Performance and Emission Test on Cashew Nut Shell Liquid Oil as Biodiesel

P.Arul kumar[1] T.Dineshkumar[2] G.Gnanamoorthy[3] R.Karthikeyan[4] K.Kavin[5]
[1,2,3,4,5]Student
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]R.M.K college of Engineering and Technology, Puduvoval, Thiruvallur Dist, Chennai, Tamil nadu, India

Abstract— The demand over the fuels through fossils has been increased dramatically due to the over usage and increase in the automobiles and other commercials and the various environmental degradation through the exhaust gases from the fossil fuel engines has been increased a lot. Hence there is in a need of various alternative sources of energy namely electrical energy, hydrogen fuels and biodiesels since biodiesels are obtained from the waste vegetable oils and the plants hence there is a huge future in the usage of the biodiesels. The biodiesels are produced from various methods they are transesterification , sublimation and pyrolysis ,various researches has been done on the biodiesels throughout the year but there is few works that is based on the usage of the cashew nut (annacardium occidentale) as the biodiesel here is the various blend of the biodiesel with the original diesel .Here is the various experiments on various blends that carried on a Kriloskar make four stroke, single cylinder engine, air cooled diesel engine to analyse Combustion ,performance and emission characteristics of the blends at the various engine loads with constant speed of 1500 rpm. As per the results the specific fuel consumption of the B20 and B80 is decreased when compared to the pure diesel and brake thermal efficiency of the blend also increased comparatively.

Key words: Emission Test, Kriloskar

I. INTRODUCTION

Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. The process used to convert these oils to Biodiesel is called transesterification .Bio diesel refers to a vegetable oil or animal fat based diesel fuel consisting of long chain alkyl-esters. Biodiesel is typically made by chemically reaching lipids (example: vegetable oil, soya bean oil) animal fat with an alcohol producing fatty acid. Bio diesel is used in standard diesel engines and in thus distinct from the vegetable and waste oils used to fuel converted diesel engines .Biodiesel can be used alone or blended with petro diesel in any proportions. Bio diesel blends can also be used as heating oil.

II. CASHEW IN INDIA

Cashew (Anacardium occidentale Linn.,), often referred to as ‘’wonder nut‟ is one of the most valuable processed nuts traded on the global commodity market and is also an important cash crop. The cashew tree originates from Brazil and is well established in tropical regions primarily for soil conservation, a forestation and wasteland development. The cashew tree has introduced in India by the Portuguese in 16th century. It is known as ”Mundiri‟ in Tamil language and also indicating the shape of the nut in Tamil Nadu. In India cashew cultivation is concentrated on the west coast between Bombay and Kanyakumari and upto Berhampur on the East coast. Since it can adapt varied agro climatic conditions it has become a crop of high economy and commercial value. India is the largest exporter after Vietnam, accounting for 34 percent of the world’s export of cashew kernels. Similarly Cashew Nut Shell Liquid, which is a byproduct of the cashew industry, is exported mainly to countries like USA, Korea, Japan and other countries.

Properties of CNSL Oil

- Low Cost Phenol
- Versatility In Polymerization And Chemical Modification
- Automobile Brake Lining Such As Liquid Resin
- Cashew Friction Dust (CFD)
- Advantage Over Phenolics In Certain Application Such As Impact Resistance, Flexibility, Faster Heat Dissipation Etc,

Application of Cnsl Oil:

- Paint and varnishes
- Laminating resins
- Rubber compounding resins
- Cashew cements
- Epoxy resins

A. Composition in the Shell

Cashew nut shell is said to be pericarp which has a liquid yellowish brown in color which can cause dermatitis. The major composition of the liquid is anacardic acids, phenolic lipids and cardanol. Anacardic acid is said to be high hydrocarbon family which is said to be a fatty acid or vegetable oil.

Name	Formula	Substance	Value
Cardanol	$C_{21}h_{30}o$	Alcholic Substance	298.47 G/Mol
Anacardic Acid	$C_{22}h_{30}o_3$	Fatty Acid	348.53 G/Mol
Cardol	$C_{21}h_{36}o_2$	Alkylresorcinol	320.52 G/Mol

Table 1: Cmposition of CNSL oil

B. Extration of CNSL Oil

Biomass in the form of cashew nut shell represents a renewable and abundant source of energy in India. Cashew nut shell (CNS) was pyrolysed in a fixed bed pyrolysis reactor under vacuum. The CNS on heating up to 175°C produced dark brown oil, which was extracted, and the CNS, after the removal of oil, was pyrolysed under vacuum. The pyrolysis vapors were condensed to get a combustible oil fraction as well as a noncombustible aqueous fraction. The CNS oils were found to be a renewable natural resource of unsaturated

phenols with long linear chains and marked absence of anacardic acid. Unlike other bio oils, the CNS oils have been found to be fairly stable. The oils were completely miscible in diesel and were found to have low corrosivity towards Copper and Stainless steel, and thus promise to be a potential fuel.

C. Structure of main components of CNSL:

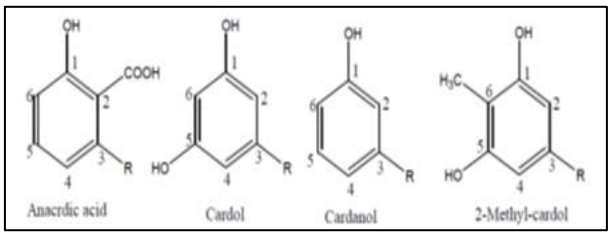


Fig. 1:

D. Methods of producing biodiesel from CNSL:

Studies have revealed that the usage of non-edible oil in neat form is possible but not preferable. The high viscosity of non-edible oils and low volatility affects the atomization and spry patterns of fuel, leading to incomplete combustion and severe carbon deposits, injector choking and piston ring sticking. The methods used to reduce the viscosity are.

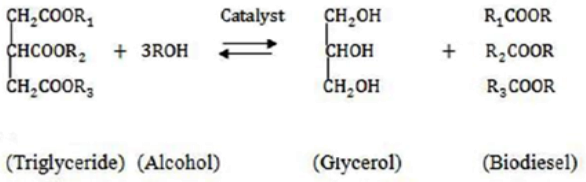
- Emulsification.
- Pyrolysis.
- Dilution.
- Transesterification.

Among these, the transesterification is commonly used commercial process

E. Transesterification:

Transesterification is the process of conversion of fatty acid or vegetable oil into a effective bio diesel combined with the diesel. Transesterification is the process which converts the viscosity by reducing the long carbon and oxygen chain that reduces the viscosity. This paper contains the details of transesterification of CNSL oil.

F. Transesterification Reaction:



G. Transesterification Process:

- CH3OH - 300ml
- NAOH - 5g
- H2SO4 - 2ml
- CNSL OIL - 1 liter
- Maintained at 60o C for two hours and kept in settling separator over a night
- Glycerol is separated and then wash the remaining oil using warm water
- To remove the water content heat the oil up to 100oC and then bio diesel is obtained

Initially take 1 liter of CNSL oil and mix with 200ml of CH3OH and 2ml of H2SO4 heat with 60oc for 3 hours and then mix 100ml of CH3OH and 5g of NAOH and then heat for further 3 hours and then kept it in a settling separator over a night. Then remove the glycerol and take the bio diesel. Then wash with the warm water. Finally bio diesel is obtained.

H. Pyrolysis:

Pyrolysis is step to convert the CNSL oil into an effective bio diesel with the amazing calorific value of 40,000kj/kg. The pyrolysis need to done at the range of 400 to 550degree Celsius which converts a fatty acid into the effective substitute for diesel.

Pyrolysis strictly defined as the conversion of one substance into another by means of heat or by heat with the aid of a catalyst. It involves heating in absence of air or oxygen and cleavage of chemical bonds to yield small molecules .The decarboxylated cardanol is termed as CNSL biodiesel. The biodiesel obtained from CNSL not required for further processing like transesterification. It can be obtained by pyrolysis. Heating CNSL decomposed the anacardic acid into cardanol and CO2. Decarboxylation of CNSL to convert anacardic acid into cardanol could be done by heating, with an optimum heating temperature of 140°C for 1 hour. Cardanol was isolated from the CNSL by vacuum distillation (4-8 mmHg) at high temperature, with an optimum temperature of 280°C, and the rendement 74.22%.

I. Load Vs Bte:

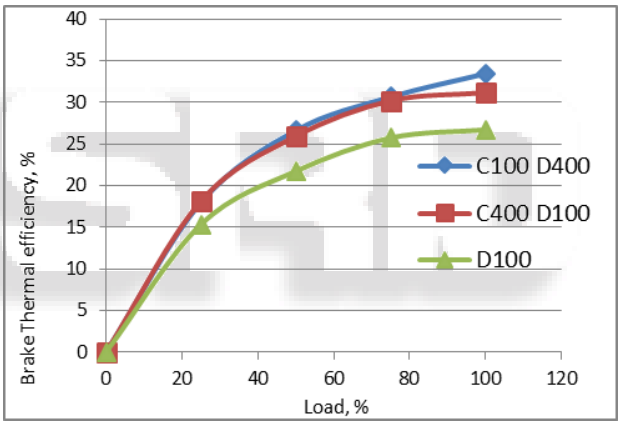


Fig. 2:

According to the load vs BTE graph the brake thermal efficiency of the B20 is maximum when compared with the B80 and pure diesel D100.

J. Load Vs Exhaust Temperature:

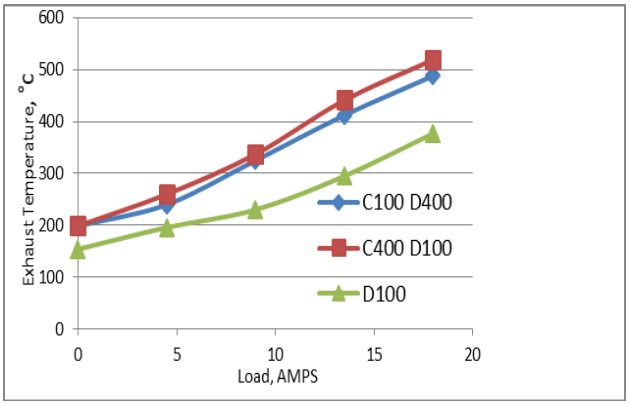


Fig. 3:

According to the load vs exhaust temperature graph the B80 is comparatively maximum and increases with respect to the increase in load with the blend B20 and D100.

K. Load Vs HC:

The below graph says that the emission of HC from the engine seems to be low at the zero load condition and gradually decreases at the average load and increases when the load seems to increase. At 100% load the HC emission is around 65 ppm.

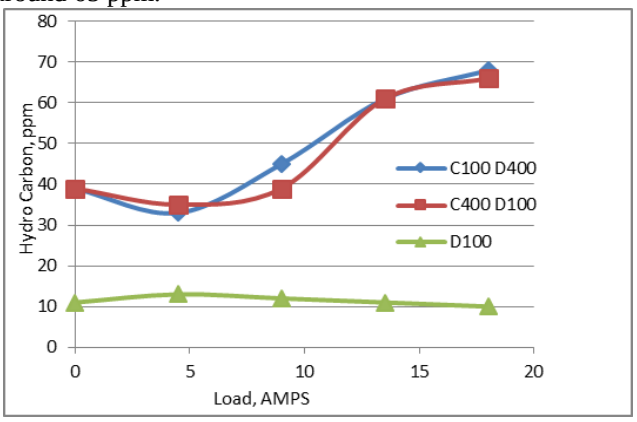


Fig. 4:

L. Load Vs Bp

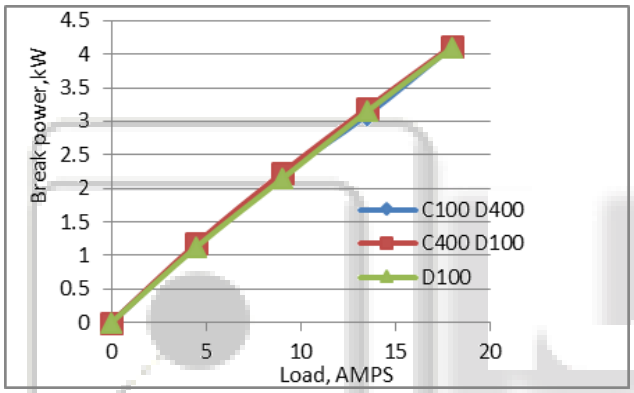


Fig. 5:

The above graph says that the brake power of the blend increases proportionally with respect to the load and its seems to be the same when compared with the diesel D100

M. Load Vs Co:

The graph on load vs CO says that the B20 and B80 decrease up to the half load condition and increases to the maximum at 100 % load and it seems to be maximum compared with D100 pure diesel

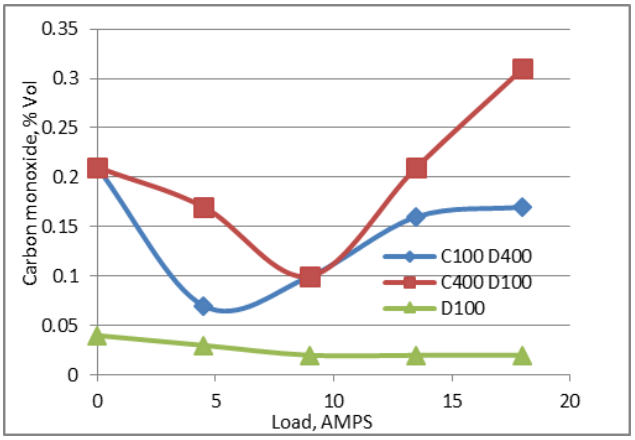


Fig. 6:

N. Load Vs Carbondioxide:

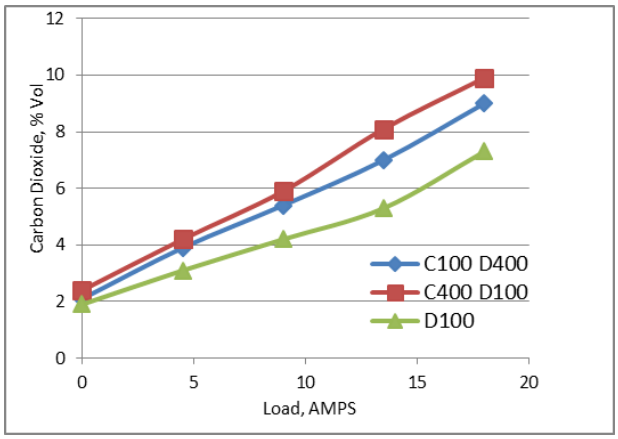


Fig. 7:

According to the graph the emission of carbon dioxide with respect to the load seems to be increasing gradually from zero load condition to full load condition. At zero load the emission of carbon dioxide for B20,B80,D100 is around 2% of total volume of the exhaust gas and increases to the B20 is 7.5% , B80 is 10% which is slightly high when compare to the diesel

O. Load Vs Nox:

The above graph says that the emission of NOX increases with respect to the load applied from 200ppm at zero load condition for B20,B80,D100 to1800ppm for B20 , 1700ppm for B80 and 1500 for D100 which is comparatively high for the blends.

P. Load Vs SFC:

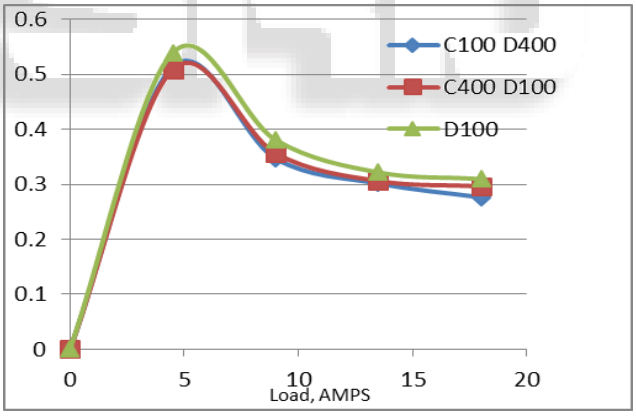


Fig. 8:

According to the above graph, the specific fuel consumption rate seems to be decreased when compare to the diesel's fuel consumption rate.

The fuel consumption rate of B20 and B80 remains high at the electrical load condition of 5AMPS.

III. Conclusion

Here the result of Cashew nut shell liquid oil that has been tested using a Kirloskar make four stroke, single cylinder engine, air cooled diesel engine to analyze Combustion, performance and emission characteristics of the blends at the various engine loads with constant speed of 1500 rpm. Says that the blends has more brake thermal efficiency and brake power than the pure diesel and the emissions like CO, HC, NOx, CO 2, O2 in the same amount as the diesel that is used in the recent days.

Among the other specifications the specific fuel consumption time is less than the diesel. As per the results the specific fuel consumption of the B20 and B80 is decreased when compared to the pure diesel and brake thermal efficiency of the blend also increased comparatively. B100 of specific fuel consumption is comparatively near to other blends. Finally we concluded that the Cashew nut shell oil has good performance characters than diesel. And having emission character is slightly higher than the diesel.

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