EXPERIMENTAL STUDY ON ENGINE PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE FUELLED WITH MAGNETIZED BIO-DIESEL BLENDS

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Abstract- The modern scenario reveals that the world is facing energy crisis due to dwindling source of fossil fuels. Rapid depletion of the resources as well as the price hike is a matter of severe concern for mankind. This might be the reason for why alternate fuels with magnetization are coming to picture. The discriminate extraction and consumption of fossil fuels have let to reduction in petroleum reserve. People may say that all our resources are still preserved, but it is an exaggeration for the self-satisfaction. The increasing import bill has necessitated the search for fuel as an alternate to the diesel, which is being used in large quantities in Agriculture, transport, commercial and domestic sectors. Environmental awareness and the depletion of the natural resources are driving the researchers to develop viable alternate fuel from renewable resources that are environmentally more accepted. Energy that can be extracted biomass and specific biodiesel is one of the prospect that could cover the future requirement of fossil fuel deficiency. Another prospect is the effect of magnetism of biodiesel blends which rises the performance and reduces the emission. The criteria reveals that the better atomization of the biodiesel and efficient combustion of the air biodiesel mixture. Bio-diesel blends are magnetized by applying the magnet field before fuel injector. The permanent magnet has been used for magnetizing the fuel..

Keywords- Bio-diesel, Alternative fuels, Internal combustion engine fuels, Pre-treatment, Pyrolysis, Water Emulsion, Magnetism, Permanent Magnet, Performance, combustion and emission of magnetized biodiesel blends.

I. INTRODUCTION

It is supposed that the petroleum products and crude oil will be not enough and will be pricey. In order to improve the fuel economy of engines, various researches and studies are going on. Due to enormous increase in number of vehicles the demand and availability for petrol and diesel is somewhat unbalanced and there is a need to balance. The scenario will be more disastrous if this situation continues then petrol and diesel will be more costly and limited. With increased usage and the depletion of fuels, today more emphasis is given on the alternate fuels. There is an essential need of alternate fuels in a way or other.

1.1. Need for Alternate fuel

The main reason for the need of alternate fuels for IC engines is the emission problems. Combined with other air polluting factors, the large number of automobiles is a major contributor to the air quality problems of the world. As the vegetable oils cannot be run directly in the engines therefore these are blended with diesel at various percentage. One of the main reasons for selecting these fuels is the similarity in the properties with diesel and they are miscible with diesel.

1.2. Alternate Fuel Scenario

In India, there are 15-20 million vehicles and to satisfy the necessity, India requires 45 million ton of fuels per year. India imports 2/3rd of its petroleum requirements last year, which involved a cost of roughly 80,000 crores in foreign exchange. India is mainly dependent on gulf nations for fuel supply. The country will thus have to continue importing oil over 70% of its need until some alternate fuels are used which can make India self-sustainable. Formerly it has already been stated that almost 95% of the current fuels are either gasoline or diesel. But as these are inadequate in quantity and the demand for these fuels is budding day by day, the total quantity may uphold for another 50-75 years only. So the time has already come to find out the most suitable alternate fuels. The muscular competitors are bio-diesel, CNG, LPG etc., These fuels have other compensation also which are finer to petrol and diesel i.e., less polluting, low maintenance cost etc., LPG & CNG are maximum used in automobile. The leading country in making CNG & LPG kit is Italy. Some of the reputed companies are- lovato, stargas, bedini etc.,the only disadvantage are that these kits are initially expensive to install (for Maruti 800, it is approximately INR 20000-25000) and there is a power drop of 10% in comparison to petrol. But the running cost is reduced up to 50-70% in comparison to petrol. Other alternative fuels are bio-diesel and hydrogen. Bio-diesel is produced from several vegetable oil. This is suitable foroperating CI engines. Government of India has already experimented it in some diesel locomotive engines and has been Hydrogen engines are being developed in Indiasuccessful so far.

1.3. Use of Vegetable oils as a Fuel

Alternative fuels should be easily obtainable, environment friendly and techno economically reasonable. One of such fuels is triglycerides (vegetable oils/animal fats) and their derivatives. Vegetable oils, being renewable, are broadly offered from a variety of sources and have low sulphur contents close to zero, and hence cause less environmental damage (lower greenhouse effect) than diesel. Besides, vegetable oils and their derivatives are produced extensively in the country for food and other purposes. Depending upon the climate and soil conditions, different countries are looking for different types of vegetable oils as substitutes for diesel fuels. For example, soybean oil in US, rapeseed and sunflower oils in Europe, palm oil in south-east Asia (mainly Malaysia and Indonesia) and coconut oil in the Philippines are being considered. Besides, some species of plants yielding non-edible oils likes jatropha, karanja, pongamia and neem may play a significant role in providing resources. Both these plants may be grown on a massive scale on agricultural/degraded/waste lands, so that the chief resource may be available to produce vegetable oil or biodiesel on 'farm scale'. It has been found that these neat vegetable oils can be used as diesel fuels in conventional diesel engines, but this leads to a number of problems related to the type and grade of oil and local climatic conditions. The injection, atomization and combustion characteristics of vegetable oils in diesel engines are significantly different from those of diesel. Vegetable oils present a very promising substitute to diesel fuel, since they are renewable and are produced easily in rural areas. They type of vegetable oils under investigation are simarouba oil, safflower oil, neem oil, Karangi oil etc.,

1.4. Characteristics of Diesel and Vegetable Oils

Petroleum based diesel fuel have different chemical structures than vegetable oils. The former contains mostly of saturated hydrocarbons comprises only carbon and hydrogen atoms which are arranged in normal as branched chain structure as well as aromatic structures. Diesel fuel can contain both saturated and straight or unbranched chain unsaturated hydro carbons, but in little amount .On the other hand, vegetable oils are tri glycerides consisting of glycerol esters of fatty acids. These fatty acids vary in their carbon chain lengths and in number of double bonds .Then high molecular weights, oxygen contents and unsaturated assure that they differ markedly from those of hydro carbon fuels (especially diesel fuels) .

Vegetable oils have better ignition qualities for diesel engine than light alcohols, as their cetane numbers are 35-40.The structure of vegetable oils can be converted in to a form which is much more acceptable to the diesel engine, by trans-esterification. By making use of triglyceride molecule in the vegetable oil with an improved cetane numbers up to 55, viscosity similar to diesel, low carbon residue and calorific value slightly lower than diesel. The exhaust temperature of these oils are lesser than diesel resulting in higher brake thermal efficiency than diesel engines .The fact that this oil in neat form does not have any aromatics makes these processed vegetable oils well compete with "clean diesel " without any modifications.

II. LITERATURE REVIEW

2.1 In an experimental investigation conducted by Velmurgan and Loganathan [1] on the performance and emission characteristics of DI diesel engine fuelled with CNSL-diesel blends that BTE increases with increase in application of load which is mainly due to reduction in heat loss and increase in power developed as increase in load. The Thermal efficiency decreases when compared to neat diesel is due to poor mixture formation such as low volatility, higher viscosity and high density of CNSL oil. The specific fuel consumption of CNSL oil is slightly high than diesel which is due to effect of high viscosity. When the fuel ratio reaches greater than the stoichiometric value, CO emission increases. There is an increase in CO emission level with increasing CNSL oil percentage. Due to the poor mixture formation tendency and lower thermal efficiency, the HC emission of CNSL oil blends is more compared to that of neat diesel. Because of the poor combustion takes place in CNSL oil, the exhaust temperature is decreased. Further studies revealed that the smoke density of CNSL oil blends is higher than diesel oil due to the poor atomization, heavier molecular structure and presence of high carbon residue. Due to the lower viscosity of CNSL blends there is an improved spracy pattern and fuel penetrates. NOX emission is lower for CNSL oil compared to diesel fuel because of the poor atomization of CNSL oil.

2.2 In other investigation by V.Palvannan et al [2] that the reduction in BTE when CNSL composition is increased by 20% which is due to reduced atomization. Fuel power is high than other blends primarily due to less efficiency. Power produced is less when loaded to 75% due to incomplete combustion. For a maximum load of 2.9 KW, the CO emission is reduced upto 60%. A 60% load and 20% CNSL blends reduces the CO emission. HC emission for neat diesel and 10% of CNSL blends are almost and there is a slight variation in behaviour of a 30% CNSL due to complete combustion. HC emission reduced for higher CNSL further investigation shows that higher the viscosity of the oil, higher will be the NOX emission due to the high exit gas temperature and higher component temperature, the smoke emission of CNSL blends falls below than that of diesel resulting in better combustion at peak loads.CO2 emission increases due to higher fuel flow rate with increasing load and increase in the carbon molecular undergoing combustion.

2.3 T.Pushparaj et al [3] studied the influence of CNSL biodiesel with ethanol additive on diesel engine performance and exhaust emission and found that BSFC increases as increase in biodiesel blends is because of low calorific value. BTE decreases with increase of ethanol blends are due to presence of increased oxygen content in blends. He also reveals that the CO emission for neat diesel, CNSL blended with diesel (B20), CNSL blends with diesel and ethanol is reduced at the medium loads and increases with heavier loads.CO emitted by CNSL blended with ethanol (5,10,15%) increase by 40%,50% and 60% respectively. While comparing B20 and this is due to the enrichment of O2 owing to the ethanol and biodiesel addition. Further investigation reveals that the CO2emission was reduced with B20 and ethanol 5% and 10% blend this is due to the lower carbon content of biodiesel fuels. Due to the quench layer of unburned ethanol present in the combustion chamber and high latent heat of vaporization of ethanol, HC emission is increased at higher loads. A remarkable diesel in the NOX emission has been observed for (5,10,15%) ethanol blends with B20, at full load conditions NOX level is directly related to exhaust temperature.

2.4 Experimental study conducted by B.P.Renjith et al [4] on the performance of Ginger oil as a bio-diesel analysed that BTE has capability to increase power developed with increasing of load due to reduction in heat loss. Higher percentage of bio-diesel blends causes SFC to increase which is caused due to combined effect of high viscosity and low calorific value of oil. He observed that co emission increased with increase in load, this is because of the reduction of air-fuel ratio with increase in load. It is also observed that the exhaust gas temperature increase with in load for all tested combinations. NOX emission also increases with increase in the exhaust gas temperature.

2.5 D.Tamilvendhan et al [5] analysed a performance, emission and combustion investigation on hot air assisted eucalyptus oil direct injection CI engine and showed that BTE is lower than diesel except at full load operation, which is due to reduction of heater contribution with respect to increase in load. CO emission of EUDI mode is closer that of standard diesel operation at all loads and when we go for HC emissions, it is observed that the HC emission is lower than that of standard diesel operation at all loads. It shows a slighter variation in the NOX emission. It is higher than that of standard fuel at all loads. Another advantage which makes EUDI unique is nothing but the smoke free exhaust. This might be due to the production of higher combustion temperature due to the rapid burning of volatile eucalyptus oil. They explained that the combustion of eucalyptus oil occurred 40 later than standard diesel operation and produced peak pressure are 50 after TDC. The ignition delay of EUDI mode is higher due to instantaneous reduction of charge temperature as a result of evaporative cooling of eucalyptus oil. In this mode, ignition delay at full load is 120 (30 higher than normal). Heat release is similar to standard diesel. The peak pressure is high due to shorter burn duration and higher rate of pressure at full load.

2.6 In one more investigation on combustion, performance and emission analysis of DI diesel engine using the blends of eucalyptus oil with methyl esters of poon oil and paradise oil by N.V.Mahalakshmi et al [6] and finalized that BTE of 50% eucalyptus oil + 50% methyl ester of poon oil blend was preferable than all other blends and diesel is mainly due to viscosity reduction, fuel vaporisation and combustion. The ignition delay of the EU50-MEPS50 and EU50-MEPS50 blends is longer. In that MEPS is shorter than MEPO ignition delay due to higher cetane number of MEPS. The cylinder peak pressure for EU50-MEPS50 and EU50-MEPO50 are higher than those of standard diesel and EU20-MEPO80, EU20-MEPS80 due to longer ignition delay. This longer ignition delay results higher premixed combustion rate and higher maximum rate of pressure rise due to higher proportion of methyl ester. The heat release for EU20-MEPS80 and EU20-MEPO80 blends are similar to that of standard diesel due to shorter ignition delay.

2.7 Effect of Fuel Magnetism on Engine Peformance And Emission by Farrag A. El Fatih proposed that magnetic effect on fuel consumption reduction was up to 15%.CO reduction at all idling speed was range up to 7%. The effect on NO emission reduction at all idling speed was range up to 30%.

2.8 Performance and emission study of four stroke CI engine using Calophylluminophyllum biodiesel with additives by Avinash et al [8] showed that BTE increases with increase in BP due to addition of SC5D additives. SFC decreases with increase in BP is also due to addition of SC5D additives. It is also found that EGT increase for CIME (CalophyllumInophyllum Methyl Ester) percentage at all loads which is mainly due to its higher viscosity. NOX is marginally increases with the addition of more CIME with SC5D additives to diesel fuel.

III. LITERATURE REVIEW

From the review of literature presented above, the following are the major conclusions:

i) Performance of an engine is enhanced by using vegetable oil as an alternate fuel for DI engine.

ii) Emission characteristics of an engine enhanced by the addition of vegetable oil in diesel fuel.

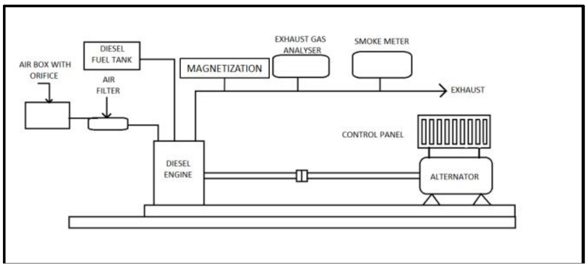
iii) Several researches investigated in several biodegradable vegetable oils, animal fat, waste cooking oils, waste fish fat oils, waste chicken oils and reported the performance and emission characteristics along with diesel blends.

iv) Several researches also investigated the use of vegetable oil as an alternate to diesel fuel along with application of magnetic field in the fuel line which results in better performance and emission characteristics.

v) Few oils such as Cashew Nut Shell Liquid (CNSL) [1] and Mustard oil [15] have the capability of using the oils without any transesterification.

vi) Some many researches resulted that B20 blend (20% biodiesel and 80% diesel) is more similar to diesel fuel and it can be used in DI engine without modifications.

IV. EXPERIMENTAL PROCEDURE



Kirloskar engine was used for test the various blends of bio diesel and diesel. Through this testing engine performance and emission characteristics are measured when it fuelled with various blends of biodiesel and diesel.

V. EXTRACTION OF CNSL

5.1Transesterification of CNSL

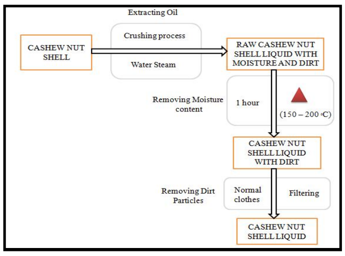


Fig 5.1 Transesterification by KOH (4g)-catalyst & ethanol-reactant

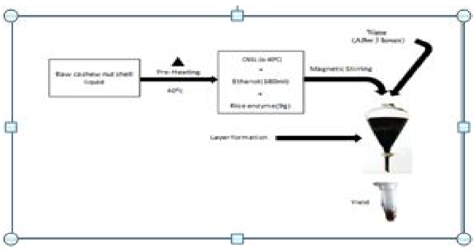


Fig 5.2 Transesterification by KOH-catalyst & ethanol-reactant

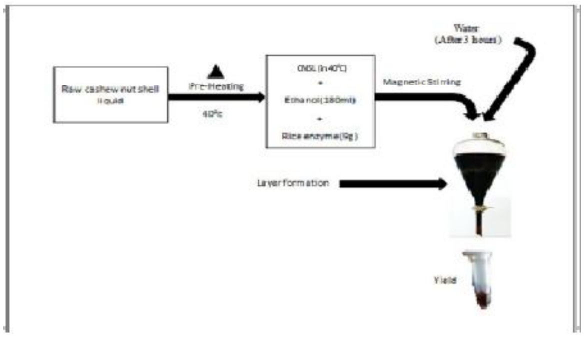
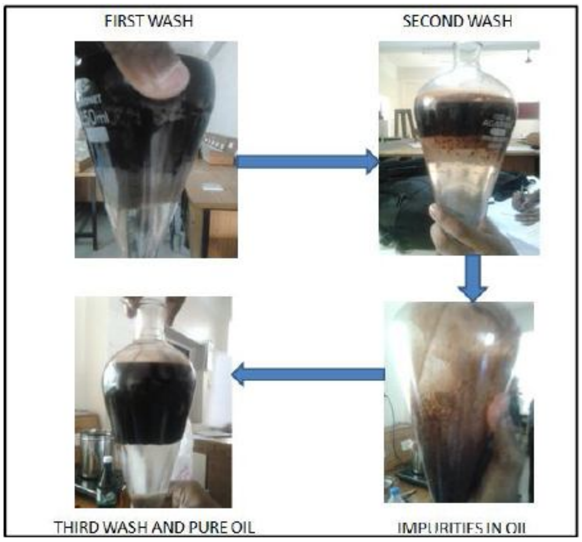


Fig 5.3 Transesterification by Enzyme-catalyst & ethanol reactant

5.1Pre-Treatment of CNSL

Pre-treatment method is the best approach for converting the Cashew Nut Shell Liquid into the biodiesel. Pre-treatment method is defined as the Trial and Error method for conversion of biodiesel. This simplest method is used to reduce the viscosity, flash point, fire point and density of the raw Cashew Nut Shell Liquid (CNSL). Since, the impurities that present in the Cashew Nut Shell Liquid are huge and hence this method is one of the sufficient and efficient methods for removing the impurities.

- Trial and Error Method.
- Reducing the Viscosity of CNSL oil.
- Reducing the Flash point of CNSL oil.
- Reducing the Fire point of CNSL oil.
- Efficient method for removal of the Impurities
- Reducing the density of CNSL oil.

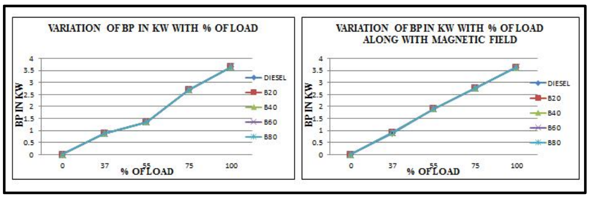


VI. RESULTS AND DISCUSSION

RESULTS

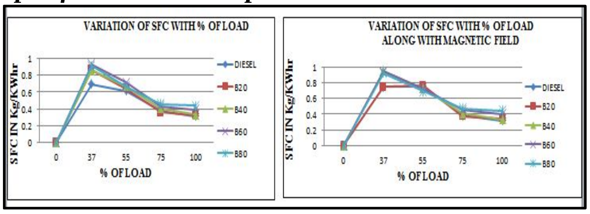
This paper explores the effect of magnetism of fuel molecules. Basically, the fuel molecules consist of number of atoms made up of electrons, protons and neutrons. Also, these molecules have positive and negative charges. These molecules have not re-aligned, the fuel is not actively interlocked with oxygen during combustion. By placing the magnet in the fuel line, the biodiesel molecules are ionized and re-aligned which results in increase in the performance and reduction in the emission.

Brake Power



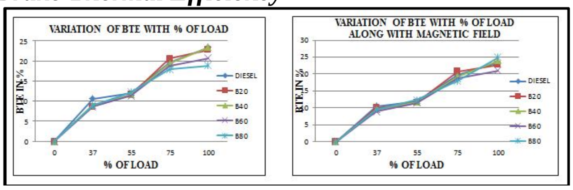
- Maximum Brake Power is 3.642 KW at full load conditions.
- The gradual increase is due to heating values of CNSL blends and stable combustion.

Specific Fuel Consumption



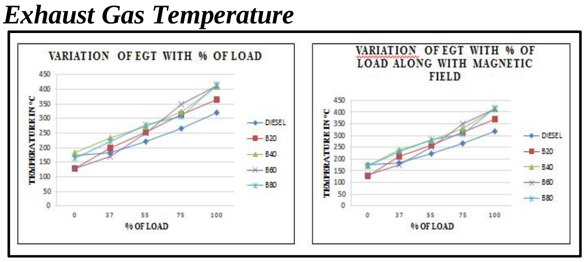
- The lower SFC was observed as 0.335 Kg/KW hr for B40 and 0.3157 Kg/KW hr for diesel.
- This phenomenon is also due to result of magnetic field which influences proper combustion

Brake Thermal Efficiency



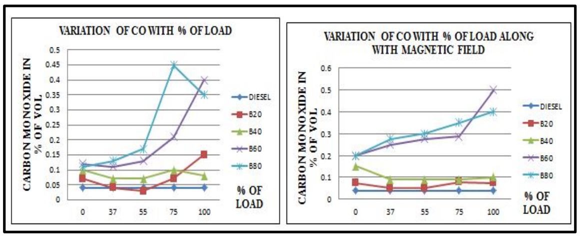
- The BTE of CNSL blends are lower due to lower calorific value of the CNSL blends.
- However, small improvements in BTE are observed with the addition of magnetic field in diesel pipeline.
- The highest BTE was observed as 23.34% for diesel and 22.75% for B20 at full load condition.

Exhaust Gas Temperature



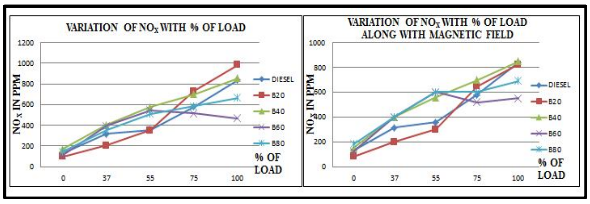
- Except B20, all other blends have higher EGT than that of diesel.
- At starting condition, delay in burning of the higher proportion of CNSL blends, shows higher EGT but lower output.
- Due to this heat loss increase and making the combustion less efficient.

Carbon monoxide



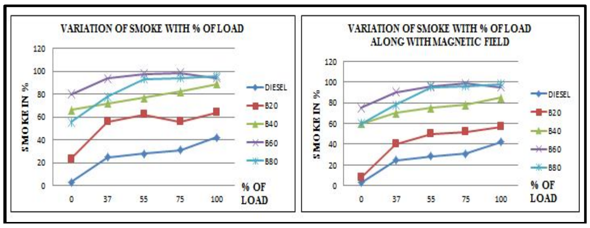
- The Carbon monoxide emission at 37% of load decreases in the CNSL oil of B20.
- The Carbon monoxide emission is marginally decreases and then increases rapidly with higher loads.
- The addition of magnetic field decreases the carbon monoxide emission of B20 at37% of load which is due to oxygen content of copper oxide and combustion property.

Nitrous Oxide



- The NOX emission is lower for neat diesel when compared to all blends except B20.
- The effect of oxygenated additives enhances combustion and the longer ignition delay due to re-alignment of oxygen molecules which results in faster premixed combustion is the cause for higher combustion temperature and subsequent higher NOX.
- The least NOX was found as 130 ppm for neat diesel at 0% load and 840 ppm at 100%.

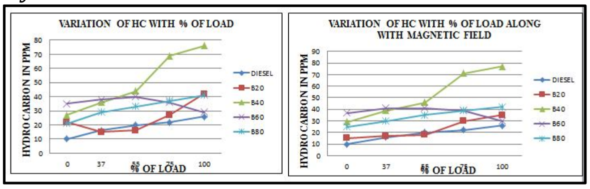
Smoke



- Smoke of CNSL oil blends is noticed generally higher than that of the diesel fuel which is due to heavier molecule structure, poor atomization, pressure of high carbon residue.

- CNSL blends results in higher smoke which is due to higher viscosity of CNSL oil and incomplete combustion.
- The smoke density of neat diesel and B20 blend is almost same compared to neat CNSL oil this is because of less viscosity and improved atomization of fuel.

Hydrocarbons



- Hydro carbon emissions is found to be significantly reduced for B20 at 55% of load.
- Magnetic influences the oxygen for reduction of HC for B20 at 55% of load condition.
- Magnetic field also lowers carbon combustion activation temperature and thus enhances HC oxidation, promoting complete combustion.

CONCLUSION

This paper explores the possibility of using CNSL oil as an alternate oil blend without any esterification. However straight CNSL oil causing various Engine problems in long term, such as coking of injected nozzles, crank case oil dilution, lubricating oil contamination. In order to overcome the use of straight vegetable oils, we go forpre-treatment method which reduces the viscosity and density of CNSL.

The main advantage of CNSL and vegetable derived fuels are bio-degradability and reduction in exhaust emission. The magnetic effect influences the bio-diesel properties to enhance engine life by smooth operation.CNSL degrade at the same rate as dextrose and it is also natural lubricant in small proportion.

The test results show that the use of CNSL as green fuel in diesel engine result in emissions comparable to diesel with substantial savings in fuel cost. The ozone (smog) forming potential CNSL constituents are less than diesel fuel. NOx level is more which can be addressed by the use of NOx control technologies that cannot be used with conventional diesel since there is no sulphur green fuel.

As per the tested results, it clearly shows that B20 blend is optional for Diesel fuel in terms of performance and emission characteristics.As per the tested results, the application of magnet in between the fuel tank and the engine influences the biodiesel molecules to ionize with oxygen for better combustion and it also decluster HC molecules which results in better atomization. This enhances TE and improves fuel economy of engine.In general, the preferred range of magnetic flux density is from 1400 to 1800 Gauss. Ferrite is the most cost effective permanent magnet for rating the bio-diesel.

In Future, additives such as magnesium oxide Nano particles can be used with CNSL-Diesel blends to improve the performance and emission of DI Diesel engine.

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