Influence of nano additives with cashew nut shell bio-oil in CI diesel engine

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Abstract: Biodiesel is a unique diverse fuel source that aims to enhance the worth of fossil fuels and the endurance and hygiene of diesel engines. This cuts requirement on overseas fuels and decreases greenhouse gas productions because of closed carbon chain. The increased nitrogen oxide emissions and their irreconcilability with cold weather environments and the many advantages of biodiesel such as regular fuel filters, fuel reservoirs and fuel fuels for engine components are outweighed. The growth and the inclusion of nanoparticles for fuel additives have another potential to overcome the shortcomings. Cashews are high in tropical biomass surplus used to generate energy such as cerium oxide. Cobalt oxide and aluminums oxide can increase the property of non-additive CNSL and reduce deficiencies.

Key words - Fossil fuels, carbon cycle, style, nanoparticle, additives

1. INTRODUCTION

Biodiesel is a distinct arrangement of fuel for compression-ignition or CI engines. It is extracted from flow sources. Biofuel mergers easily with diesel. Biofuel can be varied with petrol and diesel and is called a biodiesel blend. Can be used as fuel meant for non-stationary diesel engine. The strengths and weaknesses of biofuel use in diesel engines were revealed through an experiment. Conferring to the research, constant use of vegetal oil like gasoline in CI engine can lead to engine problems, which include poor gasoline, heavy engine installation, and high viscosity resulting from injector exposure and low volatility. Prolonged use of highly viscous biodiesel can lead to non-performance engine with a major drawback.

The usage of biofuel is valuable as it keeps the nature well balanced with its natural sources since it is extracted from biological source and emits lesser emissions than fuel used in CI engines [1]. The combination of biofuel and fuel-based fuels can be used in diesel powered engine and no alteration is required. The good thing about biodiesel is that it releases large amounts of fuel and thereby reduces greenhouse gas emissions. Emissions of particles like, HC, CO also further atmospheric poisons are also decrease when biofuel is utilized. Biofuel promotes lubrication as well
as decreases an early damage of fuel motors [2]. Most biofuel are made from edible vegetal seeds. Most of these grains are used to produce eatable oil and with that a different quest continues to recognize different fresh substantial which will be utilize for eatable propose. Another area of biofuel production is the oil shell. Coconut oil as well as cashew shell oil has a key role in bio-oil creation and surplus management.

Cashew production figures available by the FAO (Food and Agriculture Organization) are 2.5M tonnes per annum. India is first country in the region used for cashew production, despite its low yield. Brazil, Vietnam and India account for more than 85% of total cashew kernel exports. Whereas India is the chief yielder and do trading of cashew fruit in the world. Whereas in India, cashew farming nowadays has spread across an area of 0.50 million hectares, manufacturing more than 0.30 million tonnes of green beans. Currently, Cashew Shell Liquid is available as a manufactured material in the cashew industry. The cashew shell is between 2.8-3 mm thick and has a soft bee structure inside which is a vibrant black liquid, which is a cashew carp liquid. The CNSL is usually issued for roasting nuts and collecting expired beverages. Heat treatment method is also available for moisture and moderator removal method for CNSL extraction. In the present situation, thermolysis, method is used for bio-weight translation. Pyrolysis was carried out at a negative pressure of 4N/m² in the reactor and at different high temperatures between 500–700°C with the addition of 40-50°C per test. The evaporating material extracted from the thermolysis is slightly reduced on thick pan, curling the air from the condensate into an ice bath (4–6°C). CNSL is a combination of 4 elements, Usually the configuration is: about 5% cardanol, 10 to 19% cardol, 70 to 95% of anacardic acid, 0.3 to 10% of polymeric material and 1.2 to 4.1% of 2-methylcardol. It is sustainable, cost-effective, eco-friendly to burn and easily blended with diesel. Experimental survey on the benefit of biofuel as a separate fuel for diesel engines are very limited. From experimental testing of CNSL being used as a Fuel alternative for CI engine did not execute achievement, with that it describes as a less expensive fuel for the CI engine. The Research studies [3-7], especially on gas discharge, was unsatisfactory and provided dissimilar outcomes. In this paper, comprehensive study has been conducted to test CNSL bio-oil and No. 2, in which the additional nano is incorporated from several sides. Direct diesel injection engines and a large number of experimental activities are available to evaluate the temperature and implementation of cashew nut shell liquid as biofuel. Through research activities, the cashew nut shell liquid could be utilized as a capable fuel for CI engines without overhaul. The researchers concluded about 15-20% compound did not have an adverse effect so it can be taken, so around 15-20% compound was taken for testing. The cerium oxide in this study is taken considered additive and predict changes in the performance and release of the CI engine.

2. EXPERIMENTAL SETUP AND PROCEDURE:
In the present work, tests are carried out with a single cylinder four-sided cylinder, which shows the visual effects of the test engine on the instinctual desire, the diesel engine illustration. The technical details of the test set are given in the table, which are analyzed by emissions analysis to count the quantity of discharges of HC, NOx and CO. An opacimeter model of the AVL 437C was employed to measure the smoke light. The test engine specifications are:

Stroke: 4, Cylinder: A, Rated power: 9 kW, Rate speed: 1800rpm, Dynamometer: Eddy current Dynamometer, Maximum torque: 75Nm, Bore diameter (d): 80mm, Stroke (L): 90mm, compression. Average: 16.5:1, injection time: 24 ° BTDC, injection pressure: 200 bar

All tests were performed at standard temperature as well as at standard pressure. Engine speediness is calculated through rpm sensor connected to flywheel. The A.C manufacturer was also included with the loading arrangement for rival banks. The primary mechanisms of a fire pressure test setting and volume calculation are the flow sensors unit, power supply setting, voltmeter, ammeter, cold water sensors unit as well as air flow unit. The condition of water and exhaust gas is calculated directly from the thermocouple junction associated with the corresponding areas. It removes NOx, CO, HC, as well as CO2 through Bridge analyzer model. The discharge from the discharge valve is calculated at 250-300 mm. The light intensity is calculated through a smoke meter after dropping the pressure and temperature in the expansion chamber. Engine speed was maintained at 1800 rpm. Performance and emission characteristics were tested for comparison diesel fuel. Individually reading
is 3 times the figure received, maintaining the veracity of conditions.

![Test Engine Setup](image)

**Figure 1.** Test Engine Setup

### 3. TEST AND PREPARATION OF MIXTURES:

Biofuel Enhancer is a bioengineering invention made from Easter pieces of naturally degraded plant and vegetable. In addition to fuel, it breaks down hydrogen chains and fuel atoms into well-organized molecules through a process of molecular regeneration. It discloses fuel molecules to high oxygen and creates moderate heat and can raise the temperature up to 95%, providing lots of energy and power. This softens fire compartment and gives smooth movement to the piston. It was tested and approved by the E.P. Agency of USA. The additive manufacturers recommend 0.0013L per 1L of diesel. For this study cashew nut shell liquid is taken for the preparation of the biofuel. CNSL Biofuel and Diesel Average was around 20:80. As mixture was ready through a mechanical instrument by consisting a chemical reaction, which was stirred for 10 min to form uniform suspensions. The mixture is stored in the pot for 45-60mins, and it does not separate from the mixture.

### 4. NANO ADDITIVES AND THEIR POTENTIAL BENEFITS:

#### 4.1. Cerium Oxide Nanoparticles

- Cerium oxide is the metal having property of donating oxygen atom from its lattice structure which helps to catalase the combustion reaction, as we know that catalytic property depends upon the surface area of the particles. Therefore, using nanoparticles gives the advantage over using bulk or huge particles.
- Cerium oxide assists mainly two major properties which are decomposition of soot and unburnt particles, therefore helping in reducing the discharge of the pollutants it also decreases the amount of fuel used. decreasing the pressure inside the combustion chamber leads to less discharge of NOx and it is also one of the major properties of cerium oxide

#### 4.2. Aluminum Nanoparticles:

- Aluminum nanoparticles as well as microparticles are extensively used as a fuel additive because of their potential. it has been seen that aluminum has the property of increasing the combustion energy and hence more output. Ongoing many researches has given the evidence that size of the particles plays an extensive role in their properties. specially with nanoparticles of aluminum shows the extensive reaction rate as fuel additives.
4.3. Cobalt Oxide Nanoparticles:

- In cobalt oxide nanoparticles, oxygen particles present in them helps to moderate out the reaction which is similar to the cerium oxide nanoparticles. Similar functions give lots of advantages when cerium oxide additive added to fuel it noted that the CO emissions was lot less and the combustion was lot cleaner. Both unburnt hydrocarbon and CO emissions were significantly lower.

5. RESULTS AND DISCUSSIONS

5.1 Combustion characteristics:

The change of pressure in the cylinder for each mixture as shown concerning crank angle at maximum load is shown in figure 2. Yet, the topmost pressure for Diesel, CeO₂, CNSl was about 62.4 bar, 52.5 bar, 67 bar respectively. Nevertheless, the maximum cylinder pressure after the TDC used for all fuels tested is approximately 5 to 7 degrees around single crank angle positions. Due to the lengthy combustion deferment, the maximum cylinder pressure decreases.

5.2 Thermal rate:

The difference of the thermal release rate for CeO₂ and crank angle is in Figure 3. The maximum thermal rate for diesel was observed to be high; Because of high volatility and long ignition delay and on the other hand the low thermal instability and high viscosity of the bio-oil mixture have a low maximum heat release rate.

![Figure 2](image-url)  
*Figure 2. Change of cylinder pressure relative to diesel, CNSL, CeO₂*
5.3 Engine performances:

Engine brake thermal efficiency is an indication of the effective pressure (BMEP) for fuel studies, where the difference with load in case of brakes is related in figure 4. Hence it states that using cerium oxide in fuel improvises the BTE.

Figure 3. Thermal rate with crank angle for CeO₂

Figure 4. Difference of BTE with respect to engine loads
5.4 Pollutant Emissions:
Differences in carbon monoxide (CO) discharge and loading engine with different fuel combinations can be seen in Figure 5. The maximum and minimum CO creation produced are 0.08 and 0.01% (volume). It can be seen from the figure that CO was initially reduced to 80% of the load and then increased to bursting load. Low CO emissions were detected at the CeO2 compound, which is 37% higher than diesel under full loading conditions. This is due to its complete design compared to diesel. Differences in hydrocarbon (HC) emissions and refined engine loads have long-term thermal delays. This effect increases the HC emissions of biodiesel fuel related to diesel fuel. In the case of nanoparticle composite biofuels, HC emissions are lower compared to the CEO2 composite.

![Figure 5. Difference of CO emission with deference to engine load](image)

6. CONCLUSION
There are three tests performed which are performance, combustion and emission test in single cylinder CI diesel engine with the nanoparticle added fuel at the constant speed and the following conclusion can be observed:
1. Remarkable upgrades in the property of the nanoparticle blended fuel can be seen. Different nanoparticles with their properties improved the quality of fuel as well.
2. It can be seen from the graphs and the calculation that the Observable difference present at BTE, if compared to the Diesel.
3. By adding nanoparticles, the ignition delay decreases in the cylinder and it also increases the rate of combustion which results in gradual heat release and CI engine can work on optimum load.
4. The most significant change can be observed in the emission of any of the nanoparticles shows the improvement.
5. Specifically in the CO emission, we can observe that the cobalt oxide nanoparticle and the Aluminum nanoparticles show the reduction up to 40% from the diesel and cerium oxide shows 4% less emission than the diesel. It’s the huge decrease in the amount of CO released.
6. Emission of CHC and NOx is also noteworthy, because here cerium oxide shows the major improvement of 30% less emission compared to diesel as well as diesel and CNSL blend.

7. These nanoparticles work on the similar process of catalyzing the reaction by providing extra oxygen molecules to the reaction by the oxidation, it can be also observed from the graph and table of efficiency.

Thoroughly, combustion, emission and performance are seen to be improved without changing the characteristics of the CI diesel engine. Significant improvement is shown by Cerium oxide nanoparticles followed by aluminum nanoparticles without modifying the engine.

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