# Improvement Of Fuel Properties Of Thumba Biodiesel On Single Cylinder Diesel Engine

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***Abstract***

An increasing demand of fossil fuels has being a critical problem for us. The natural resources of fossil fuel are dwindling day by day. Biodiesel that may called natural fuel may be a good source or substitute for fossil fuel in future. Biodiesel can be produced from non-edible oil like pongamiapinnata, Madhucaindica, Gossypiumarboreum, Simaroubaglauca etc. and more. There is a best source as a raw material that is Citrullus Colocynthisschard (Thumba) oil for biodiesel production. As it is anclimber and grows wild in western part of Rajasthan. Our study is focused on the collection of seeds and oil extraction then proceed for biodiesel production with molar ratio 8:1, KOH were 0.75wt%, temperature 65°c, reaction time 90 minutes were used and testing of parameters as per ASTM 6751 standards. The physical properties like acid value, density, Calorific value, Flash point, Fire point and Moisture, Viscosity of Thumba methyl ester (TME) were 0.42,0.870gm/cc, 37.00MJ/Kg, 1640c, 1720c and 0.02%, found. The process variables that influence the trans-esterification of triglycerides, such as catalyst concentration, molar ratio of methanol to raw oil, reaction time, reaction temperature, and free fatty acids content of raw oil in the reaction system were investigated and optimized. It was concluded that TME may works as a sustainable feedstock for biodiesel production that is equivalent to fissile fuel as per ASTM 6751.

***Keywords* : Biodiesel, Calorific Value, Molar ratio, Trans-esterification, Viscosity**

## I. INTRODUCTION

The concept using vegetable oil as a fuel dates back to 1895 when Dr. Rudolf Diesel developed the first diesel engine to run on vegetable oil. Rudolf Diesel Sated: “the use of vegetable oil for engine fuels may seem insignificant today. But such oil may become in source of time as important as petroleum & the coal tar products of the present time Biodiesel is a non-petroleum based fuel defined as fatty acid methyl ethyl esters derived from vegetable oil or animal fats & it is used in diesel engines & heating systems. Thus this fuel could be regarded as mineral diesel substitute with the advantage of reducing greenhouse emissions because it is renewable resource.1Mostly biodiesel is prepared from oils like soybean, sunflower, rap seed etc. throughout the world. Depending on the climate and soil conditions, different nations looking into different vegetable oils for diesel fuel substitute; soybean oil in USA, sunflower and rapeseed oil in Europe, palm oil in Malaysia and coconut oil Philippines are being considered as substitutes for diesel fuel seed oil. The extracted oil could not be used directly in diesel because of its higher viscosity. High viscosity of pure vegetable oil would reduce the fuel atomization and increase the fuel spray penetration, which would be responsible for high engine deposits and thickening of lubricating oil. The use of chemically altered vegetable oil called biodiesel does not require modification in engine or injection system or fuel.

## II. OBJECTIVES

The main objective of this project is to improve the fuel properties of biodiesel and obtain higher Cetane number with less monoxide emissions.carbon

## III.METHODOLOGY

The following section will discuss experimental equipment, the set-up and test procedures. Lastly, the procedures followed for the data analysis will be outlined and discussed. Experiments were performed in the internal combustion engine laboratory, department of mechanical engineering, G.H. Raisoni College of Engineering, Chas, Ahmedangar.

**Preparation of Thumba Methyl Ester (Biodiesel)**

**Pretreatment**

In this method, the jatropha oil is first filtered to remove solid material then it is preheated at 110° C for 30 min to remove moisture (presence of moisture responsible for saponification in the reaction). After de-moisturisation of oil we removed available wax, carbon residue, un-saponificable matter and fiber that are present in a very small quantity and carried out some important tests for available free fatty acids oil.

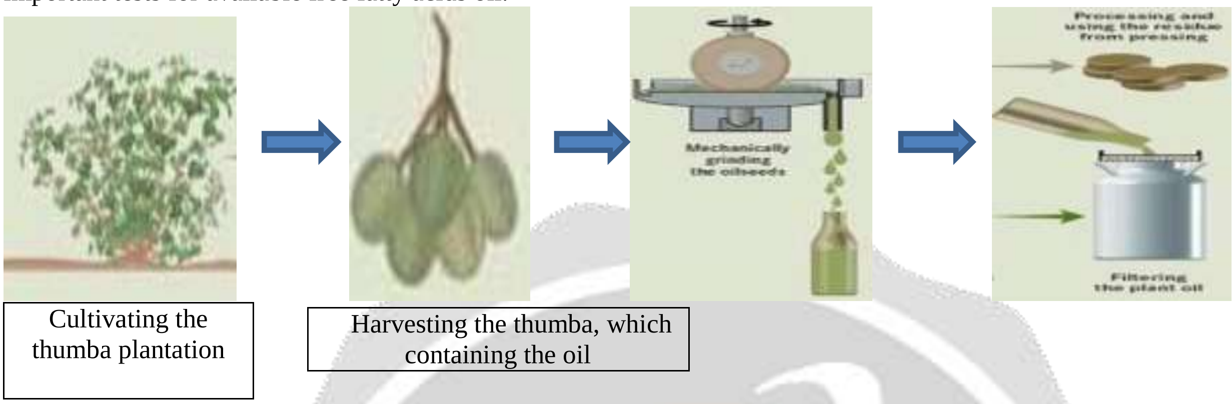



**Figure 1. Pretreatment of Thumba Oil**


**Figure 2. Flow Chart for Trans-esterification of Thumba Crude Oil**

**Esterification**

Thumba oil contains 6%-20% (wt.) free fatty acids. The methyl ester is produced by chemically reacting thumba oil with an alcohol (methyl), in the presence of catalyst. A two stage process is used for the transesterification of thumba oil. The first stage (acid catalyzed) of the process is to reduce the free fatty acids (FFA) content in thumba oil by esterification with methanol (99% pure) and acid catalyst sulfuric acid (98% pure) in one hour time at 57oC in a closed reactor vessel. The thumba crude oil is first heated to 50oC and 0.5% (by wt.) sulfuric acid is to be added to oil then methyl alcohol about 13% (by wt.) added. Methyl alcohol is added in excess amount to speed up the reaction. This reaction was proceed with stirring at 650 rpm and temperature was controlled at 55-570C for 90 min with regular analysis of FFA every after 25-30 min. When the FFA is reduced up to 1 %, the reaction is stopped. The major obstacle to acid catalyzed esterification for FFA is the water formation. Water can prevent the conversion reaction of FFA to esters from going to completion. After dewatering the esterified oil was fed to the trans esterification process. up to 1 %, the reaction is stopped. The major obstacle to acid catalyzed esterification for FFA is the water formation. Water can prevent the conversion reaction of FFA to esters from going to completion. After dewatering the esterified oil was fed to the trans esterification process.

**Figure 3. Esterification**

**Experimental Setup**

The experimental set up is shown. A 2000 ml three necked round –bottom flask was used as a reactor. The flask was placed in heating mantle whose temperature could be controlled within +20C. One of the two side necks was equipped with a condenser and the other was used as a thermo well. A thermometer was placed in the thermo well containing little glycerol for temperature measurement inside the reactor. A blade stirrer was passed through the central neck, which was connected to a motor along with speed regulator for adjusting and controlling the stirrer speed. 1000ml of Thumba oil was measured using measuring cylinder, then poured into a 2000 ml three necked round bottom flask. This oil was heated upto 600C. In 250ml beaker a solution of potassium methoxide was prepared using 5g (catalyst concentration 0.5%) sodium hydroxide pellet and 214 ml (mole ratio of methanol to oil, 1:6) of methanol. The solution was properly stirred until the potassium hydroxide pellet was completely dissolved. The solution was then heated up to 600C and slowly poured into the biodiesel removed. The process flow chart is shown in preheated oil. The mixture was stirred vigorously for one half hour. Finally FFA was checked and mixture was allowed to settle for 24 hours.

**Trans-esterification Reaction**

Trans-esterification or biodiesel was decanted into a separate beaker while the lower alcoholics is the displacement of alcohol from an ester by layer which comprised glycerol and soap was collected from the another in a process similar to hydrolysis, except an alcohol is bottom of separating funnel. To remove any excess glycerol and used instead of water. Soap from the biodiesel, hot water was used to wash it and then allowed it to remain in separating funnel until clear water was this process has been widely used to reduce the high viscosity seen below the biodiesel in the separating funnel. The pH of triglycerides. The trans-esterification reaction is represented biodiesel was then checked. The washed biodiesel sample was then dried by placing it on a hot plate and excess water still in the biodiesel removed. Trans-esterification or Alcoholics is the displacement of alcohol from an ester by another in process similar to hydrolysis except an alcohol is used instead of water. This process has been widely used to reduce the high viscosity of triglycerides. The trans-esterification reaction is presented by general equation. a separating funnel.

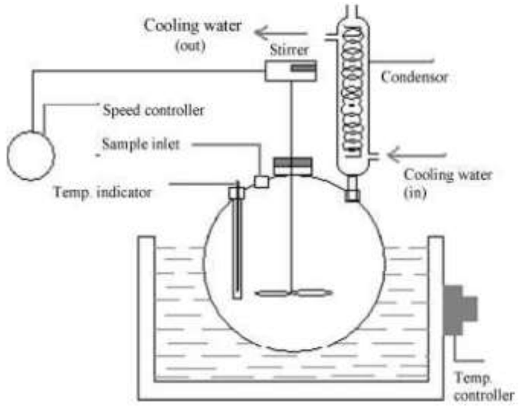



**Figure 4. Experimental Setup for Trans esterification of thumba Crude Oil**

Some feedstock must be pretreated before they can go through conversion. In the present work the reaction is conducted in the trans-esterification process. Feedstock with less than 5 % presence of base catalyst 23. The mechanism of alkali-catalyzed Free Fatty Acid, may not require pretreatment. When an alkali trans-esterification is described below. The first step involves the catalyst is added to the feedstock's (With FFA > 5 %), the Free attack of the alkoxide ion to the carbonyl carbon of the Fatty Acid react with the catalyst to form soap and water as triglyceride molecule, which results in the formation of shown in the reaction below: tetrahedral intermediate. The reaction of this intermediate with an alcohol produces the alkoxide ion in the second step. In the If methane is used in this process it is called methanolysis. Last step the rearrangement of the tetrahedral intermediate gives Methanolysis of glyceride is represented.

**Effect Of Various Parameter On Biodiesel**

**Effect of moisture and water content on the yield of biodiesel**

Kusdiana and Sakaobserved that water could pose a greater negative effect than presence of free fatty acids and hence the feedstock should be water free. Romano and Canacki and Van Gerpen insisted that even a small amount of water (0.1%) in the transesterification reaction would decrease the ester conversation from vegetable oil. Demirbas too reported a decrease in yield of the alkyl ester due to presence of water and FFA as they cause soap formation, Consume catalyst and reduce the effectiveness of catalyst Srivastava and Vermaremoved the moisture content from the vegetable oil by heating in oven for 1 h at 383 K.Meher et al. too reported a precautionary step to prevent moisture absorbance and maintenance of catalyst activity by preparing the fresh solution of potassium hydroxide and methanol. Ellis et al. found that even a small amount of water in the feedstock or from esterification reaction producing water from FFA might cause reduction in conversion of fatty acid methyl ester and formation of soap instead

**Effect of free fatty acids**

Free fatty acids (FFAs) content after acid esterification should be minimal or otherwise less than 2% FFAs. These FFAs react with the alkaline catalyst to produce soaps instead of esters.

**Effect of temperature**

The temperature maintained by the researchers during different step range between 60-65oc.It is near to boiling point of methanol. Temperature higher than this will burn the alcohol and will result in much lesser yield a study by Leung and Guo showed that temperature higher than 65oc had a negative impact on the product yield for neat oil but had a positive effect for waste oil with higher viscosities.

**Effect of Stirring**

Stirring can play an important role in the yield of biodiesel production Mehar et al. conducted the transesterification reaction with 180,360 and 600 revolution perminute (rpm) and reported incomplete reaction rpm. Sharma and Singh reported that mode of stirring too plays a vital role in the transesterification reaction The yield of biodiesel increased from 85% to 89.5% when magnetic stirrer (1100 rpm) was replaced with mechanical stirrer (1100 rpm).

**Dilution or Blending**

High viscosity fuels like vegetable oils can be mixed with low viscosity fuel like diesel to overcome overall viscosity. These blends can then be used as diesel engine fuels. Dilution of vegetables oil can be accomplished with a solvent, methanol or ethanol. Vegetable oils can be directly mixed with diesel and may be used to run diesel engines. Blending of vegetables oil with diesel has been tried successfully by a no. of researchers. The dilution of sunflower oil with diesel fuels in the ratio of 1:3 by volume has been studied and engine tests were carried out by Ziejewskiet,al. They concluded that the blend could not be recommended for a long term use in the direct injection diesel engines. Pryor et,al. had conducted the short term and long term performance tests with blends of vegetables oil with diesel. In short term performance test, crude-degummed soybean oil and soybean ethyl ester were found suitable substitutes for diesel fuels.

**Blend**

It is mixture of certain amount of thumba oil and pure diesel .
Example :- B5 (5% thumba oil and 95% pure diesel )
B09 (09% thumba oil and 91% pure diesel)
B18 (18% thumba oil and 72% pure diesel)
B27 (27% thumba oil and 73% pure diesel)
B36 5(36% thumba oil and 64% pure diesel)
B45 (45% thumba oil and 55% pure diesel)
B54 (54% thumba oil and 46% pure diesel)
B100 (100% biodiesel)

## IV. OBSERVATION TABLE

| Particulares | Load in (kg) | Fuel consumption (kg/sec)(10^¯4) | Heat supplied (kg/sec) | Brake torque (N-m) | Brake power (kw) | BSFC (kj/kwh) | BTE (%) |
|---|---|---|---|---|---|---|---|
| **B00%** | 0 | | | 0 | 0 | 0 | 0 |
| | 3 | 1.24 | 5.03 | 5.44 | 0.8791 | 0.5110 | 16.57 |
| | 6 | 1.66 | 7.07 | 10.89 | 1.749 | 0.3425 | 24.73 |
| | 9 | 1.94 | 8.25 | 16.33 | 2.596 | 0.2692 | 31.46 |
| **B09%** | 0 | 0.69 | 2.85 | 0 | 0 | 0 | 0 |
| | 3 | 1.25 | 5.12 | 5.43 | 0.875 | 0.5159 | 17.06 |
| | 6 | 1.67 | 6.83 | 10.88 | 1.7415 | 0.3452 | 25.49 |
| | 9 | 2.09 | 8.54 | 16.33 | 2.59 | 0.2905 | 30.32 |
| **B18%** | 0 | 1.82 | 7.38 | 0 | 0 | 0 | 0 |
| | 3 | 1.96 | 7.94 | 5.44 | 0.878 | 0.8036 | 11.04 |
| | 6 | 2.66 | 10.78 | 10.85 | 1.74 | 0.5503 | 16.13 |
| | 9 | 2.80 | 11.35 | 16.30 | 2.59 | 0.3891 | 22.81 |
| **B27%** | 0 | 1.26 | 5.07 | 0 | 0 | 0 | 0 |
| | 3 | 1.82 | 7.30 | 5.44 | 0.8775 | 0.7466 | 12.02 |
| | 6 | 2.11 | 8.46 | 10.88 | 1.7437 | 0.4356 | 20.60 |
| | 9 | 2.25 | 9.02 | 16.33 | 2.5985 | 0.3117 | 28.80 |
| **B36%** | 0 | 0.99 | 3.86 | 0 | 0 | 0 | 0 |
| | 3 | 1.27 | 4.96 | 5.44 | 0.8775 | 0.5210 | 17.59 |
| | 6 | 1.84 | 7.19 | 10.88 | 1.7494 | 0.3786 | 24.33 |
| | 9 | 2.12 | 8.28 | 16.33 | 2.6019 | 0.2933 | 31.42 |
| **B45%** | 0 | 1.12 | 4.46 | 0 | 0 | 0 | 0 |
| | 3 | 1.41 | 5.62 | 5.44 | 0.8804 | 0.5765 | 15.66 |
| | 6 | 1.83 | 7.29 | 10.88 | 1.7437 | 0.3778 | 23.91 |
| | 9 | 2.25 | 8.97 | 16.33 | 2.5951 | 0.3121 | 28.93 |
| **B54%** | 0 | 1.13 | 4.48 | 0 | 0 | 0 | 0 |
| | 3 | 1.41 | 5.61 | 5.44 | 0.8843 | 0.5760 | 15.76 |
| | 6 | 1.98 | 7.85 | 10.88 | 1.76 | 0.4052 | 22.40 |
| | 9 | 2.26 | 8.97 | 16.33 | 2.65 | 0.3075 | 29.52SS |

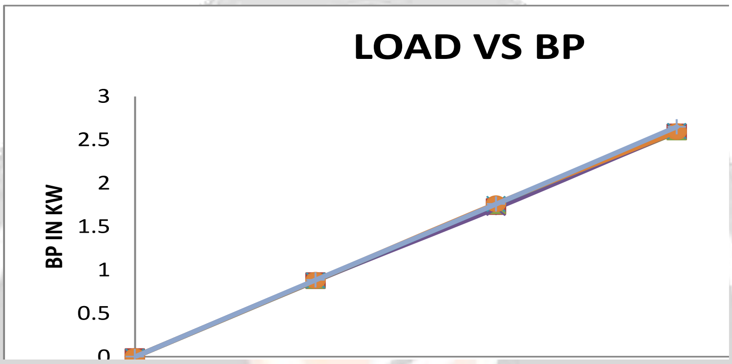
## V. RESULTS

**Table 1 for brake power**

| Load | B00% | B9% | B18% | B27% | B36% | B45% | B54% |
|---|---|---|---|---|---|---|---|
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **3** | 0.8791 | 0.875 | 0.878 | 0.8775 | 0.8775 | 0.8804 | 0.8843 |
| **6** | 1.729 | 1.7315 | 1.74 | 1.7137 | 1.7594 | 1.7637 | 1.76 |
| **9** | 2.596 | 2.59 | 2.59 | 2.5985 | 2.6019 | 2.595 | 2.65 |

**Table 1**

**Graph 1 of load vs brake power**




**Graph 1. load vs brake power**

Figure represents the variation of BP with respect to LOAD in kilogram. The figure indicates that BP of all samples were when load increases, BP also increase in minimum variation.The blend B18% represents higher BP among all blended fuels. The BP of B36% found to be close to that of diesel fuel.

**Table 2 for heat supply**

| Load | B00% | B09% | B18% | B27% | B36% | B45% | B54% |
|---|---|---|---|---|---|---|---|
| **0** | 4.122 | 2.851 | 7.38 | 5.05 | 3.86 | 4.46 | 4.48 |
| **3** | 5.304 | 5.128 | 7.94 | 7.3 | 4.96 | 5.62 | 5.61 |
| **6** | 7.072 | 6.83 | 10.78 | 8.46 | 7.19 | 7.29 | 7.85 |
| **9** | 8.25 | 8.54 | 11.35 | 9.02 | 8.28 | 8.97 | 8.97 |

**Table 2 .heat supply**

**Graph 2 for load vs heat supply**

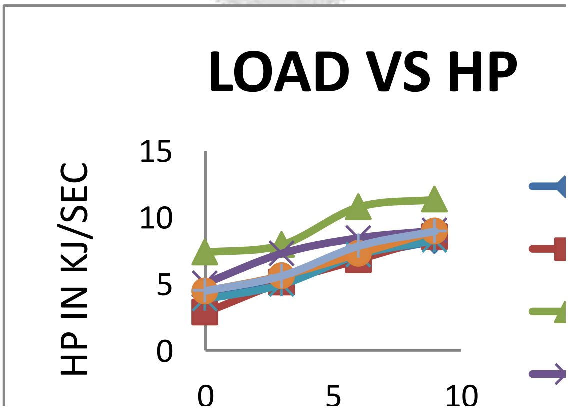


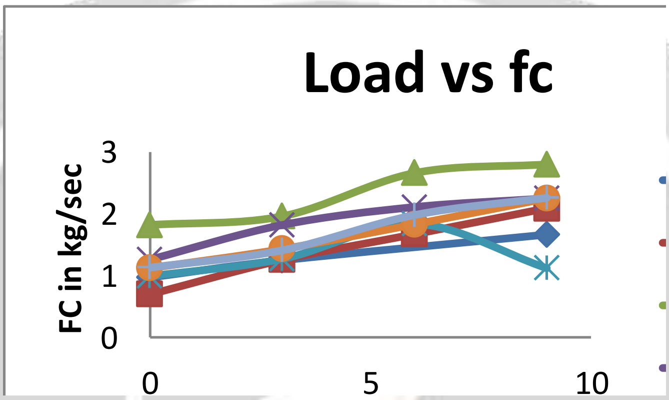
Figure represents the variation of HP with respect to LOAD in kilogram. The figure indicates that HP of all samples were B18% and B27% increases simultaneously and other blends are in minimum variation.The blend B18% represents higher HP at load of 9 kg among all blended fuels. The HP of B45% found to be close to that of diesel fuel.

**Table 3 for fuel consumption**

| Load | B00% | B09% | B18% | B27% | B36% | B45% | B54% |
|---|---|---|---|---|---|---|---|
| **0** | 0.97 | 0.6966 | 1.82 | 1.26 | 0.99 | 1.12 | 1.13 |
| **3** | 1.248 | 1.254 | 1.96 | 1.82 | 1.27 | 1.43 | 1.41 |
| **6** | 1.664 | 1.67 | 2.66 | 2.11 | 1.84 | 1.83 | 1.98 |
| **9** | 1.9413 | 2.09 | 2.8 | 2.25 | 1.12 | 2.25 | 2.26 |

**Table 3**

**Graph 3 for load vs fuel consumption**




**Graph 3 shows load vs fuel consumption**

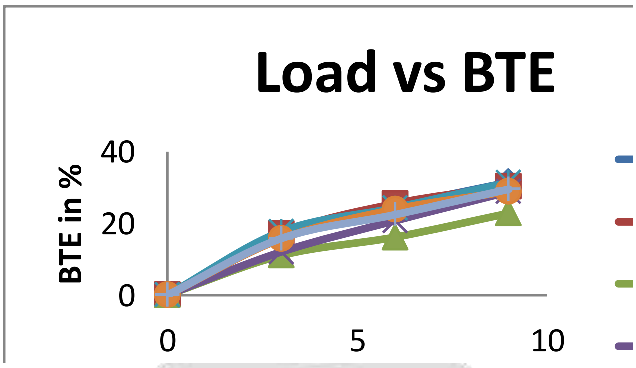
Figure represents the variation of FC with respect to LOAD in kilogram. The figure indicates that FC of all samples were B18% constant upto load of 3 kg and increases upto 6 kg and after that constant at 9 kg and other blends are rapidly increases and decrease at various loads.The blend B18% represents higher FC at load of 9 kg among all blended fuels. The FC of B09% found to be close to that of diesel fuel.

**Table 4 for brake thermal efficiency**

| Load | B00% | B09% | B18% | B27% | B36% | B45% | B54% |
|---|---|---|---|---|---|---|---|
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **3** | 16.57 | 17.06 | 11.04 | 12.02 | 17.69 | 15.66 | 15.76 |
| **6** | 24.73 | 25.49 | 16.13 | 20.7 | 24.33 | 23.91 | 22.4 |
| **9** | 31.46 | 30.32 | 22.81 | 28.8 | 31.42 | 28.93 | 29.52 |

**Table 4**

**Graph 4 for load vs brake thermal efficiency**




**Graph 4. load vs brake thermal efficiency**

Figure represents the variation of BTE with respect to LOAD in kilogram. The figure indicates that BTE of all samples were all the blends are increases rapidly at different load except that B18% reduced at load of 3 kg and increases at load of 6 kg. The blend B36% represents higher BTE among all blended fuels. The BTE of B36% found to be close to that of diesel fuel.

## VI. CONCLUSION

1. In this project we had studied and performed everything related to manufacturing of Thumba methyl ester and testing it on C.I. engine and evaluating different efficiency on different loads.
2. There is very small difference in the performance of some blends as compare to diesel.
3. We had observed that the desired efficiencies of blends B18, B36 and B45 are considerably greater than the efficiencies of diesel.
4. By studying the research papers we had noted that the value of emissions like HC, CO2, CO are reduced as compared to diesel and the only major disadvantages of the biodiesel is that it increases the NOX emission because, in combustion of biodiesel the temperature rises above 1000°c.
5. It is concluded that its ignition delay reduces due to higher Cetane number.

## VII. FUTURE SCOPE

1] The future scope of our project is that with reference to biodiesel is safe alternative fuel to replace traditional petroleum diesel.
2] It has high lubricity is a clean burning fuel and can be a fuel component for using existing.
3] Biodiesel is diesel for complete compatibility with petroleum diesel and can be blended in any ratio.
4] Any diesel vehicle can be powered by biodiesel from 10% to 100% blends regular petroleum diesel.
5] Performance is usually not affected.
6] The longer term goal is to have the short term action lead to the development of functional biodiesel industry in specific north west.

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