Performance evaluation of Alternate fuels of diesel blended with cotton seed oil, rubber seed oil and Mesquite Beans oil

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Abstract

Diesel plays imperative role than other fossil fuels. The objective of this research is how effectively using the diesel fuel as blended diesel. In this research apart from diesel, ten different blended diesels are included for investigation. The diesel fuel blended with cotton seed oil, rubber seed oil, Mesquite bean oil with three different proportions and the diesel blended. The engine load varied from no load to full load conditions. The performance of these blended diesels investigated and presented with discussion of effective blended diesel preparation.

Keywords:
Cotton Seed oil, Rubber seed oil, Mesquite bean oil, Diesel, Bio-diesel, Fuel consumption.

1. Introduction

Research on use of non-renewable fossil fuels is must to meet global energy the demand. The supply of fossil fuels is getting reduced and price hike of them is increased day by day. This simulates the researchers to search the alternate fuels to make up the supply and meeting the fast growing energy demand globally. Biodiesel is one of the option and plausible supplement for conventional diesel demand. [1]The biodiesel from the vegetable oil (which use for food preparation) increase the cost of food and biodiesel, [2]If the blend proportion in diesel increases the total fuel consumption will be increased, [3]emission of CO_2 and HC will be decreased and NOx emission increased. [4]The use of biodiesel may cause problem in long term but initially none and does not need to modify the engine.

[5] reported that biodiesel of rubber seed oil meet the bio-auto fuel EN 14214 standard and compared its thermal stability with petrol and diesel through thermo-gravimetric analysis and highlighted such fuel source in Thailand, [6] also ensured that rubber seed oil based biodiesel fulfilled the bio-auto fuel ASTM D6751 and EN14214, [7] reported as sub-Saharan Africa (SSA) countries has capacity of 166.91MT of biodiesel production from the estimated 179.47MT of rubber seeds, such countries have an attractive choice for the sustainable development, [8] optimized the transesterification parameters of cotton seed oil like catalyst concentration (0.6%), methanol/oil molar ratio (6:1), reaction time (60 min), reaction temperature (55 °C) by using response surface methodology. [9] reported that the blend of cotton seed oil with diesel 10% yielded 26.04% break thermal efficiency, specific fuel consumption and improved emission characteristics. [10] investigated the performance of cotton seed methyl ester and its blend with petro-diesel and reported that the optimal performance can be obtained when 1:3 ratio (i.e.,) cotton seed biodiesel. [11] compared cotton seed oil methyl esters and neem kernel oil methyl esters with diesel and sated that at full load condition the brake thermal efficiency is lower by 5.91% and 7.07% than diesel fuel respectively. [12] Investigated the engine performance of biodiesels of

soybean, sunflower, hazelnut, canola and corn oils blend with diesel fuel in the proportion of B20, B50 and B100. The best performance observed for B20 hazelnut bio diesel,[13] provided the statistics that nearly 150% of biomass and renewable diesel demand increased in 2017 than 2011 at the same time the price of soybean price dropped by 40%. These status increases the import of China's soybean get boom. As the rubber seed comes under the category of non-edible crops, it is a source to produce oil for biodiesel (rubber seed contains 35–45 wt.% oil), researchers analyzing its potential of such corps,[14] Mesquite trees are unique kind, abundantly available which offers non-edible organic products, [15] They emit CO_2 spoil the agriculture land and Nowadays researchers reported that primary food source for caravans and settlers, at 1841 suffering men used beans of Mesquite and termed as "manna from heaven, [16]used Carboxymethyl cellulose pulp which derived from mesquite tree, as nano-composite material for preparing CMC/Fe_3O_4nano-composite material.

2. Materials and Methods

2.1 Biodiesel Preparation

The preparation include to maintain the viscosity (reduce if it is high) to suit for the fuel for IC engine. Transesterification process employed for biodiesel preparation which is the reaction of vegetable oil or fat or oil in presence of alkaline, acidic with alcohol to form the glycerol and biodiesel. Here methanol used as alcohol. Initially the oils are filtered for removing solid impurities and heated up to 100^{0}C and maintain for 30 minutes to remove the moisture presence. The first stage is called stage esterification and the second stage is referred as Transesterification process. In the first stage the free fatty acid content in oil is removed by heated up the oil at 60-65^{0}C for 60 minutes in magnetic stirrer with pure methanol and pure acid catalyst. Then water wash of oil is done in separating funnel. The hot water of same oil temperature added in the separating flask for washing out the dust, sulphur and carbon contents. The esterified oil is taken for transesterification process. The 1% by weight of solid catalyst of 4g Sodium hydroxide dissolved in 130 ml of methanol then the same added in esterified oil of 1000 ml at the temperature of 60^{O}C for 60 minutes. After completing of reaction, the mixture is allowed to settle for more than 10 hours in the separating flask. In the settled flask bottom layer of the mixture contains glycerin, excess alcohol, catalyst impurities and traces of un-reacted oil. The coarse biodiesel floats at the top. Again the mixture heated above 100^{O}C and maintained for 10 to 15 minutes to separate coarse biodiesel. The impurities were cleaned by washing two to three times with 100ml water. Now the biodiesel is ready for use in CI engine for investigation.

2.2 Blending with the diesel

After successful completion of the transesterification process, such vegetable oils can use for CI Engine fuel either in pure form or blends of diesel. Here both cases are considered for evaluation. Some of the merits like no need of engine modification, minimizing the cold weather effects, and particulate emission reduction and improve the capability and solvency, can be get by blending the vegetable oil with diesel. For blending the oils with diesel blender equipment is used. The blender equipment has reactor, heater with thermostat control and mechanical stirrer and separately a glass separator. The preferred blending ratios are: 30%, 40% and 50%.

2.3 Blend Properties

It is important to know the properties of blends before test in the Engine. The addition of biodiesel to diesel may affect some key properties like viscosity, lubricant, blend stability and energy content.

3. Experimental Setup

The naturally aspirated Kirloskar make,single cylinder four-stroke compression ignition engine is considered for testing the alternate fuels. The Eddy current Dynamometer used to add the load from 20% to 100% with step of 20%. The sensors provided for measuring various temperatures. The engine specifications furnished in Table 1. The experimental set up consists of smoke meter to evaluate the emission.

Table 1 Experimental setup

Description	Specification
Engine model	Kirloskar TV 1 model
Compression ratio	5:1-23:1
Fuel	Diesel
Engine type	Vertical, 4 stroke cycle, single acting, High Speed, Diesel Engine
Number of cylinders	Single
Bore &Stroke (mm)	80*110
Cubic Capacity	0.553 liters
Rated shaft speed	1500 rpm
Compression ratio	16.5 .1
Starting	Crank(manually)
Dynamometer	Eddy current
Combustion	Direct injection
Governing	Class “B1”
Power Rating	5 HP
Cooling system	Water cooled
Type of load	Electrical load
Description	Specification
Engine model	Kirloskar TV 1 model
Compression ratio	5:1-23:1
Fuel	Diesel
Engine type	Vertical, 4 stroke cycle, single acting, High Speed, Diesel Engine
Number of cylinders	Single
Bore &Stroke (mm)	80*110

3.1 Experimentation

The load test and emission test were conducted. The appropriate fuel filled in the fuel tank. The engine oil level, cooling water flow, no load conditions were ensured then start the engine manually. After reach of rated speed of 1500 rpm, the dynamometer, analysers and measuring meters switched on. The load of 20%, 40%, 60%, 80% and 100% were set by the ampere rating as 3,5,7,9 and 11Amps. The engine speed adjusted to 1500 rpm by increasing the acceleration on every loading. The required parameters (quantity of air consumed, fuel consumed, temperatures of cooling water at inlet and outlet, exhaust air temperature, etc) observed for heat balance and load test for computing the total fuel consumption, specific fuel consumption, indicated power, frictional power, break power, indicated thermal efficiency, break thermal efficiency and mechanical efficiency. The is alternate fuel performance with the engine was furnished in terms of TFC , SFC , IP , BP , FP η_{ith}, η_{bth} and η_{mech}. For emission test, the smoke, hydrocarbons and carbon monoxide were observed and such a way the diesel, biodiesel and their blends with various proportions were investigated.

4. Results and Discussions

The fuels like pure diesel, blended diesel of Mesquite bean oil of contents 30%, 40% and 50%, blended diesel of cotton seed oil of contents 30%, 40% and 50%, preheated soybean oil of content 30% at preheating temperatures like 50, 60,70 and 80 degree centigrade are used separately from no load condition to full load condition. The performance of these fuels presented in the graphical form.

The figure 1 illustrates the performance relationship with Brake Power and specific fuel consumptions. The pure diesel needs low specific fuel consumption at all load conditions than other blended diesels considered in this study. B30 RSO needs lighter higher specific fuel consumption at all conditions when compare to Pure diesel but other than B30 RSO that’s required more SFC .

The figure 2 illustrates the performance relationship with Brake Power and total fuel consumptions. The pure diesel needs low total fuel consumption at all load conditions than other blended diesels considered in this study. B30 RSO needs lighter higher total fuel consumption at all conditions when compare to Pure diesel but other than B30 RSO that’s required more TFC .

The figure 3 illustrates the performance relationship with Brake Power and Indicated power. The pure diesel needs low Indicated power at all load conditions than other blended diesels considered in this study. B30 RSO performs lighter higher Indicated power at all conditions when compare to Pure diesel but other than B30 RSO that’s produce very High Indicated power.

The figure 4 illustrates the performance relationship with Brake Power and Brake Thermal Efficiency. The pure diesel needs high Brake Thermal efficiency at all load conditions than other blended diesels considered in this study. B30 RSO performs lighter lower Brake Thermal efficiency at all conditions when compare to Pure diesel but other than B30 RSO that’s produce very low Brake Thermal Efficiency.

The figure 5 illustrates the performance relationship with Brake Power and Indicated Thermal Efficiency. The pure diesel needs low Indicated Thermal efficiency at all load conditions than other blended diesels considered in this study. B30 RSO performs lighter higher Indicated Thermal efficiency at all conditions when compare to Pure diesel but other than B30 RSO that’s produce very High Indicated Thermal Efficiency.

The figure 6 illustrates the performance relationship with Brake Power and Mechanical Efficiency. The pure diesel needs high mechanical efficiency at all load conditions than other blended diesels considered in this study. B30 RSO performs lighter lower mechanical efficiency at all conditions when compare to Pure diesel but other than B30 RSO that's produce very low Mechanical Efficiency.

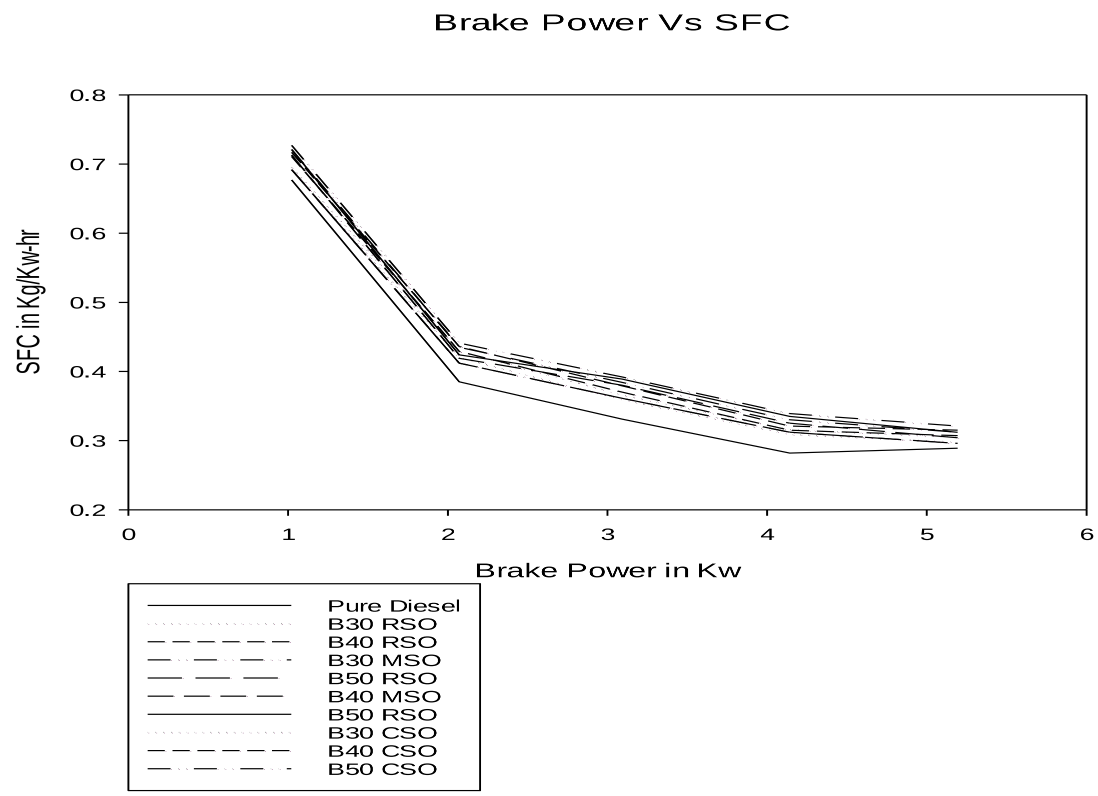

Figure 1. Brake Power Vs SFC

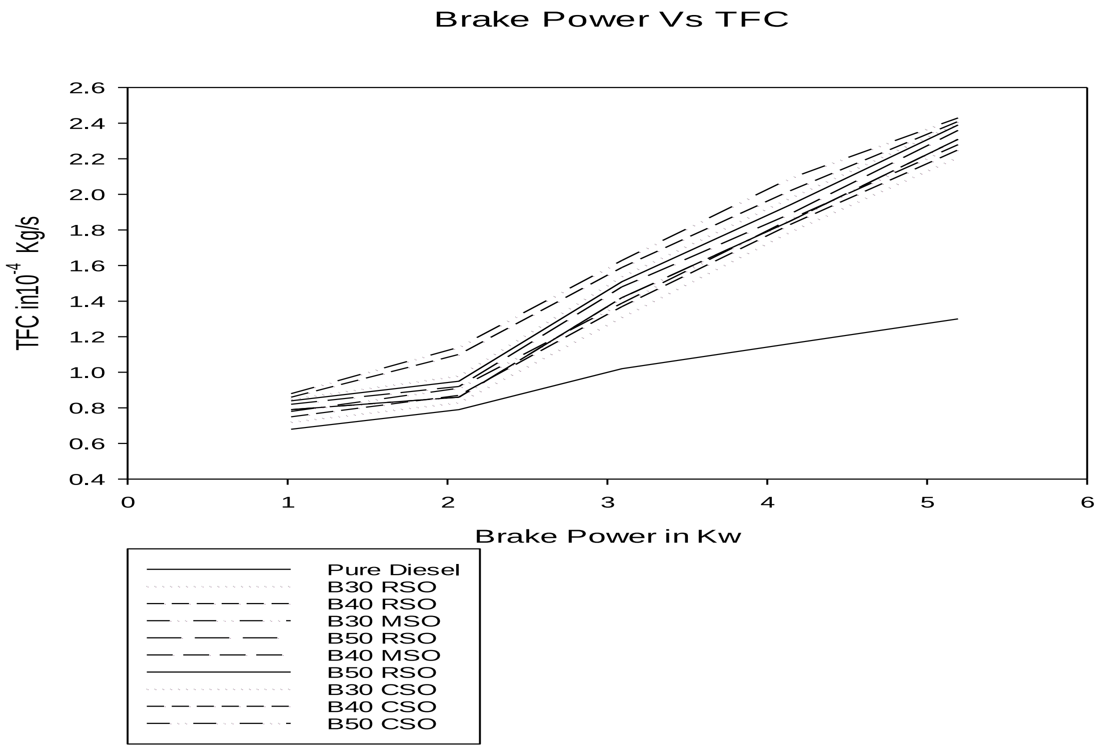

Figure 2. Brake Power Vs TFC

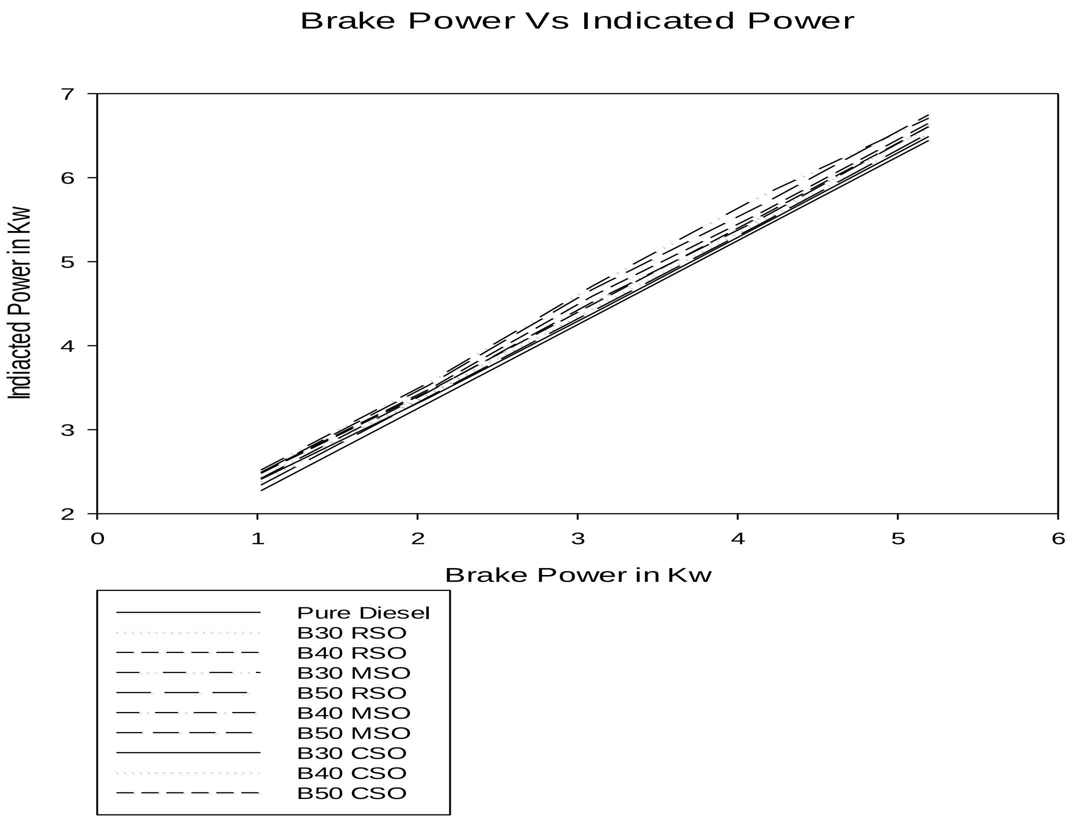

Figure 3. BP VS Indicated Power

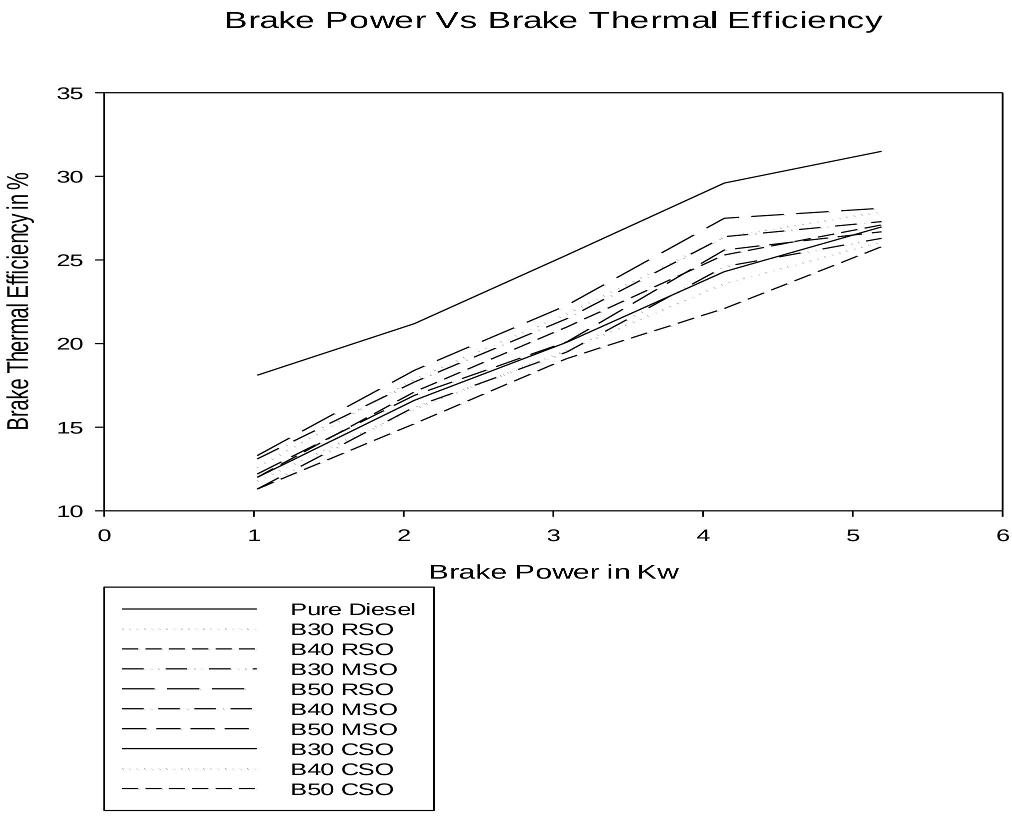

Figure 4. BP VS Brake thermal Efficiency

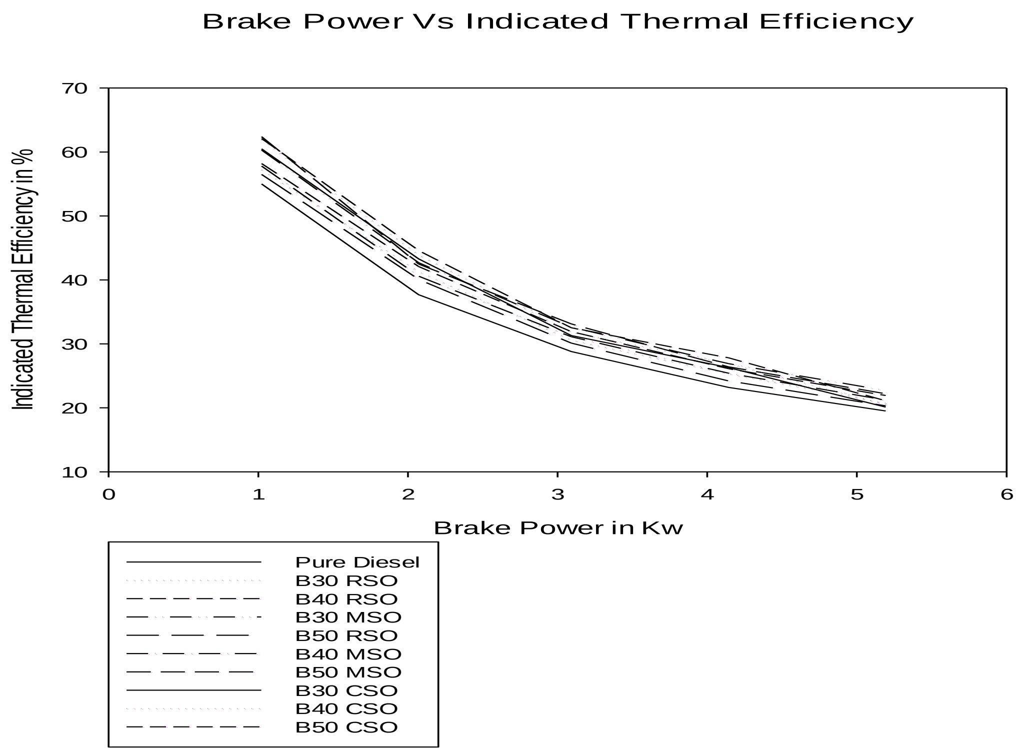

Figure 5. BP VS Indicated thermal Efficiency

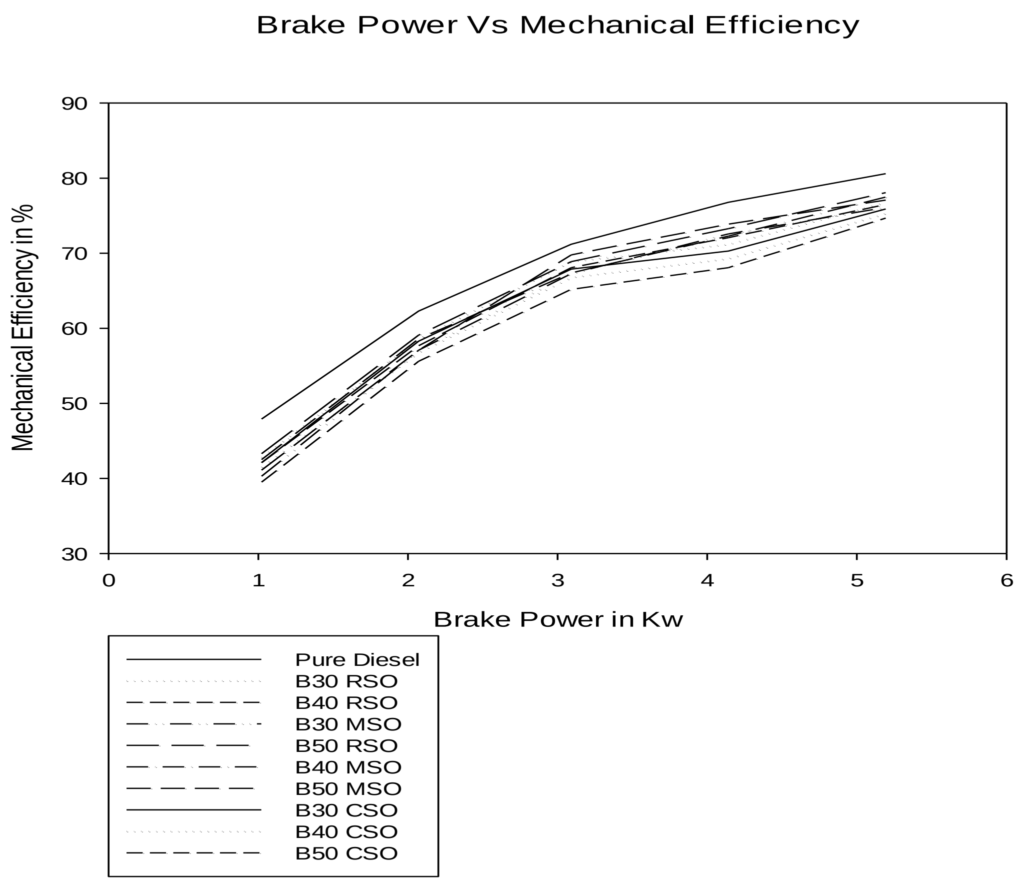

Figure 6. BP VS Mechanical Efficiency

5. Conclusion

The diesel blended with Cotton seed oil , rubber seed oil and mesquite bean oil in different proportion to form the six different kind of blended diesels for conventional use. The experiments were carried out successfully and discussed well. The Rubber Seed oil with 30% blend with diesel gave low total fuel consumption, high Mechanical Efficiency, high Indicated Thermal Efficiency, high Brake Thermal Efficiency, low specific fuel consumption and develop high Indicated power than other blended diesel but higher than the pure diesel. Hence the Rubber Seed oil with 30% blend with diesel is suggested.

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