors for the biodiesel quality. Biodiesel content of glycerine can be in the form of free glycerine or bound glycerine in the form of glycerides. In this work we refer to the total glycerine, which is the sum of free glycerine and bound glyc- erine. Severe consequences may result due to the high content of free and total glycerine, such as buildup in fuel tanks, clogged fuel systems, injector fouling and valve deposits.

3.2 BIODIESEL EXTRACTION METHODS

3.2.1 One step transesterification

For the synthesis of biodiesel, the following materials were used: oil sample (FFM Sdn Bhd), methanol (Merck 99%), and potassium hydroxide (NaOH) as a catalyst (HMGM Chemicals >98%). Methanol and potassium hydroxide were pre-mixed to prepare potassium methox- ide, and then added to oil in the reactor with a mixing speed of 400 rpm for 2 h at 50 °C. The molar ratio of oil to methanol was 1:10. Finally, the mixture was left overnight to settle form- ing two layers, namely: biodiesel phase (upper layer) and the glycerin-rich phase.

3.2.2 Second step transterification

The production methodology followed in this study was according to with some modification, where the alkali-catalyzed transesterifica- tion was applied. Basically, methanol was the alcohol of choice and NaOH was used as the catalyst. Potassium methoxide solution (PMS) was prepared freshly by mixing a pre- determined amount of methanol (≈ 12 wt % of oil) with KOH (≈ 1.0 wt % of oil) in a container until all the catalyst dissolved. The PMS was then added to 200 g of oil and stirred vigorously for 30 min at 30°C. Then after, the mixture was carefully transferred to a separating funnel and allowed to stand for 4 h. the lower layer (glycerol, methanol and most of the catalysts) was drained out. The upper layer (methyl esters MEs, some methanol and traces of the catalyst) was transferred into another flask containing fresh- ly prepared PMS mixed at 60 rpm under reflux at 60oC for 30 min. afterwards; the mix- ture was carefully transferred to a separating funnel and allowed to stand there over night. The glycerol was removed by gravity settling, whereas the obtained crude esters layer was transferred into water bath to remove excess methanol at 65°C and 20 kPa. The obtained crude methyl esters were then cleaned thoroughly by washing with warm (50°C) deionized water, dried over anhydrous Na_2SO_4 , weighted and applied for further analyse.

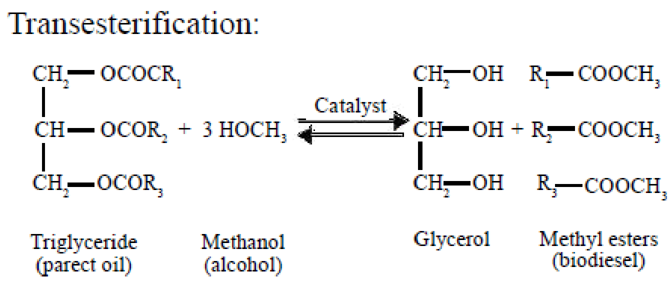


Figure 3.2 Tranesterification process

3.2.3 Qualitative analysis of glycerol

The Borax/phth test is special test for detection on the compound contain two neighboring hydroxyl group as in glycerol organic compound as the following: 1 ml glycerol layer mix with 1 ml of Borax/phth (red color) if the red color disappear in cold and appearing after heating (direct) this positive control.

3.2.4 Fourier transforms infrared spectroscopy (FTIR) analysis

FTIR analysis was performed using instrument, Perkin Elmer, model spectrum one, for de- tection of transesterification efficiency of oil by determination of the active groups produced from these process. The results obtained. found that, two step transterification of oil led to 100 % disappearance of hydroxyl group but this was less than 100 % in case of one step transterification.

3.3 ADVANTAGES OF BIODIESEL

- **Produced from Renewable Resources**: Biodiesel is a renewable energy sourceunlike other petroleum products that will vanish in years to come. Since it is made from animal and vegetable fat, it can be produced on demand and also causes less pollution than petroleum diesel.
- **Can be Used in existing Diesel Engines**: One of the main advantage of using biodiesel is that can be used in existing diesel engines with little or no modifications at all and can replace fossil fuels to become the most preferred primary transport energy source. Biodiesel can be used in 100% (B100) or in blends with petroleum diesel. For e.g.: B20 is called as 20% blend of biodiesel with 80% diesel fuel. It improves engine lubrication and increases engine life since it is virtually sulphur free.
- **Less Greenhouse Gas Emissions** (e.g., B20 reduces CO_2 by 15%): Fossil fuels when burnt release greenhouse gases like carbon dioxide in the atmosphere that raises the temperature and causes global warming. To protect the environment from further heating up, many people have

adopted the use of biofuels. Experts believe that using biodiesel instead of petroleum diesel can reduce greenhouse gases up to 78%.

- **Grown, Produced and Distributed Locally**: Fossil fuels are limited and may not be able to fulfill our demand for coal, oil and natural gas after a certain period. Biodiesel can work as an alternative form of fuel and can reduce our dependence on foreign suppliers of oil as it is produced from domestic energy crops. It is produced in local refineries which reduce the need to import expensive finished product from other countries.
- **Cleaner Biofuel Refineries**: When oil is extracted from underground, it has to be refined to run diesel engines. You can't use it straight away in the crude form. When it is refined, it releases many chemical compounds including benzene and butadiene in the environment which are harmful for animals, plants and human life. Biofuelrefineries, which mainly uses vegetable and animal fat into biofuel releases less toxic chemicals, if spilled or released to the environment.
- **Biodegradable and Non-Toxic**: When Biofuels are burnt, they produce significantly less carbon output and few pollutants. As compared to petroleum diesel, biodiesel produces less soot (particulate matter), carbon monoxide, unburned hydrocarbons, and sulfur dioxide. Flashpoint for biodiesel is higher than 150°C whereas the same is about 52°C for petroleum diesel, which makes it less combustible. It is therefore safe to handle, store and transport.
- **Better Fuel Economy**: Vehicles that run on biodiesel achieve 30% fuel economy than petroleum based diesel engines which means it makes fewer trips to gas stations and run more miles per gallon.
- **Positive Economic Impact** : Biofuels are produced locally and thousands of people are employed in biofuel production plant. Since biodiesel is produced from crops , an increase in demand for biodiesel leads to increase in demand for suitable biofuel crops. Moreover, it creates less emission by reducing the amount of suspended particles in the air. This reduces the cost of healthcare products.
- **Reduced Foreign Oil Dependance**: With locally produced biofuels, many countries have reduced their dependance on fossil fuels. It may not solve all problems in one blow but a nation can save billions by reducing their usage on foreign oil.
- **More Health Benefits**: Air pollution cause more deaths and diseases than any other form of pollution. Pollutants from gasoline engines when released in the air, form smog and make thousands of people sick every year. Biodiesel produce less toxic pollutants than other petroleum products.

3.4 DISADVANTAGES OF BIODIESEL

- **Variation in Quality of Biodiesel**: Biodiesel is made from variety of biofuel crops. When the oil is extracted and converted to fuel using chemical process, the result can vary in ability to produce power. In short, not all biofuel crops are same as amount of vegetable oil may vary.
- **Not Suitable for use in Low Temperatures**: Biodiesel gels in cold weather but the temperature that it will gel depends on the oil or fat that was used to make it. The best way to use biodiesel during the colder months is to blend it with winterized diesel fuel.
- **Food Shortage**: Since biofuels are made from animal and vegetable fat, more demand for these products may raise prices for these products and create food crisis in some countries. For e.g.: the production of biodiesel from corn may raise its demand and it might become more expensive which may deprive poor people from having it.
- **Increased use of Fertilizers**: As more crops are grown to produce biofuels, more fertilizer is used which can have devastating effect on environment. The excess use of fertilizers can result in soil erosion and can lead to land pollution.
- **Clogging in Engine**: Biodiesel cleans dirt from the engine. This proves to be an advantage of biofuels but the problem is that this dirt gets collected in fuel filter and clogs it.
- **Regional Suitability**: Some regions are not suitable for oil producing crops. The most productive crops can't be produced anywhere and they need to be transported to the plants which increases the cost and amount of emission associated with the production and transportation.
- **Water Shortage**: The use of water to produce more crops can put pressure on local water resources. The areas where there is water scarcity, production of crops to be used in making of biofuels is not a wise idea.
- **Monoculture**: Monoculture refers to the practice of producing same crop over and over again rather than producing different crops. While this results in fetching best price for the farmer but it has some serious environmental drawbacks. When the same crop is grown over large acres, the pest population may grow and it may go beyond control. Without crop rotation, the nutrients of soil are not put back which may result in soil erosion.
- **Fuel Distribution**: Biodiesel is not distributed as widely as petroleum diesel. The infrastructure still requires more boost so that it is adopted as most preferred way to run engines.
- **Use of Petroleum Diesel to Produce Biodiesel**: It requires much amount of energy to produce biodiesel fuel from soy crops as energy is needed for sowing, fertilizing and harvesting crops. Apart from that, raw material needs to be transported through trucks which may consume some additional fuel. Some scientists believe that producing one gallon of biofuel needs energy equivalent to several gallons of petroleum fuel.
- **Slight Increase in Nitrogen Oxide Emissions**: Biodiesel has about 10% higher Nitrogen Oxide(NoX) than other petroleum products. Nitrogen Oxide is one the gas that is used in the formation of smog and Ozone. Once it gets dissolved in atmospheric moisture, can cause acid rain.

4. PROPERTIES OF CASTOR AND COTTONSEED OIL

Table 4.1 Properties of castor and cottonseed oil

S. No	PARAMETERS	RESULT OBTAINED FOR CCME	DIESEL
1.	Flash point by PMCC	164°C	52 °C
2.	Fire point by PMCC	174°C	56 °C
3.	Kinematic viscosity @ 40°C	4.78 cst	2.60 cst
4.	Density @15°C	0.8839 gm/ml	0.850 gm/ml
5.	Gross calorific value	7618 Kcal/ kg	4392 Kcal/ kg
6.	Conrad son carbon residue	0.05 %	0.17 %
7.	Ash content	0.01 %	0.01%

5. PERFORMANCE AND EMISSION TEST

Engine performance is an indication of the degree of success with which it does its assigned job *i.e.*, conversion of chemical energy contained in the fuel into useful work. In evaluation of engine performance certain basic parameters are chosen and effect of various operating conditions and modifications on these parameters are studied.

5.1 Basic performance parameters

1. Power and mechanical efficiency
2. Mean effective pressure
3. Volumetric efficiency
4. Thermal efficiency
5. Specific fuel consumption

5.2 Internal combustion research engine

The performance tests were carried out in IC research engine for various proportions of CCME oil diesel blends.

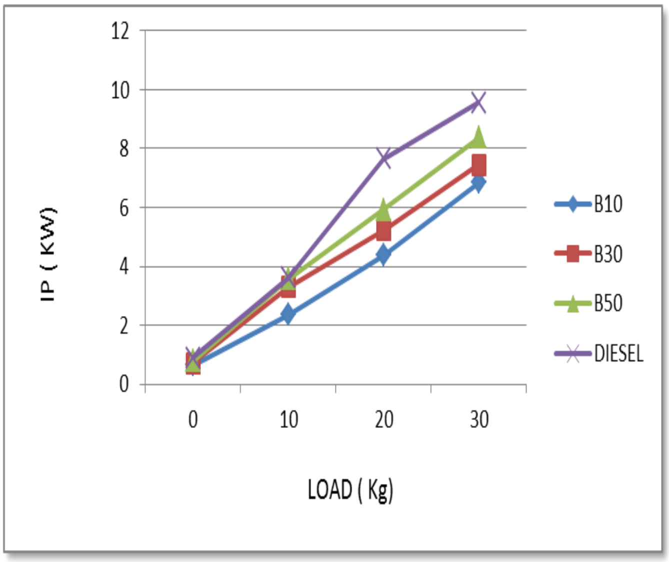
Figure 5.1 Specification of IC research engine

5.3 Data collection

There are four test fuels were used during performance test includes 100 % diesel, 10 % CCME blend with diesel, 30% CCME blend with diesel, 50 % CCME blend with diesel. The following tables shows the obtained data's from performance tests for various CCME Diesel blends such as Brake power, Indicated power, brake mean effective pressure, indicated mean effective pressure, brake thermal efficiency, indicated thermal efficiency, mechanical efficiency, volumetric efficiency, specific fuel consumption, air flow, fuel flow and air fuel ratio

Table 5.1 Indicated power for various CCME Diesel blend

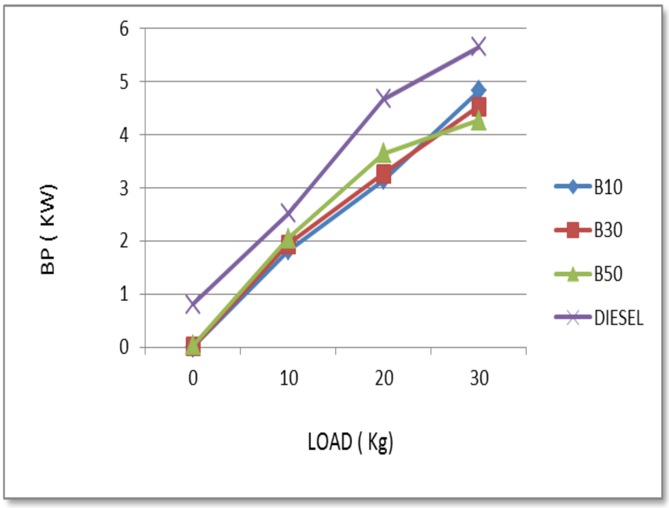
LOAD (kg)	INDICATED POWER (kW)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	0.65	0.72	0.79	0.89
10	2.36	3.29	3.56	3.62
20	4.38	5.23	5.91	7.65
30	6.85	7.45	8.36	9.56



This graph shows how the indicated power is varies for 25 %, 50 %, 75% Castor and Cottonseed methyl ester diesel blends and pure diesel. Indicated power for diesel at 30kg is 9.56 kW. Indicated power for 25 %, 50 %, and 75 % of Castor and Cottonseed methyl ester diesel blend is 6.85, 7.45, and 8.63 kW respectively. It clear that indicated power is decreases if the CCME percentage in fuel is increased.

Table 5.2 Brake power for various CCME Diesel blend

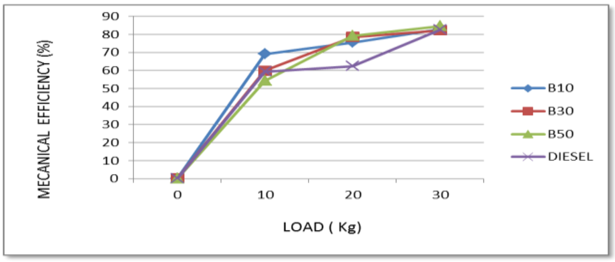
LOAD (kg)	BRAKE POWER (kW)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	0	0.01	0.03	0.8
10	1.82	1.94	2.05	2.51
20	3.14	3.26	3.64	4.67
30	4.82	4.53	4.26	5.64



This shows how the brake power is varies for 25 %, 50 %, 75% Castor and Cottonseed methyl ester diesel blends and pure diesel. Brake power for diesel at 30kg is 5.64 kW. Indicated power for 25 %, 50 %, and 75 % of Castor and Cottonseed methyl ester diesel blend is 4.82, 4.53, and 4.26 kW respectively. It is observed that brake power for different blends is higher as compared to pure diesel.

Table 5.3 Mechanical efficiency for various CCME Diesel blends

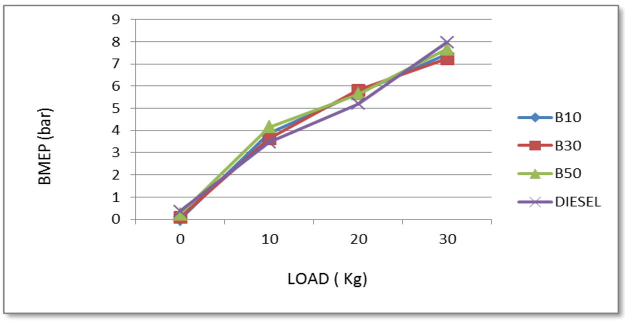
LOAD (kg)	MECHANICAL EFFICIENCY (%)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	0.05	0.07	0.09	0.10
10	69.23	59.86	54.26	59.31
20	75.61	78.56	79.19	62.35
30	83.01	82.36	84.65	82.56



The comparisons of CCME diesel blends with pure diesel are shown in figure. Mechanical efficiency for pure diesel at 30kg load is 82.56 %. The same for 25 %, 50 %, and 75 % CCME diesel blends are 83.01 %, 82.36%, and 84.56% respectively. It is observed that for all CCME diesel blends mechanical efficiency is higher when compared to pure diesel. It is also observed that the mechanical efficiency is decreased from 83.01 to 82.36 % for 50% CCME diesel blend from 25 % CCME diesel blend and again it is increased to 82.56 % for 75 % CCME diesel blend.

Table 5.4 Brake mean effective pressure for various CCME Diesel blends

LOAD (kg)	BRAKE MEAN EFFECTIVE PRESSURE (%)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	0	0.1	0.23	0.36
10	3.89	3.63	4.16	3.46
20	5.68	5.82	5.64	5.19
30	7.45	7.23	7.68	7.98



The variation of brake mean effective pressure for various CCME diesel blend and pure diesel is shown in figure. Mean effective pressure for pure diesel at 30kg load is 7.98 bar. The same for 25 %, 50 %, and 75 % CCME diesel blends are 7.45, 7.23, and 7.68 bar respectively. It is observed that for 75% CCME brake mean effective pressure is higher as compared to diesel after that it is decreases for 25 % and 50 % CCME gradually.

Table 5.5 Indicated mean effective pressure for various CCME Diesel blends

LOAD (kg)	INDICATED MEAN EFFECTIVE PRESSURE (kW)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	3.25	3.15	2.87	1.65
10	6.75	6.98	6.94	6.21
20	7.54	8.12	8.54	9.02
30	9.26	9.54	9.66	10.09

The variation of indicated mean effective pressure for various CCME diesel blend and pure diesel is shown in figure. Indicated mean effective pressure for pure diesel at 30kg load is 10.09 bar. The same for 25 %, 50 %, and 75% CCME diesel blends are 9.26, 9.54, and 9.66 bar respectively. It is observed that indicated mean effective pressure is decreases if CCME diesel blend is increases.

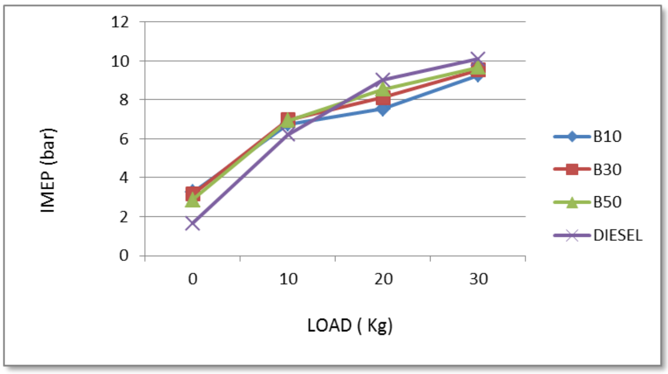
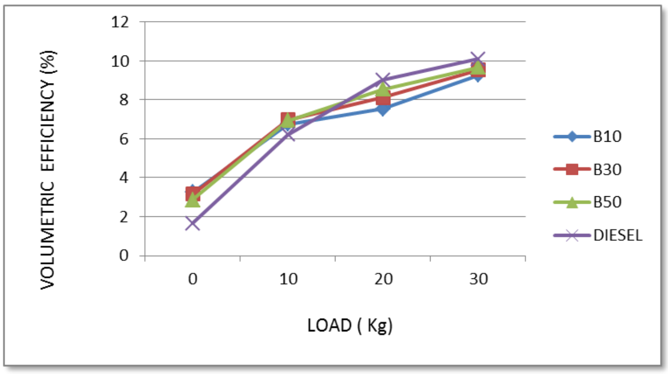


Table 5.6 Volumetric efficiency for various CCME Diesel blends

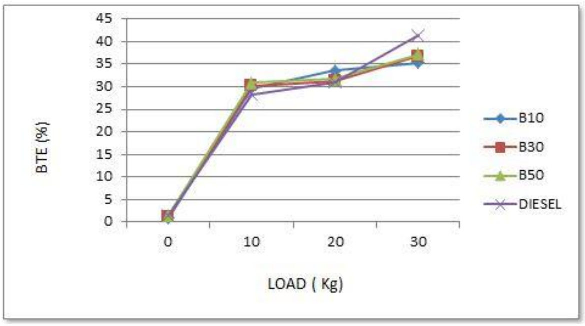
LOAD (kg)	VOLUMETRIC EFFICIENCY (%)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	78.23	78.54	78.12	79.84
10	77.28	77.34	77.75	77.44
20	76.25	76.56	76.09	75.89
30	75.68	75.16	74.26	73.36



The variation of volumetric efficiency with load is shown in Figure. It can be observed from the figure that the volumetric efficiency is 73.36 % at 15kg for diesel. However when the engine is fuelled with CCME-diesel blends such as 25% CCME, 50% CCME, and 75% CCME, It gives the volumetric efficiency of 75.68%, 75.16% and 74.26%, respectively at full load. It is observed that the volumetric efficiency of the Castor and Cottonseed methyl ester blend is closer or slightly higher to diesel except 25% CCME diesel blend.

Table 5.7 Brake thermal efficiency for various CCME Diesel blends

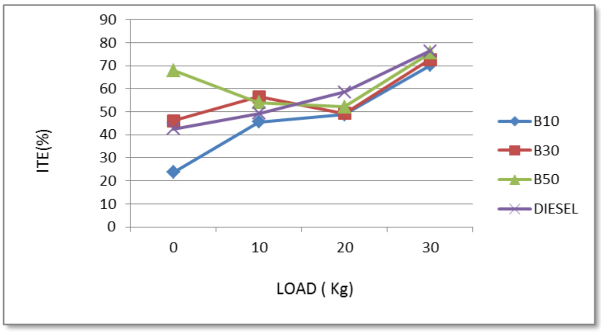
LOAD (kg)	BRAKE THERMAL EFFICIENCY (%)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	1.04	1.23	1.56	1.49
10	29.65	30.26	30.93	28.31
20	33.53	31.25	31.63	31.02
30	35.36	36.82	37.26	41.36



The variation of brake thermal efficiency with load is shown in Figure. It can be observed from the figure that the thermal efficiency is 41.36% at 30kg load for diesel. However when the engine is fuelled with CCME-diesel blends such as 25% CCME, 50% CCME, 75% CCME, it gives the thermal efficiency of 35.36%, 36.82%, 37.26%, respectively at 30kg load. It is also observed that brake thermal efficiency is higher for 25% and 75% CCME Diesel blends and it is slightly lower for 50 % CCME Diesel blend when compared to pure diesel.

Table 5.8 Indicated thermal efficiency for various CCME Diesel blends

LOAD (kg)	INDICATED THERMAL EFFICIENCY (%)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	23.76	46.14	67.93	42.53
10	45.54	56.60	53.96	49.21
20	48.82	49.36	52.16	58.47
30	70.14	72.64	75.62	76.35



The variation of indicated thermal efficiency with load is shown in Figure. It can be observed from the figure that the indicated thermal efficiency is 76.35 % at 30kg load for diesel. When the engine is fueled with CCME diesel blends such as 25% CCME, 50% CCME, and 75% CCME, it gives the thermal efficiency of 70.14%, 72.64%, and 75.62% respectively at 30kg load. It is also observed that indicated thermal efficiency is also higher for 50% and 75% blends and it is slightly lower for 25% CCME Diesel blend when compared to pure diesel.

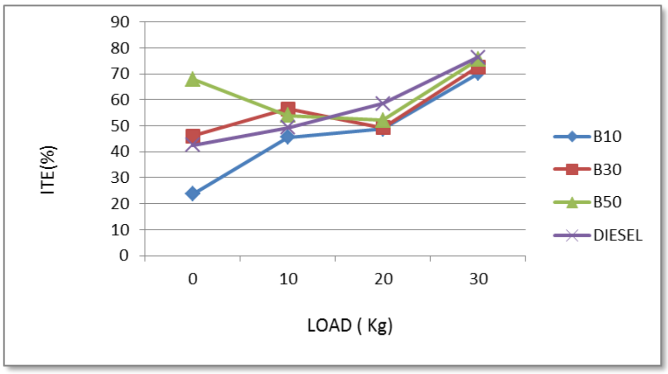
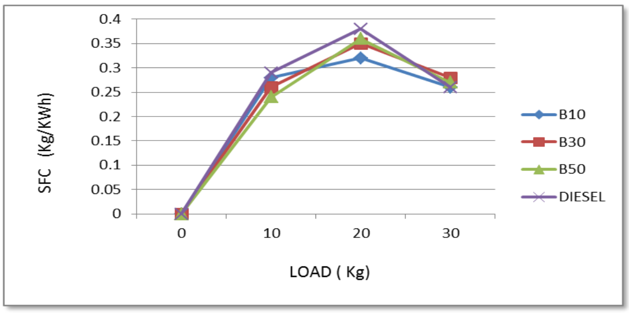


Table 5.9 Specific fuel consumption for various CCME Diesel blends

LOAD (kg)	SPECIFIC FUEL CONSUMPTION (kg/kWh)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	0.00	0.00	0.00	0.00
10	0.28	0.26	0.24	0.29
20	0.32	0.35	0.36	0.38
30	0.26	0.28	0.27	0.26



The variation of specific fuel consumption with load is shown in Figure. It can be observed from the figure that the specific fuel consumption is 0.26kg/kWh at 30kg load for diesel. When the engine is fueled with CCME diesel blends such as 25% CCME, 50% CCME and 75% CCME, its specific fuel consumption is 0.26 and 0.28 kg/kWh, and 0.27 kg/kWh respectively at 15kg load. It is also noted that the specific fuel consumption is decreased for 25 % and 50% CCME Diesel blends and it is equal for 75 % CCME Diesel blend when compared to diesel.

6. EMISSION TEST

6.1 Types of Emission

1. Carbon monoxide (CO)

2. Hydrocarbons (HC)
3. Carbon dioxide (CO_2)
4. Oxygen (O_2)
5. Nitrogen oxide (NO_X)

Table 6.1 carbon monoxide (CO) for various CCME Diesel blends

LOAD (kg)	CARBON MONOXIDE (CO)(% BY VOLUME)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	0.08	0.07	0.06	0.09
10	0.09	0.09	0.08	0.10
20	0.10	0.10	0.12	0.12
30	0.16	0.13	0.17	0.18

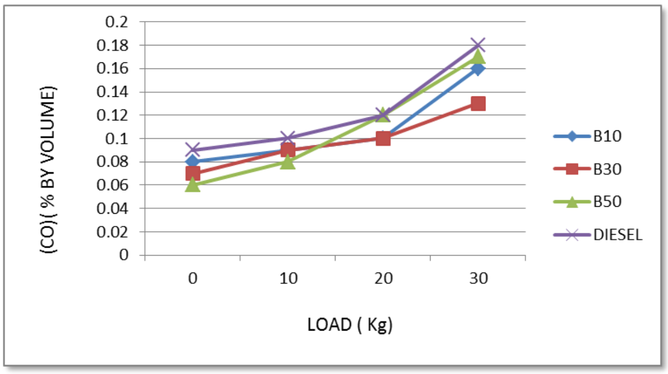


Table 6.2 hydrocarbons (HC) for various CCME Diesel blends

LOAD (kg)	HYDROCARBONS (HC) (ppm)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	55	60	61	83
10	57	62	63	100
20	62	61	66	102
30	71	74	76	106

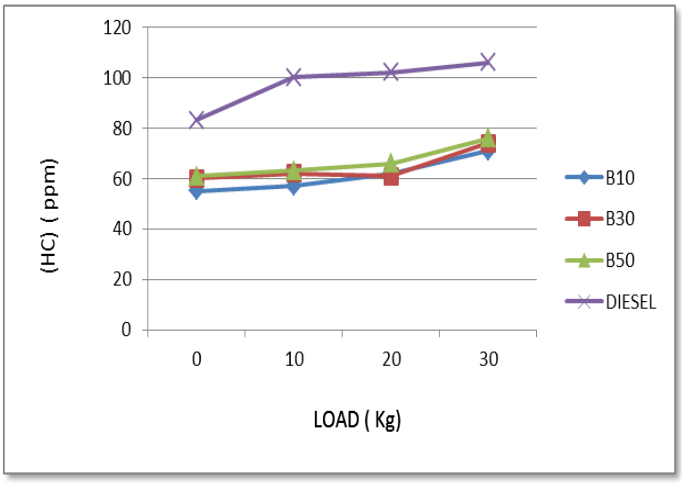


Table 6.3 Carbon dioxide (co_2) for various CCME Diesel blends

LOAD (kg)	CARBON DIOXIDE (CO_2) (% BY VOLUME)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	2.56	2.52	2.36	2.42
10	3.02	3.06	3.30	3.62
20	3.06	4.08	4.16	4.02
30	5.23	6.12	5.08	5.73

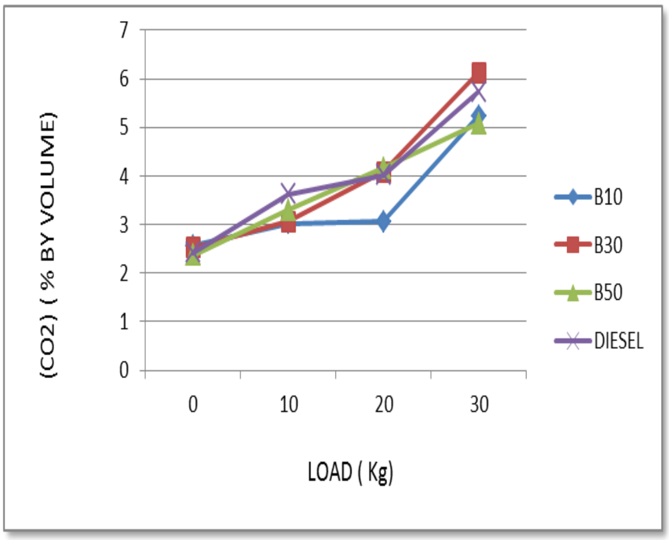


Table 6.4 Oxygen (O_2) for various CCME Diesel blends

LOAD (kg)	OXYGEN (O_2) (% BY VOLUME)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	19.23	19.26	20.56	27.23
10	17.28	16.25	18.25	25.62
20	16.94	15.96	14.32	23.82
30	15.36	14.27	12.56	20.64

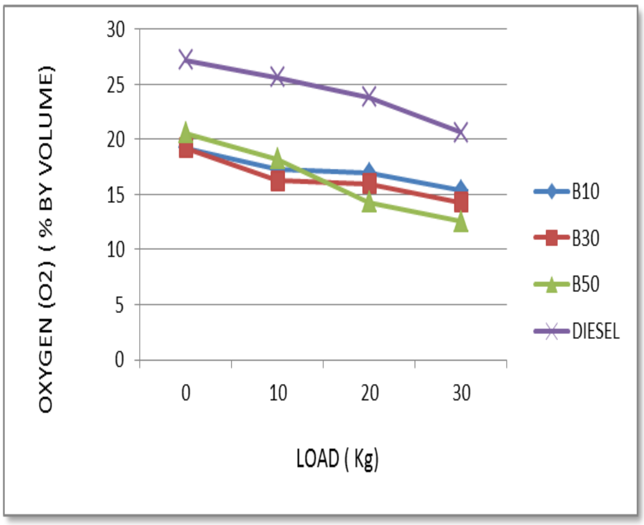
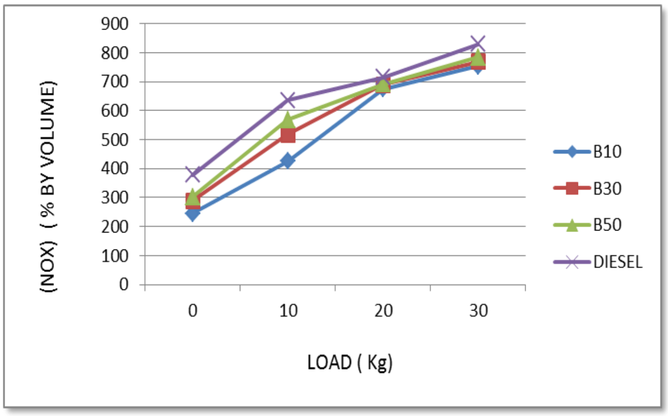


Table 6.5 Nitrogen oxide (NO_X) for various CCME Diesel blends

LOAD (kg)	NITROGEN OXIDE (NO_X) (% BY VOLUME)			
	25 %CCME Diesel blend	50%CCME Diesel blend	75 %CCME Diesel blend	Diesel
0	246	289	302	378
10	426	518	569	636
20	674	689	692	715
30	754	769	784	829



7. CONCLUSION

In my project work to study the performance and Emission test on castor and cottonseed biodiesel and its different blends with diesel and find the optimum blend to be used in diesel engine. B50 show the overall optimum performance when used in Compression ignition engine. Also it is found that overall performance characteristics of castor and cottonseed oil biodiesel and diesel are similar. Hence, Use of castor and cottonseed biodiesel will increase the use of waste land and will generate rural employment. The Local production of biodiesel will save a huge amount of foreign exchange. This capital when invested in country will improve its financial structure.

8. REFERENCES

[1].S. Chandra Sekhar ,K.Karuppasamy, K.Sathiyamoorthy (2017) 'Study on Optimization of Cottonseed oil Transesterification Process' Vol. 10 No.5, 122-130.

[2]. AllenJeffrey.J KiranKumar.S, and Antonynishanthraj Arivoli.N (2017) ' Experimental Analysis of Cotton Seed oil Biodiesel in a Compression Ignition Engine' Volume: 06 Issue: 03, pp. 65-81

[3]. Hariram Venkatesan , Godwin John , Seralathan Sivamani (2017)' Cotton Seed Biodiesel as Alternative Fuel: Production and its Characterization Analysis using Spectroscopic Studies' Volume 7, Issue 3, pp. 23-10

[4]. Orijajogun Joyce Omohu, Ayegba Clement Omale (2017) 'Physicochemical Properties and Fatty Acid Composition of Castor Bean Ricinus communis L. Seed Oil' Volume 5, Issue 4, pp 62-65.

[5]. Kamisah D. Pandiangan, Novesar Jamarun (2016) 'Transesterification of Castor oil using MgO/SiO2 Catalyst and Coconut oil as Co-reactant' Vol. 32, Issue 1, pp: (385-390).

[6]. S. S. Ingle , V. M. Nandedkar (2016) 'Castor oil Biodiesel an alternative fuel for Diesel in Compression Ignition Engine' Volume 12, Issue 4 PP.10-13.

[7]. Gopal BV, Sridevi V , Sarma AJN and Rao PV (2015) ' Processing and Characterization of Cotton Seed Methyl Ester' Volume 7, Issue 5, pp 673-676.

[8]. Vineet Kumar, Manish Jain, Amit Pal (2015) 'Green Product of Liquid Fuel from Plastic Waste by Pyrolysis at 900 °C' Vol. 9, Issue 2, pp: 40-44.

[9]. A.K. Yusuf, P.A.P. Mamza, A.S. Ahmed and U. Agunwa (2015) 'Extraction And Characterization Of Castor Seed Oil From Wild Ricinus Communis LinN' Vol. 5, No. 4, pp 1392-1404.

[10]. Ajaygiri K. Goswami1, G. A. Usmani (2014) 'Study of Process Parameters of Biodisel Production from Cottonseed Oil' vol 66 issue 4 PP 66-21.

[11]. Yogendra Prasad Upadhyay, Mr. R. B. Sharma, and Dr. Amit Pal (2013) 'An Experimental Study On Biodiesel Production Of Cotton Seed Oil Through Conventional Method' Vol. 2 Issue 7, pp 2349-4476.

[12]. Sumedh S. Ingle, Vilas M. Nandedkar, Madhav V.Nagarhalli (2013) 'Prediction of Performance and Emission of Castor Oil Biodiesel in Diesel Engine., vol.1 (1), pp.63-67.

[13]. Deshpande D.P.1, Urunkar Y.D. and Thakare P.D.. (2012) 'Optimization of Process Parameters for Castor Oil Production, ISSN : 2277-4106, Vol. 4, No. 6.

[14]. C. L. Peterson, J. C. Thompson, J. S. Taberski, D. L. Reece, and G. Fleischman (2011) 'Experimental study on the performance of C.I. diesel engine using plastic pyrolysis oil blends with pure diesel', IJERT ISSN: 2278-0181, vol. 1 Issue 6.

[15]. G. Schumacher, S. C. Borgelt, and W. G. Hires (2010) 'Catalytic pyrolysis of plastic wastes with different types of catalysts: ZSM-5 zeolite and red mud' Applied Catalyst B: Environmental 104, pp.211-219.

[16]. P.-q. Tan, Z.-y. Hu, D.-m. Lou, (2010) 'Catalytic processing of coal and petroleum residues with waste plastics to produce transportation fuels', Fuel Processing Technology 92, pp.1109-1120.

[17]. Siva Kumar.A, Maheswar.D, Vijaya Kumar Reddy.K (2009) ' Comparision of Diesel Engine Performance and Emissions from Neat and Transesterified Cotton Seed Oil Vol. 3(3), pp.190-197.

[18]. M.P. Sharma (2009) 'Experimental evaluation of diesel engine with blends of Diesel-Plastic pyrolysis oil', International Journal of Engineering Science and Technology (IJEST), ISSN: 0975-5462 Vol. 3 No. 6.

[19]. Crabbe E, Nolasco Hipolito CN, Kobayashi G, Sonomoto K,Ishizaki A (2008) 'production and characteristics of castor oil', vol.3(2), pp.161-165.