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Experimental Investigation on Performance and Emission Characteristics of a Diesel Engine Fueled With Jatropha, Neem, and Rubber Seed Oil as Biodiesel

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Abstract – Evolutions of vehicles lead to the increase in the usage of fuels. Therefore demand and price of fuel is increasing day by day. This led to find an alternative fuels for internal combustion engines. Biodiesel production is worthy of continued study and optimization of production procedures because of its environmentally beneficial attributes and its renewable nature. Non-edible vegetable oils such as rubber seed, jatropha and neem 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 rubber seed, jatropha and neem 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 rubber seed, jatropha and neem oil separately resulted in optimum yield in which the biodiesel content exceeded 95% at 2 hours. The resulting 30% rubber seed, 30% jatropha and 40% neem oil is blended with diesel in different percentage.

Performance and emission tests were carried out for 25%, 50%, 75%, and 100% rubber seed, jatropha and neem oil diesel blends. Results confirm that the performance of the engine fuelled with rubber seed, jatropha and neem oil biodiesel and its blends with diesel fuel is by and large comparable with pure diesel.

Index Terms – Rubber seed, jatropha oil, neem oil, Biodiesel, transesterification, Performance, Emission.

1. INTRODUCTION

The world at present mainly dependent on petroleum based fuels for power generation. Since these fuel sources are depleting fast, it is foremost important to find alternative sources of fuel for power generation. Moreover the capacity production of power is very less compared to the demand and due to problem in transmission; it is a greater task to electrify all parts, especially the rural parts of most of the developing countries. A promising way to electrify the rural areas in the developing countries is developing decentralized power generating units for various operations like pumping, lighting etc. At this scenario, it is foremost important to work at the scope of the fuel sources available at the native areas as input for decentralized power generating units because the benefits of such transition would go immediately to the local community in terms of economy, employment, etc.

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 jatropha, 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 RUBBER SEED OIL

In recent years, the use of biodiesels as alternative fuels has been extensively investigated with the objective of ensuring energy security and reducing the environmental impacts of diesel emissions. Rubber seed oil (RSO) has potential to become a prominent resource as it is non-edible. The rubber tree (Hevea brasiliensis) is a perennial plantation crop, originated from South America and cultivated as an industrial crop since its introduction to Southeast Asia in 1876. The rubber trees growth is most rapid at altitudes below 200 m and with monthly mean temperatures about 27 or 28ºC which is appropriate in ASEAN countries. Natural rubber producer in the world are Thailand (35%), Indonesia (23%), Malaysia (12%), India (9%), and China (7%). Cambodia now has planted these trees 70000 hectares in 2001. Normal seed production yields vary from 70 to 500 kg/ha/year while the annual rubber seed production potential in India is about 150 kg per hectare. Ramada's demonstrated that methyl esters of rubber seed oil could be successfully used in existing diesel engines without any modifications. Lower concentrations of biodiesel blends improved thermal efficiency. At higher concentrations of biodiesel in the blend, there was a reduction of smoke density in exhaust gas The main purpose of this investigation are to analyze and compare the effects of rubber seed biodiesel (RSB) fuel, which its properties are followed ASTM and SNI (Standard National Indonesia), with conventional diesel (CD) using an endurance test to enable evaluation of the impact of blended fuels on critical components of a direct injection (DI) diesel engine [3]. Performance and emission parameters were also measured,

Analyzed and compared. The results add to the amount of information available on the effects of using biodiesel in diesel engines. It is also an example of the type of research basic for the development of other biodiesel resources in the agricultural countries of Southeast Asia.

Figure 1.1 rubber Tree

Figure 1.2 rubber seed

Figure 1.3 rubber seed oil

1.3 JATROPHA OIL

It is also known as Jatropha cruces. It is drought resistant and grows well in poor soil. It grows quickly and produces seeds for 50yrs.It produces seeds with an oil content of 37%. Its oil cake is used as bio-fertilizer and organic manure.

The biofuels are destined to make a substantial contribution to the future energy demands of the domestic and industrial economies. jatropha will impact most significantly through the extraction of seed oil for use in the manufacture of biodiesel. jatropha oil as a source of fuel for the biodiesel industry is well Recognized. Moreover, the use of vegetable oils from plants such as jatropha has the potential to provide an environmentally acceptable fuel, the production of which is greenhouse gas neutral, with reductions in current diesel engine emissions. Importantly, the successful adoption of biofuels is reliant on the supply of feedstock from non-food crops with the capacity to grow on marginal land not destined to be used for the cultivation of food crops. In this regard jatropha is a strong candidate to contribute significant amounts of fuel feedstock, meeting both of these criteria. Existing feed stocks such as palm oil and canola are costly, making the production of biodiesel economically marginal. Sources such as tallow and waste oil from food outlets are seen as variable in availability and/or of low quality. Spreading crown and a short bole. It is a medium sized evergreen tree with a tree is planted for shade and is grown as ornamental tree. It is one of the few nitrogen fixing trees producing seeds containing 37% oil. The natural distribution is along coasts and river banks in lands and native to the Asian subcontinent. It is also cultivated along road sides, canal banks and open farm lands.

Figure 1.4 jatropha fruit

Figure 1.5 jatropha Tree

Figure 1.6 jatropha seed

1.3 NEEM OIL

In the current energy scene of fossil fuel, renewable energy sources such as bio diesel, bio-ethanol, bio-methane, and biomass from wastes or hydrogen have become the subjects of great interest. These fuels contribute to the reduction of dependence on fossil fuels. In addition, energy sources such as these could partially replace the use of those fuels which are responsible for environmental pollution and may be scarce in the future. For these reasons they are known as “alternative fuels”. Vegetable oil cannot be directly used in the diesel engine for its high viscosity, high density, high flash point and lower calorific value. So it needs to be converted into biodiesel to make it consistent with fuel properties of diesel.

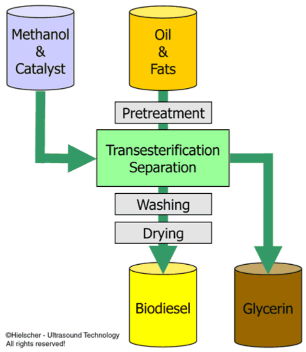
The growing demand for fuel and the increasing concern for the environment due to the use of fossil fuel have led to the increasing popularity of biofuel as a useful alternative and environmentally friendly energy resource like neem oil.

Figure 1.7 Neem Tree

Figure 1.8 Neem seed

Figure 1.9 Neem oil

2. RELATED WORK



PURCHASING OF OIL

Jatropha,neem ,rubber seed oil's are purchased from the Shop .

TRANSESTERIFICATION PROCESS

In organic chemistry transesterfifcation is the process of exchanging the alkoxy group of an ester compound by another alcohol. These reaction are often catalyzed by the addition of an acid.

The main reaction for converting oil to biodiesel is called transesterfifcation. The sample picture of the oil is added to the slide.

3. RESULTS AND DISCUSSIONS

The performance and emission was compared with pure diesel from the obtained performance and emission graphs. The basic performance and emission parameters were presented against brake power for all biofuel oil diesel blends.

7.1 Brake thermal efficiency

The variation of brake thermal efficiency with brake power is shown in Figure 7.1. It can be observed from the figure that the thermal efficiency is 28.67% at 5.19kw brake power for diesel. However when the engine is fuelled with biofuel -diesel blends such as 25% biofuel, 50% biofuel, 75% biofuel , and 100% biofuel, it gives the thermal efficiency of 31.16%, 30.82%, 27.90%, and 26.40% respectively at 5.19kw brake power. It is also observed that brake thermal efficiency is higher for 25% and 50% biofuel Diesel blends and it is slightly lower for 75 % and 100% biofuel Diesel blend when compared to pure diesel.

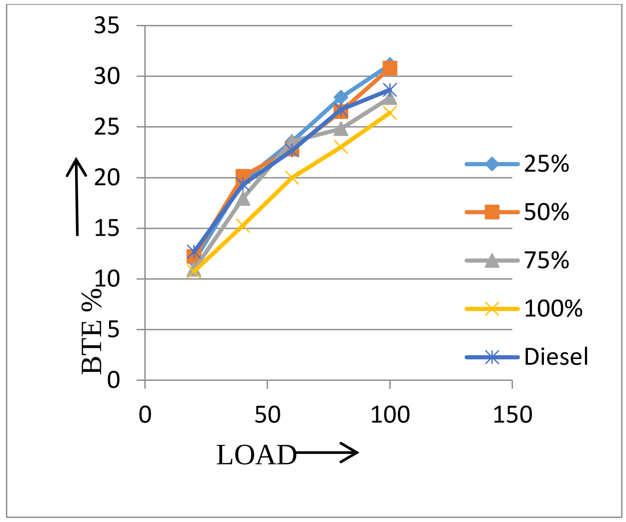
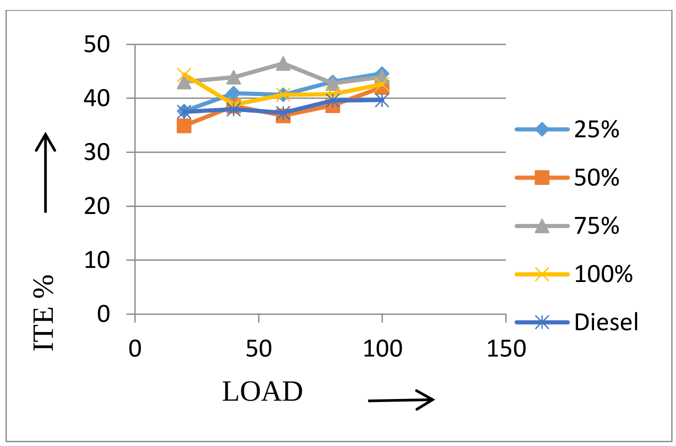


Figure 7.1 Brake thermal efficiency against load

7.2 Indicated thermal efficiency

The variation of indicated thermal efficiency with load is shown in Figure 7.2. It can be observed from the figure that the indicated thermal efficiency is 34.30 % at 5.19kw brake power for diesel. When the engine is fueled with biofuel diesel blends such as 25% biofuel, 50% biofuel, 75% biofuel , and 100% biofuel, it gives the thermal efficiency of 37.27%, 36.86%, 33.37% and 31.57 % respectively at 5.19kw brake power. It is also observed that indicated thermal efficiency is also higher for 25% and 50% blends and it is slightly lower for 75% and 100% biofuel Diesel blend when compared to pure diesel.

Figure 7.2 Indicated thermal efficiency against load



7.3 Brake specific fuel consumption

The variation of brake specific fuel consumption with load is shown in Figure7.3. It can be observed from the figure that the brake specific fuel consumption is 0.282 kg/kWh at 5.19kw brake power for diesel. When the engine is fueled with biofuel diesel blends such as 25% Biofuel, 50% biofuel, 75% biofuel , and 100% biofuel, its brake specific fuel consumption is 0.2597 kg/kWh, 0.2626 kg/kWh, 0.29 kg/kWh and 0.3066 kg/kWh respectively at 5.19kw break power. It is also noted that the brake specific fuel consumption is decreased for 25 % and 50% biofuel Diesel blends and it is slightly increase for 75% and 100% biofuel Diesel blend when compared to pure diesel.

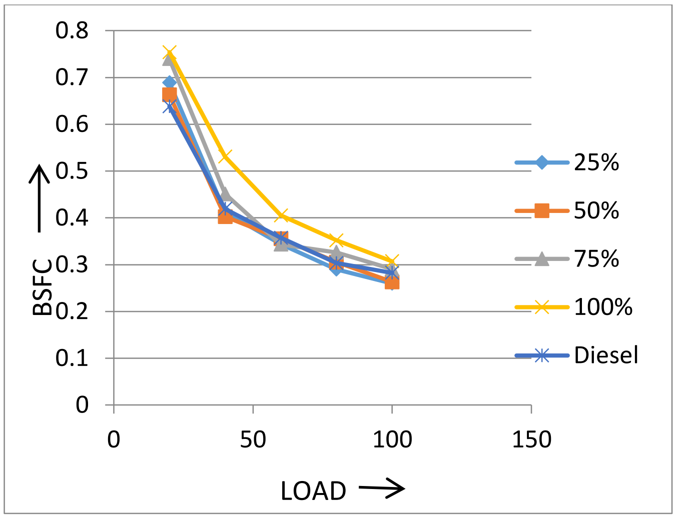


Figure 7.3 Brake specific fuel consumption against brake power

7.4 Indicated specific fuel consumption

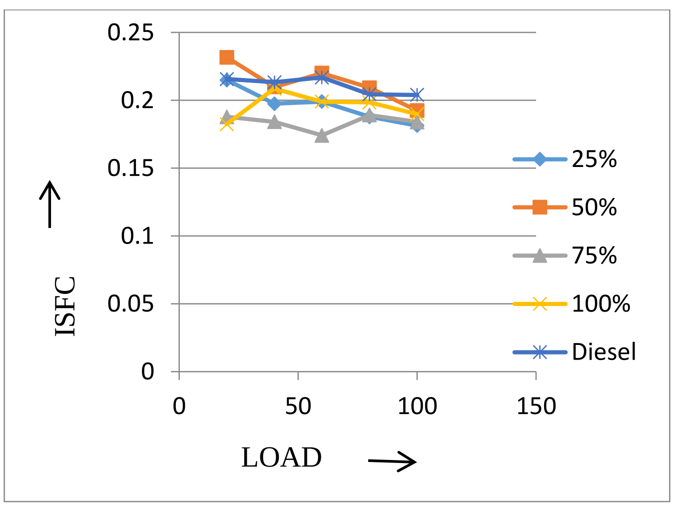


Figure 7.4Indicated specific fuel consumption against brake power

The variation of indicated specific fuel consumption with load is shown in Figure7.4. It can be observed from the figure that the indicated specific fuel consumption is 0.236 kg/kWh at 5.19kw brake power for diesel. When the engine is fueled with biofuel diesel blends such as 25% BIOFUEL, 50% biofuel, 75% biofuel, and 100% biofuel, its indicated specific fuel consumption is 0.2171 kg/kWh, 0.2195 kg/kWh, 0.2485 kg/kWh and 0.2563 kg/kWh respectively at 5.19kw break power. It is also noted that the indicated specific fuel consumption is decreased for 25 % and 50% biofuel Diesel blends and it is slightly increase for 75% and 100% biofuel Diesel blend when compared to pure diesel.

7.5 carbon monoxide (CO)

The variation of carbon monoxide (CO) with brake power is shown in Figure7.5. It can be observed from the figure that carbon monoxide (CO) is 0.36% at 5.19kw brake power for diesel. However when the engine is fuelled with biofuel -diesel blends such as 25% biofuel , 50% biofuel, 75% biofuel, and 100% biofuel, it gives the carbon monoxide (CO) of 0.32%, 0.24%, 0.27%, and 0.34% respectively at 5.19kw brake power. It is also observed that carbon monoxide (CO) is lower for 25% , 50%, 75% and 100% biofuel Diesel blends when compared to pure diesel.

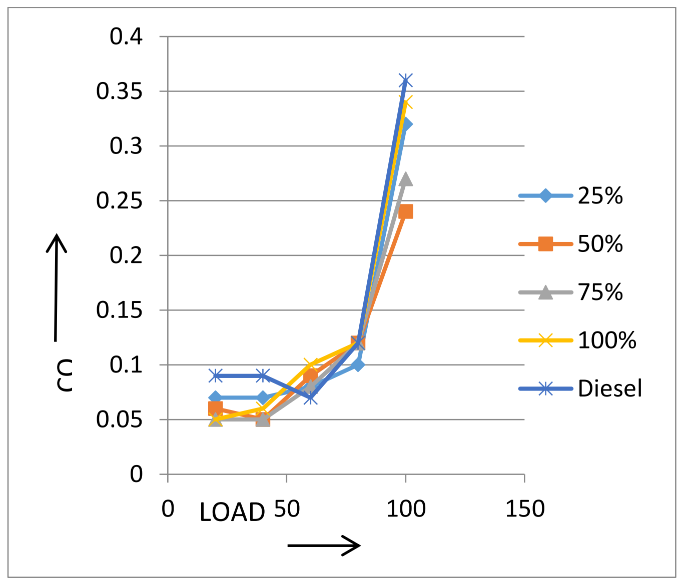


Figure 7.5 carbon monoxide (CO) against brake power

7.6 hydrocarbons (HC)

The variation of hydrocarbons (HC) with brake power is shown in Figure7.6. It can be observed from the figure that a hydrocarbon (HC) is 154ppm at 5.19kw brake power for diesel. However when the engine is fuelled with biofuel -diesel blends such as 25% biofuel, 50% biofuel, 75% biofuel, and 100% biofuel, it gives the hydrocarbons (HC) of 67ppm 69ppm, 69ppm , and 67ppm respectively at 5.19kw brake power. It is also observed that hydrocarbons (HC) is lower for 25% , 50%, 75% and 100% biofuel Diesel blends when compared to pure diesel.

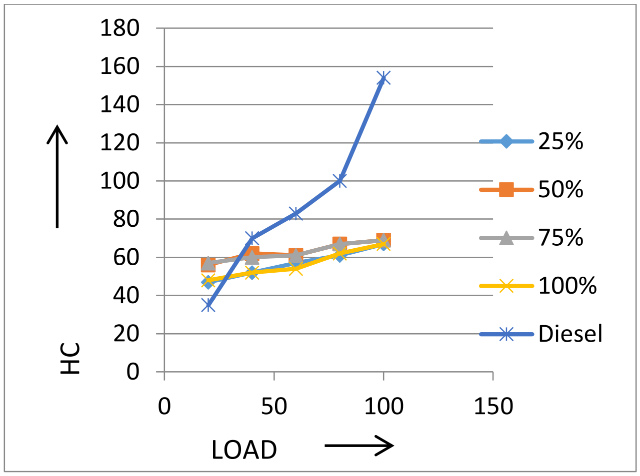


Figure 7.6 hydrocarbons (HC) against brake power

7.7 Carbon dioxide (CO_2)

The variation of Carbon dioxide (CO_2)with brake power is shown in Figure7.7. It can be observed from the figure that Carbon dioxide (CO_2)is 7% at 5.19kw brake power for diesel. However when the engine is fuelled with biofuel -diesel blends such as 25% BIOFUEL, 50% BIOFUEL, 75% BIOFUEL, and 100% biofuel, it gives the Carbon dioxide (CO_2)of 5.1%, 6.8%, 5.4% and 6.1% respectively at 5.19kw brake power. It is also observed that Carbon dioxide (CO_2) is lower for 25% , 50%, 75% and 100% BIOFUEL Diesel blends when compared to pure diesel.

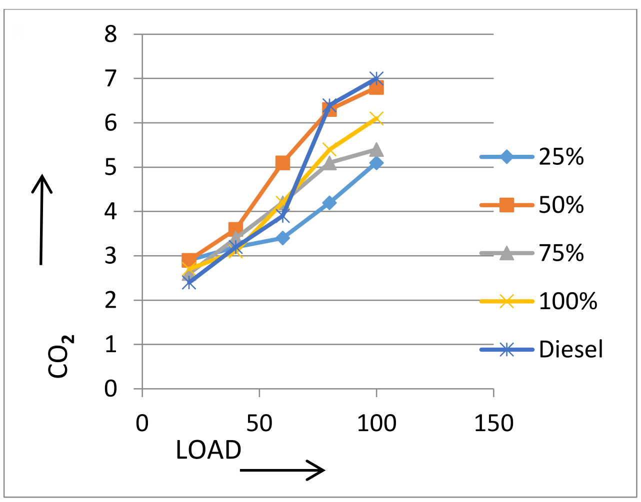


Figure 7.7 Carbon dioxide (CO_2) against brake power

7.8 Oxygen (O_2)

The variation of Oxygen (O_2)with brake power is shown in Figure7.8. It can be observed from the figure that Oxygen (O_2)is 12.1% at 5.19kw brake power for diesel. However when the engine is fuelled with biofuel biofuel -diesel blends such as 25% biofuel biofuel, 50% biofuel, 75% biofuel, and 100%EL biofuel it gives the Oxygen (O_2)of 11.1%, 10.24%, 11.24%, and 12.6 % respectively at 5.19kw brake power. It is also observed that Oxygen (O_2)is lower for 25%, 50% and 75% biofuel Diesel blends and it is slightly higher for 100% biofuel Diesel blend when compared to pure diesel.

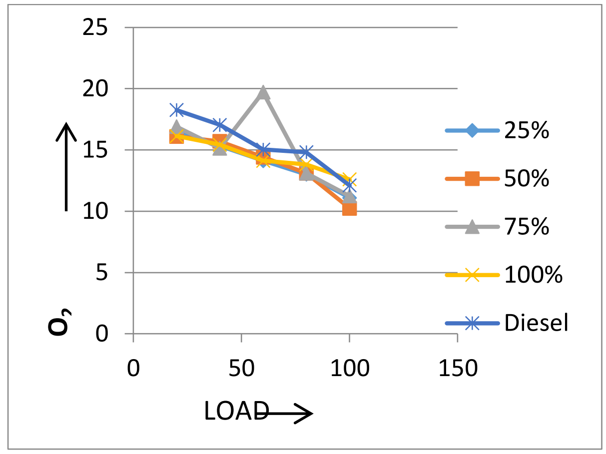


Figure 7.8 Oxygen (O_2) against brake power

7.9 Nitrogen oxide (NO_X)

The variation of Nitrogen oxide (NO_X)with brake power is shown in Figure7.5. It can be observed from the figure that Nitrogen oxide (NO_X)is 1230ppm at 5.19kw brake power for diesel. However when the engine is fuelled with biofuel -diesel blends such as 25% biofuel, 50% biofuel 75% biofuel, and 100% biofuel, it gives the Nitrogen oxide (NO_X) of 940ppm, 934ppm,818ppm and 801ppm respectively at 5.19kw brake power. It is also observed that Nitrogen oxide (NO_X) is lower for 25% , 50%, 75% and 100% biofuel Diesel blends when compared to pure diesel.

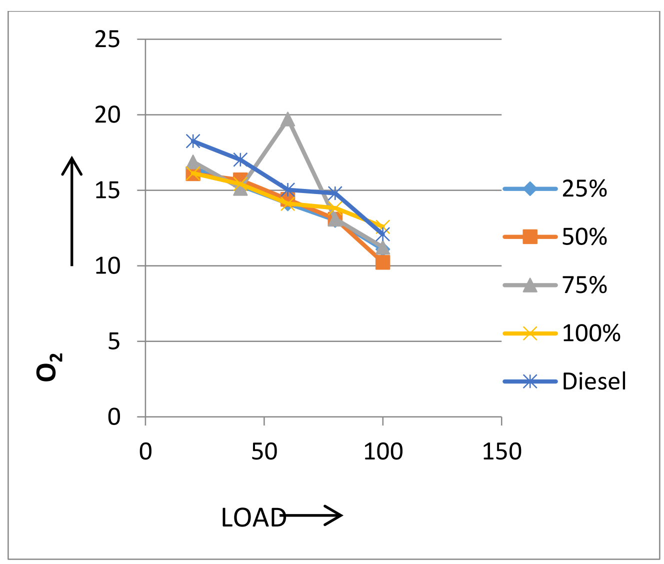


Figure 7.9 Nitrogen oxide (NO_X)against brake power

4. CONCLUSION

In our work the Biodiesel was prepared from the non-edible oil of rubber seed jatropha and neem oil by transesterification of the crude oil with methanol in the presence of NaOH as catalyst. A maximum conversion of 92% (oil to ester) was achieved at 65˚C. the received rubber seed jatropha and neem oil is blended in different propotion 10%,30%, and 50%.the blends are subjected to performance and emission test rig engine the calculation are arrived Engine was able to run with 50% biofuel oil-diesel blend Engine fuelled with 50 % biofuel oil-diesel blend exhibits higher brake thermal efficiency (30.815%) when compared to pure diesel (28.673%).

Engine fuelled with 50% biofuel oil-diesel blend exhibits higher indicated thermal efficiency (36.85%) when compared to pure diesel (34.30%).Brake specific fuel consumption 75% and 100% biofuel oil-diesel blend exhibits higher indicated thermal efficiency (0.3066kg/ kw-hr) when compared to pure diesel (0.2822 kg/ kw-hr)Emission level is less compare to pure diesel. So, it's more suitable for alternate fuel in diesel engines.

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