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*Review Article*

# Performance Evaluation of C.I. Engine using Castor Oil: A Review

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***Abstract***

*The demand of the petroleum products are increasing day by day. So we need to look for alternative options to bridge this gap of increased consumption of fuel. The attempt is being made to reduce the consumption of Non-Renewable fuel by adding some vegetable oils in them. We can use edible and non-edible vegetable oil as a raw material for biodiesel. This can be achieved by transestersification reaction of vegetable oils with alcohol such as methanol and ethanol. The bio-diesel is blended with diesel as an alternative option. This paper focuses on comparison of engine performance by using various blends of fuel (B10, B20, B30, etc.). So various parameter of performances are studied keeping in mind reduction in consumption and environmental safety by controlling the exhaust emissions.*

***Keywords:*** *Biodiesel, Blends, Castor oil, Performance, Emissions, Transestersification.*

## 1. Introduction

Rudolph Diesel, the inventor of the Diesel engine experimented with fuels ranging from powdered coal to peanut oil. In the late 20th century, the cost of petroleum products increased at faster rate and the fuel reserves were depleting. In the late 70's USA started the production of biodiesel to fulfill the needs of petroleum products. This paper represents a brief study of diesel engine performance and an overview of biodiesel. Due to increased prices of fuels and lesser availability of commercial products, biodiesel is an emerging idea of high concern. The world was facing the problems like environmental degradation and fossil fuels depletion. So, Vegetable oil is a promising alternative to petroleum products. The economic feasibility of bio-diesel depends on the price of crude petroleum and the cost of transporting diesel over long distances to remote areas. The fuel properties of biodiesel such as cetane number, gravity, heat of combustion and viscosity influences the combustion and the engine performance and emission characteristics because it has different physical and chemical properties than petroleum based diesel fuel.

### *1.1 Biodiesel*

Biodiesel, a biodegradable and renewable form of energy, emitting less carbon monoxide, sulphur compounds, particulate matter is usually composed of fatty acid methyl esters formed by transestersification of renewable triglycerides such as vegetable oils and animal fats with methanol. Edible vegetable oils such as palm oil, sunflower oil, rapeseed oil and soybean oil are generally suitable feedstock for biodiesel production (P. Ranjith Kumar *et al*. 2013). Biodiesel is made from vegetable sources which may be edible or non-edible. It does not contain any sulphur, aromatic hydrocarbons, metals or crude oil residues. Biodiesel is an oxygenated fuel for which emissions of carbon monoxide and soot tend to be reduced compared to conventional fuel. Unlike fossil fuels, biodiesel does not contribute to global warming. Thus $CO_2$ balance is maintained. The use of biodiesel can extend the life of diesel engines as it is more lubricating than petroleum diesel fuel. Biodiesel is produced from renewable vegetable oils/animal fats and hence improves fuel or energy security and economy independence (Onkar V. Dixit *et al*. 2015).

### *1.2. Castor seed oil*

Castor oil is non-volatile fatty oil taken from beans of the plants. It ranges in color from colorless to greenish. It has two derivatives such as blown castor and hydrogenated oil. Castor oil used in textiles, paints, varnishes, plastics, cosmetics, fibers, hair oils and drying oils. It is also used for traditional and medical treatment purposes (Debiprasad Behera *et al*., 2010). The castor oil is produced by transestersification process. The seeds contain between 40% and 60% oil that is rich in triglycerides, mainly ricinolein. The seeds are contains ricin, toxin, which is also present in lower concentrations throughout the plant. The toxicity of raw castor beans due to the presence of ricin a poisonous substance. The toxin provides the castor oil

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plant with some degree of natural protection from insect pests (R. Sattanathan *et al*., 2015).

*1.3. Castor oil blend*

Castor oil is mixed with diesel to prepare its blend. The Table 1 shows properties of samples of prepared blend.

**Table 1** Properties of blend

| Properties | Diesel | B25 | B50 | B75 | B100 |
|---|---|---|---|---|---|
| Density ($kg/m^3$) | 845.0 | 868.4 | 891.8 | 912.5 | 945.2 |
| Flash Point ($^0C$) | 68 | 89.7 | 134 | 167 | 189.4 |
| Cloud Point ($^0C$) | - | -5 | -9 | -14 | -19 |
| Pour Point ($^0C$) | -6 | -15 | -27 | -31 | -35 |
| Kinematic Viscosity ($mm^2/s$) | 3.51 | 4.82 | 7.85 | 13.7 | 16.5 |
| Specific gravity | 0.845 | 0.868 | 0.891 | 0.912 | 0.954 |

## 2. Literature Survey

P. Ranjith Kumar *et al*., (2013) studied and compared the Performance of castor and mustard oil with diesel in a single and twin cylinder kirloskar diesel engine, the paper focuses on use of castor and mustard oil based biodiesel as an alternative fuel in future. For experimentation blends of castor oil and mustard oil have been prepared and tested for single and twin cylinder kirloskar engine. They found that the specific fuel consumption of castor oil based biodiesel is less than diesel and mustard oil and brake thermal efficiency is higher than the other two fuels for both single as well as twin cylinder engine, also the blend percentage for better performance to be 20% blend and 80% diesel.

Onkar V. Dixit *et al*., (2015) published a review paper on Efficiency improvement and reduction in emission by using blended vegetable oil biodiesel in CI engine. They focuses on the various biodiesel that can be used as fuel in CI engine like castor seed oil, neem oil, sunflower seed oil etc., its manufacturing and properties of this edible oil. After experimentation they found that the performance of engine could be satisfactorily increased by blending the Sunflower, Mustard and Castor oil biodiesel in diesel with 5%, 10% and 15% proportions and ascertain best blend of biodiesel from comparing it with diesel performance. The emissions using the biodiesel could be satisfactorily reduced; the CO, CO2 and HC reduce while the NOx emissions should increase because of higher oxygen content and higher exhaust gas temperature as compared to that with diesel.

P. V. Ramana *et al*, (2015) studied engine performance using biodiesel blends. The study contains overview of biodiesel, its preparation and experimentation. The experiment was conducted on a single cylinder kirloskar av-1 diesel engine having a rated power of 3.7 kW at 1500 RPM whose compression ratio is 16.5:1. The electrical dynamometer is used and engine is water cooled. The blends of fuel B10, B20, B30 are prepared and fueled in the engine and trial is conducted for each blend at 1500 RPM. According to the results obtained, graphs were plotted. From the performance and emission characteristic of engine it is observed that brake thermal efficiency increases with increasing biodiesel concentration but $CO_2$ emissions decreased with increasing blend concentration, also emissions are on the lower side for all the biodiesel blends as compared to pure diesel.

R. Sattanathan, (2013) studied the production of biodiesel from castor oil with its performance and emission test, the study focuses on testing of engine by using the blends of castor oil. The blends of fuel B25, B50, B75, B100 are prepared and fueled into 4 strokes, single cylinder, water cooled, direct injection engine whose compression ratio is 17.5:1. The performance as well as emission characteristic of the engine have been studied and found that the brake power of biodiesel was nearly same as with diesel engine, while specific fuel consumption was higher than diesel. Also emission of hydrocarbon and smoke for biodiesel is less than that of the diesel.

Debiprasad Behera, (2010) from NIT, Rourkela submitted a thesis of Study on the performance and emission characteristics using castor and mustard seed oil mixture and diesel blend in CI engine in which overview of fuel selection and properties of castor oil is done. He carried out a trial on a 4 strokes, twin cylinder, water cooled, direct injection, 3.7 kW power kirloskar TV1 engine having a bore diameter of 80 mm and stroke 110 mm whose compression ratio is 17.5:1. He prepared blends of castor oil with diesel i.e. B10 (10% castor oil and 90% diesel), B20, B30 etc. to be used as fuel for the engine. Each blend is fuelled to engine and then readings are noted down. He then draw performance and emission characteristic for each blend and found that 10% blending (B10) gives optimum result for performance as well as emission, so it can be used as alternative fuel.

S. S. Ingle *et al*., (2010) studied castor oil biodiesel as alternative fuel for diesel in compression ignition engine. The study focuses only on the performance characteristic of engine using castor oil, they have not considered emission characteristic of engine while using a particular fuel. For experimentation blends of castor oil B100, B80, B60, B40, B20, B0 are prepared and fueled in engine. The engine is single cylinder, 4 strokes cycle, single acting, totally enclosed, water cooled, compression ignition engine, then engine is trial ran at an average speed of 1500 RPM. According to the results obtained graphs of BTE (Brake thermal

efficiency) and load, BSFC (Brake specific fuel consumption) and load, $m_f$ (Fuel consumption kg/hr.) and load are plotted. From graph it is concluded that B80 shows the overall optimum performance when used in compression ignition engine, also overall performance characteristic of castor oil biodiesel and diesel are similar. Hence, use of castor biodiesel will increase the use of waste land and will generate rural employment.

M. P. Sudesh Kumar *et al*., (2015) reviewed vegetable derived biodiesel fuel as an alternative fuel for diesel engine. The review was done in order to search for an alternative fuel that can easily replace diesel. They investigated various fuels like methyl ester of paradise oil, eucalyptus oil, jatropha oil, linseed oil, waste cooking oil, linseed oil, mustard oil, castor oil, etc. and analyzed the test results of each vegetable derived oil. They found that the thermal efficiency of some of the biodiesel may increase or decrease whereas due to high oxygen content there is reduction in emission, the study suggested that it is possible to convert vegetable oils into biodiesel which has similar properties to diesel and can be used as fuel in existing unmodified diesel engines without any difficulty and also replace the diesel fuel in the near future.

## Conclusions

Castor seed plant can easily grow on waste land, so manufacturing of castor seed can be increased by using waste land for their growth, this will help in employment in the rural areas also increases the percentage of useful lands in country. Also extraction of castor oil from seed is easy. The castor seed oil can be directly used in engine without any modification by proper blending with diesel, the blending percentage should range from 80 to 95% diesel in order to have optimum result for performance as well as emission.

Though castor oil on its own cannot fully used in the engine but certainly some amount of fuel is getting saved by the use of castor oil by its addition with diesel. Biodiesel produced from castor oil gives optimum results in terms of performance as well as emission, so it can be viewed as future replacement for diesel.

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