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Experimental Analysis of CNSL as an alternate fuel for CI Engine

Sangeetha Krishnamoorthi*, Mohammad Ramees KS, Mohammad Iqubal V, Melbin Chacko
Aarupadai Veedu Institute of Technology, Tamilnadu, India.
***Corresponding author: E-Mail: mvramcet@yahoo.co.in**

ABSTRACT

Nowadays biodiesel which is an alternate fuel, is produced from easily available resources like virgin or used vegetable oils, both edible and non-edible. Without any further changes it can be used in compression-ignition (diesel) engines. There is a big demand to produce bio diesel in India and supply of this oil is becoming necessary. Indian plants like Jatropha (Jatrophacurcas), Mahua (MadhucaIndica), Karanja (Pongamiapinnata) and Neem (Melliaazadirachta) contain some percentage of oil in its seed, fruit or nut. In India, as edible oils are less in supply, non-edible seeds of karanja, Jatropha, Mahua and Neem are found as the sources of neat vegetable oil and biodiesel. Plant species, which has a certain amount of oil in their seeds or kernel, have been identified. The outer part of cashew nut contains a honey comb network of cells containing a viscous liquid called cashew nut shell liquid (CNSL). This liquid is obtained from the shell of a cashew nut. Almost 30-35% of CNSL which is present in the shell, can be used as an alternate fuel for CI Engines.

KEY WORDS: Edible oil, Cashew nut shell liquid.

1. INTRODUCTION

CNSL: Portuguese brought this Cashew tree (Anarcardium Occidentale) to Africa which is a native of southern America. The economic importance of this nut and tree was of very high value. The major producing countries of cashew are Tanzania, India, Mozambique, Sri Lanka, Kenya, Madagascar, Thailand, Malaysia, Indonesia, Nigeria, Senegal, Malawi, and Angola. The by-product of the cashew industries is the Cashew nut shell liquid (CNSL). Open pan roasting drum roasting, hot oil roasting and cold extrusion is some of the methods by which the cashew oil is extracted. Cashew nut is the main product of cashew plant, such as the secondary products are false fruits and cashew nut shell liquid (CNSL). These secondary products are not used in a fruitful manner and are considered as simply wastes. The production of unshelled cashew nuts in the year 2002 was about 95000 tons and about approximately 42000 tons of CNS were obtained, hence it contained about 7,650- 10,861 tons of CNSL. The main components of CNSL are anacardic acid, cardanol and cardol.

Uses of CNSL: The different ways in which the Cashew nut tree, Cashew nut, and cashew oil are used is given below:

Food: Botanically, the fruit of the cashew tree is the nut and it is considered as one of the more costlier food which is used in day to day life. The roasted nuts are shelled and the seeds kernels are extracted. Cashew is used as a food by all which has a lot of proteins, vitamins, minerals and is also rich in fat.

Fodder: Even animals are fed with the cake which remains after the oil has been extracted. Poultry are also fed with seed coats.

Fuel: The outer cover of the shell is mostly used as fuel in the extraction plants of cashew nut shell liquid.

Fiber: Hardboxes are fabricated by using the pulp from the wood.

Gum or resin: For the curing of Epoxy hardeners and epoxy resins the cashew nut shell liquid is used as a important raw material.

Lamination: For improving the flexibility and reducing the brittleness the derivatives of cardanol are used. **Lipids:** The derivatives of cardanol are used as antioxidants, plasticizers, and also for ion exchange resins

Alcohol: Cashew wine is enjoyed by many people in different countries and also in India to make 'fenni' which is a type of 'Brandy'.

Poison: Sometimes it acts as a high insect repellent properties.

Medicine: For curing many stomach problems, coughs and cold cashew syrup is used by many people even both in urban and rural areas.

Timber: The important applications like making furnitures, for making false ceilings, and also for interior decoration the wood of cashew is used which has a density of approximately 450-500 kg/cm.

2. MATERIALS AND METHODS

Technical CNSL and natural CNSL are the two types obtained which also depends on the type of Extraction. Technical CNSL is rich in Cardanol (also known as Decarboxylated CNSL) whereas Natural CNSL is rich in Anacardic acid. Subbarao explained the three methods of producing the cashew liquid from the nut and the types are:

- Thermal extraction
- Mechanical extraction
- Solvent extraction

Methods of producing biodiesel from CNSL: The use of non-edible oil in neat form is not preferred even though it is possible to use it. The viscosity of these oils is more and so it can lead to many combustion problems and deposits, injector choking and piston ring sticking. Velmurugan explained the methods used to reduce the viscosity which are listed below.

1. Emulsification.
2. Pyrolysis.
3. Dilution.
4. Transesterification.

Transesterification of CNSL: Mallikappa, explained that the engine deposits, injector plugging, or lube oil gelling are the problems caused when the pure oils are used directly in the diesel engines. In diesel engines these oils are used after, they are chemically treated and that chemical process is known as transesterification. The transesterification which is also known as alcoholysis is the reaction of fat or vegetable oil with an alcohol to form esters and glycerol. Adding a catalyst can improve the rate and yield of the reaction. Excess alcohol moves the equilibrium to the product as the reaction is reversible in nature. The primary and secondary monohydric aliphatic alcohols which has about 1-8 carbon atoms are generally used in this purpose.. The chemical reaction of transesterification processes is shown below

$$\begin{array}{ccccccc} CH_2COOR_1 & & (Catalyst) & & CH_2OH & & R_1COOR \\ & & & & \downarrow & & \\ CHCOOR_2 & + & 3ROH & \leftrightarrow & CHOH & + & R_2COOR \\ & & & & \downarrow & & \\ CH_2COOR_3 & & & & CH_2OH & & R_3COO \end{array}$$

Table.1. Moisture content of CNSL extracted by screw press and hot oil bath method

Type of oil	Moisture content.% (wb)
Crude CNSL extracted by screw press	0.75± 0.01
Heated CNSL extracted by screw press	0.69±0.01
CNSL extracted by hot oil bath method	0.65±0.01

Table.2. Specific gravity of CNSL extracted by screw press and hot oil bath method

Type of oil	Specific gravity
Crude CNSL extracted by screw press	0.98 ± 0.01
Heated CNSL extracted by screw press	0.96 ± 0.01
CNSL extracted by hot oil bath method	0.96 ± 0.01

Methodology: The methodology that was adopted in this study is listed below.

- Selection of water cooled diesel engine with single cylinder.
- Instruments the engine air flow, fuel flow, emission measurements.
- The engine was run with neat diesel.
- Optimisation of preheated CNSL oil and ethanol.
- Conduct the experiments with the preheated blend of CNSL oil and ethanol.
- Compare the CNSL oil and ethanol results with neat diesel.
- Developing an experimental setup with required instrumentation of the diesel engine.
- Conducting experiment with CNSL to study the performance, emission and combustion

Figure.1.VCR Engine -A Schematic view

3. RESULTS AND DISCUSSION

The engine tests have been conducted to test the performance, emissions and combustion characteristics of diesel engine using CNSL and its diesel blends as fuel.

From the results, the following conclusions were made: Compared with diesel fuel, the cylinder peak pressure is lower compared with diesel fuel. The heat release rate of all CNSL-diesel blends are lower compared to that of diesel fuel. The brake thermal efficiency is lower for all CNSL and its diesel blends compared to diesel.

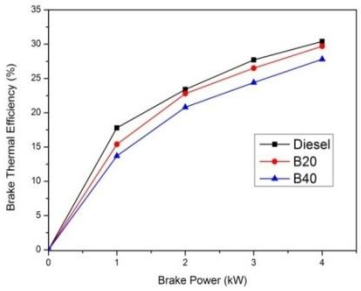
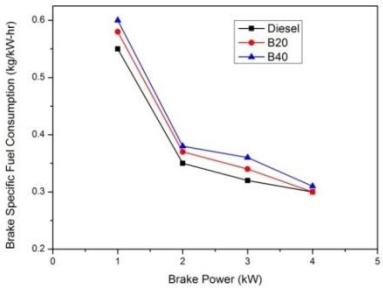


Figure.2.



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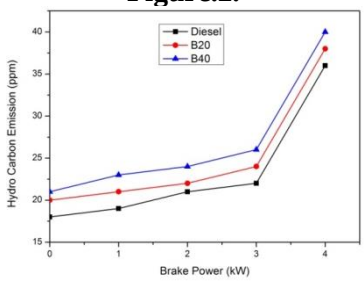

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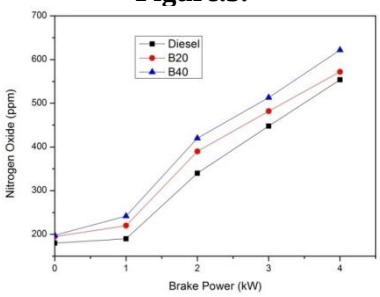

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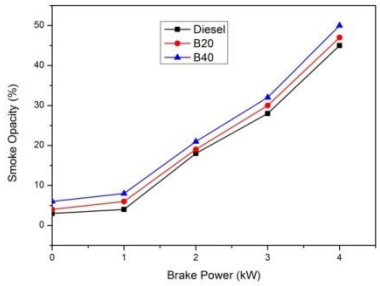

Figure.5.

4. CONCLUSION

The brake specific fuel consumption was increased for the CNSL compared to diesel fuel. For lower blends the BSFC values are acceptable. The HC emissions are higher for all the CNSL blends compared to that of the diesel fuel. The exhaust gas temperature was increased for all the CNSL blends at all loads compared to diesel.The NO emissions were increased for all the CNSL blends compared to diesel fuel. The smoke emissions are lower for all CNSL and its blends compared to diesel fuel. The smoke opacity value is lowered by 40% compared to diesel fuel at full load. On the whole, it is concluded that the lower blends of CNSL-diesel blends might be used as an alternative fuel with slight increase in emissions for diesel engines without any modifications.

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