# BIO-DIESEL FROM CASHEW NUT SHELL OIL

[1]AMIT KUMAR H, [2]SHAMANTH, [3]ABOOBAKAR SIDDIQE ZAMEER, [4]SYED MUSTHAHEEB, [5]KARTHIK V KUMAR
[1]Assistant Professor, [2345]Student
[1]Department of Automobile Engineering.
[1]Srinivas Institute of Technology, Mangalore, India.

***ABSTRACT:*** *Diesel Engine is widely used than any other engine, the performance characteristics of cashew nut shell liquid into a neat diesel in a diesel engine. As a fuel play an immortal role in modern transportation system, Due to lack of petroleum product and the diminution of fossil fuel finding the alternative fuel to the society is necessary. Country like India and Africa are having larger growth in cashew product and it is abundantly available and it is inexpensive. The experiments were conducted with blends of cardanol and diesel namely B25. Break thermal efficiency of B25 is nearer to that of diesel and also emission characteristics slightly increased. The higher viscosity and lower volatility of CNSL leads to poor mixture formation and hence lower brake thermal efficiency and higher emission levels. The higher emission level can be reduced by adding suitable additives and oxygenates with CNSL and Diesel blends.*

*Key words: CNSL, biodiesel, cardanol, distillation*

## I. INTRDUCTION:

The uses of alternative fuel resources is play an vital role in the mode of transportation .cashew oil is one of the bio-fuel resources .Cashew is an important plantation crop of India. It is presently grown in an area of 9.23 Lakh hectares. India is the second largest producer of cashew in the world. Maharashtra is the state which produces and exports large tones of cashews. Alternative fuel for compression ignition engine finds very attractive and has greater scope especially in developing and undeveloped countries due to the fast depletion, cost and environmental pollution from fossil fuel [1].

In the last two decades, extensive research was carried out in using various vegetable oils such as Jatropa oil, Karanja oil, rubber seed oil, cotton seed oil, coconut oil etc in diesel engines using different techniques such as preheating, Transesterification, blending with orange oil, blending with methanol, blending with diethyl ether, and hydrogen supplementation [3].Presently cashew nut shell liquid (CNSL) is obtained as a byproduct of cashew industry. The cashew nut has a shell with soft honey comb structure inside it. Cashew nut shell liquid (CNSL) is acidic in nature it contains anacradic acid. There are different methods used to take derivatives of CNSL it may be pyrolysis or distillation process which we obtain cardanol further process is done and we obtain cardo.

Supercritical extraction of Cold extracted CNSO as well as CNSO obtained from Steam extracted shells can also be carried out for recovery of anacardic acid to compare the extent of anacardic acid obtained with that of chemical methods[6]. We perform various property tests like viscosity flash point, fire point, and calorific value in order to compare with the diesel and to perform in the engine test rig.

It is extensively used in the manufacture of superior type of paints, insulating varnishes in the electrical industry, special types of adhesive cement, friction and brake linings, laminating and epoxy resins, rubber compounding resins. From these studies, the cardanol have the properties much closer to the conventional diesel and which can be used as a biofuel in addition with diesel fuel.[8]

### I.1 History

Cardanol-phenol resins were developed in the year 1920 by Mortimer T. Harvey. Cardanol is smooth honey like structure, the main component of cashew nut shell liquid (CNSL) is a byproduct of cashew nut processing. Cardanol finds use in the chemical industry in resins, coatings, frictional materials, and surfactants used as pigment dispersants for water-based inks. At commonly used densities of more than 100 trees per hectare, many of these trees yield 10 to 15 tons of seeds per hectare on maturing.[4]

### 1.2 Introduction of Cardonal

Cardonal is a byproduct of CNSL (**C**ashew **N**ut **S**hell **L**iquid), CNSL is derived from naturally occurring cashew seed, after the removal of cashew apple the remaining part is called as the cashew in which outer shell of the nut is known as kernel.it has got benzene like structure that molecular structure is obtained as anacradic acid ($C_{15}H_{31-n}$).

### I.1.1 Blends Of Cardanol and Diesel

In previous study paper the different quantity of blends were done. The blends are B20, B30 and B40. In which neat diesel is blended with cardonal added by volume ratio as B20 without adding any additives. Further by adding additives the test results were conducted. The blending of oil was mixed with help of a mechanical stirrer, and it is found that up to 50% of CPO bio oil blend diesel fuels, without any separation for long time. CPO10, CPO 20, CPO 30, CPO 40 and CPO50 blends of pyro oil have comparable low properties compared to diesel fuel.[2]

## I.2 GENERAL METHODOLOGY:

### I.2.1 Oil Extraction

Kernel preparation: After removal of cashew apple the remaining cashew nut is sent to food industries they remove the outer shell of nut by using hand cutter. In which kernel get separated And it is fed into mechanical screw presser, in which oil get extracted. Followed processes are being used in separation of oil from husk of the kernel:

1. Roasting method (a) Hot oil bath( b) Using solar cooker
2. Mechanical extraction
3. Solvent extraction. (Diethyl ether)
4. Thermal extraction

### I.2.2 Separation Of Solid Waste Of Kernel

The removal of solid particle done by filtration, and it is reused. Cashews are in the same "family" as poison ivy and poison; these pants contain powerful chemicals called anacardic acids. So handling and eating raw cashew nuts will cause itchy skin. These chemicals are found in the shell oil but not in the nuts. That is why they are roasted as when they are roasted at high temperatures it destroys the shell oil making it safe to eat.

### 1.3.3 Followed Processes Of Extraction From CNSL to Cardonal

i. transesterification method
ii. distillation method
iii. chemical method

## II. OBJECTIVE:

Biodiesel is the fuel of future. Once it gets in to mass production it will be cheaper than the petroleum. Since petroleum is a diminishing source of energy there is a wide market for biodiesel to run conventional diesel engine. Biodiesel is a green energy source which reduces the addition of pollutants to atmosphere. India is one of the largest producers of cashew, which will result in easier availability of raw material. Selection of bio oil which is suits for different blends. Comparing the blended oil with the neat diesel. Carryout the different processes like screw press method and distillation process in order to get a derivative of CNSl (cashew nut shell liquid). Blends of 25%, 30%&35% are done by electronic stirrer. Cardonal is added to diesel without any additives .In order to get blended fuel characteristic's and fuel property as that of diesel, we conducted various property test like viscosity, flash point, fire point, and calorific value. Conducting FTIR test for confirmation for different wavelength. Conducting Engine performance test and emission characteristics. Main Objective is to follow simple steps in extraction & blending processes and also biofuel is to perform similar to that of diesel without adding any additives. This study gives relevant results than other available papers on cashew bio-diesel.

## III. METHODOLOGY:

### 3.1 To produce biodiesel 3 basic steps has to be followed

a. Extraction
b. Processing
c. Testing

### 3.1.1 Extraction

The cashew nut outer shell is about 0.3 cm thick, having a soft feathery outer skin and a thin hard inner skin. Between these skins is the honeycomb structure containing the phenolic material known as CNSL .In extraction process there are several kind may be Thermal extraction, a) Roasting method b) Hot oil bath c) Using solar cooker, Mechanical extraction, Solvent extraction. (Diethyl ether) the outer shell of cashew called as kernel in which the oil is got extracted .Here we followed a simple method called mechanical screw press method for extracting the shell. The impingement of hot steam is deemed to soak the shells in a hot environment for some time and help recover some amount of oil. Subsequently, the hot shells are crushed in a mechanical expeller. Further the distillation processes is conducted in a boiler were the black brown liquid of CNSL is got turned into a light brown color.

**Cashew nut, Cashew kernel and Cashew nut shell**

### 3.1.2 Processes

According to the invention CNSL contains ancradic acid which is converted by decarboxylation processes of anaradic acid. In this processes natural CNSL is heating under vacuum condition up to 180 °C in which ancradic acid is converted into cardonal. After this cardonal is further sent for purification in which it is separated from rest component.

In CNSL distillation, cardonol is recovered at the top of column and at the bottom of column tarry type matter is remains. It has been found that there are certain difficulties of operation with regard to single stage fractional distillation. The processes are carried pout within a short period of time or else it loses its property.

CNSL distillation is done at about 200°C to 240°C under reduced pressure condition in which thick tarry type material is settled and same procedure taken into second distillation processes after that it is subjected to boiler and heated up were the black brown liquid of CNSL is got turned into a light brown color. After getting a raw as cardanol, it is blended with the diesel as B25-(25% cardanol with 75%diesel) it is done with the electric stirrer.

## IV. Testing

As we reviewed there is no higher version of blend is done yet only up-to B20(20%cardonal and 70%diesel), But there is a higher version of blending(B30,B40…uptoB50) is done by adding additives as an catalyst to alter the fuel property. So As per study we moved on B25 (25% of cardinal with 75% of diesel) and we got nearer property as of diesel has, that is flash point, fire point, viscosity and calorific value.

## V. RESULTS AND DISCUSSION:

### 5.1 PROPERTY COMPARISON OF CARDANOL, DIESEL, B25, B30

| Sl.no | property | Cardanol | diesel | B25 | B30 |
|---|---|---|---|---|---|
| 1 | Flash point | 92°c | 74°c | 79°c | 83°c |
| 2 | Fire point | 96°c | 82°c | 88°c | 90°c |
| 3 | Kinematic viscosity(mm2/sec) @30°c | 43.8 | 5.16 | 8.41 | 8.70 |
| 4 | Calorific value (MJ/Kg) | - | 44 | 34.05 | 32 |

### 5.2 ENGINE SPECIFICATION

| Sl.no | Engine specification | |
|---|---|---|
| 1 | Engine | 4 stroke 1 cylinder water cooled multi fuel engine |
| 2 | Basic Engine | Kirloskar |

| | | |
|---|---|---|
| 3 | Rated power | up to 5 HP (DIESEL) |
| 4 | Rated power | up to 3 HP (PETROL) |
| 5 | Bore dia | 80mm |
| 6 | Stroke length | 110mm |
| 7 | Connecting rod length | 234mm |
| 8 | Swept Volume | 552cc |
| 9 | Compression ratio | 18 :1 |
| 10 | Rated Speed | 1500 rpm |

### 5.3 EMISSION TEST RESULT

| Sl.no | | Diesel | | Bio diesel | |
|---|---|---|---|---|---|
| | | loads | | loads | |
| | | 2kg | 4kg | 2kg | 4kg |
| 1 | Ambient temperature | 34°c | 34°c | 34°c | 34°c |
| 2 | Fuel gas temperature | 110°c | 117°c | 109°c | 112°c |
| 3 | $CO_2$ | 5.4% | 5.5% | 5.5% | 5.5% |
| 4 | $SO_2$ | 318ppm | 329ppm | 269ppm | 276ppm |
| 5 | $NO_x$ | 135ppm | 147ppm | 147ppm | 151ppm |
| 6 | CO | 2978ppm | 2994ppm | 2694ppm | 2704ppm |
| 7 | $O_2$ | 13.1% | 13.3% | 13.84% | 13.8% |

### 5.4 COMPARATIVE CHART FOR PERFORMANCE

| Sl. no | nomenclature | Diesel | | | | Bio diesel | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Torque(nm) | 2.36 | 4.43 | 6.14 | 8.05 | 2.36 | 4.23 | 6.11 | 8 |
| 2 | BP(Kw) | 0.38 | 0.65 | .96 | 1.27 | 0.37 | 0.68 | 0.95 | 1.30 |
| 3 | IP(Kw) | 1.54 | 1.60 | 1.78 | 2.05 | 1.24 | 1.34 | 1.55 | 1.58 |
| 4 | FP(Kw) | 1.16 | 0.96 | 0.82 | 0.78 | 0.87 | 0.66 | 0.61 | 0.29 |
| 5 | ISFC(kgkwhr) | 0.27 | 0.24 | 0.21 | 0.18 | 0.54 | 0.47 | 0.30 | 0.35 |
| 6 | BSFC(kgkwh) | 1.11 | 0.59 | 0.39 | 0.30 | 1.81 | 0.93 | 0.49 | 0.42 |
| 7 | AFR | 62.19 | 68.21 | 67.32 | 67.32 | 38.87 | 40.93 | 55.08 | 46.61 |
| 8 | BMEP(bar) | 0.54 | 0.92 | 1.38 | 1.84 | 0.53 | 0.96 | 1.38 | 1.84 |
| 9 | IMEP | 2.19 | 2.29 | 2.56 | 2.96 | 1.78 | 1.91 | 2.27 | 2.24 |
| 10 | SV($m^3$/hr) | 25.28 | 25.18 | 25.08 | 24.86 | 25.13 | 25.26 | | 25.36 |
| 11 | VE (%) | 92.17 | 91.34 | 90.51 | 91.29 | 92.72 | 91.04 | 92.15 | 89.50 |
| 12 | BthE (%) | 7.75 | 14.63 | 21.79 | 28.76 | 4.74 | 9.20 | 17.54 | 20.34 |
| 13 | IthE (%) | 31.45 | 36.37 | 40.45 | 46.38 | 15.87 | 18.23 | 28.83 | 24.82 |
| 14 | ME (%) | 24.65 | 40.24 | 53.88 | 62.01 | 29.83 | 50.46 | 60.85 | 81.94 |

## VI. Conclusion and Future scope

### Conclusion

As per the test conducted we found that the specific fuel consumption is increased and slight decrease in break Thermal efficiency. Also we tested property like density, viscosity, flash point, fire point, calorific value was Improved and it is

nearer to the value that of diesel. Emission characteristics were found like CO, HC, NOx and Smoke levels were increased compared with diesel fuel. Further improvement can be done by any extra agent in Future analysis.

**Future Scope**

- The obtained fuel with some modification could be utilized in diesel generators, vehicles such as tractors and also passenger vehicles such as cars.
- The fuel can be refined at the industrial establishments, based on the results of which small scale industry can be established.
- As there is high demand of crude oil and due to the sky reaching prices, we can use this cashew nut shell oil as biodiesel.
- The application of this project could help in reducing dependency on the gulf countries and promote a step towards innovation.

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