

Using of Coconut Oil in Diesel Engine as a Biofuel and Performance Testing

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Abstract— Recent developments in the direction of procedure of diesel engines and reducing fossils fuels. There has been a worldwide attention in examining for substitutes to petroleum-derived fuels due to their reduction as well as due to the anxiety for the environment. The work done on one of the auspicious diesel substitute is defined. The literature reviewed most of the vegetable oil and its methyl ester and their performance appearances are also studied from literature. The properties of CME thus found are equal with ASTM biodiesel criteria. One such CME has been used as the test fuel for the research. The performance of diesel engine on CME and its mixture with diesel were related with diesel. Experiments are conducted on a 7.4kw, computerized single cylinder 4-stroke stationery diesel engine to estimate the prospect of CME and its diesel combinations as alternative fuels. The experiment was shown with the different loads. The result shown that the CME can be used as an unconventional fuel compared to mineral diesel. CME mixtures give rather same brake thermal efficiency as conventional diesel. As the amount of CME in the mixture increase the HC, CO, and NOx concentrations in the exhaust decreased when equated to mineral diesel. However this resulted in an increase in the BSFC. This was credited to the lower calorific value of CME.

Key words: Biodiesel, Coconut, Engine Performance, CME

I. INTRODUCTION

A. Introduction to Bio-Diesel

Alternative fuels urgently needed to mitigate the impact of transport on the environment and depleting fossil- fuels reserves. Suitable alternative should therefore, be environment friendly and hold be compatible with existing engines and available equipment.

The use of vegetable oils in diesel engines is nearly as old as the diesel engine itself. The inventor of the diesel engine Rudolf Diesel, reportedly used groundnut (peanut) oil as a fuel for demonstration purpose in 1900. Some other work was carried out on the use of vegetable oils in diesel engines in the 1930's and 1940's. The fuel and energy crises of the late 1970's and early 1980's as well as accompanying concerns about the depletion of the world's non - renewable resources provided the incentives to seek alternatives to conventional, petroleum- based fuels. In this context, vegetable oils as fuel for diesel engines were remembered. They now occupy a prominent position in the development of alternative fuels. Hundreds of scientific articles and various other reports from around the world dealing with vegetable oil based alternative diesel fuels ("biodiesel") have appeared in print.

Vegetable oil is found to be good suitable for diesel because of its attractive properties such as biodegradability,

low toxicity, low evaporation, high flash point and reduced emissions. Since vegetable oil is produced from crops that balance CO₂ level in atmosphere, they are considered as a substitution for diesel environment context.

During the Second World War the armies fighting in the Philippines used coconut oil to run diesel engines. Since then many further experiments and trials have been successfully run using coconut oil as a direct substitute for diesel. Bougainville Island in Papua New Guinea had diesel generators and truck run on locally produced coconut oil during a trade blockade. A coconut/diesel fuel blend currently being used in Vanuatu initially mixes 20 parts coconut oil with one part kerosene. This blend is then mixed 2:1 with diesel to give effective 64% coconut oil bio-fuel.

B. Introduction of coco Bio-Diesel

The world is confronted with the twin crises of fossil fuel depletion and environmental degradation. The indiscriminate extraction and consumption of fossil fuels have led to a reduction in petroleum reserves. From the point of view of protecting the global environment and the concern for long term supplies of conventional diesel fuels, it becomes necessary to develop alternative fuels comparable with conventional fuels. For developing countries, fuels of bio-origin, such as alcohol, vegetables oils, biomass, biogas, synthetic fuels, etc are becoming important. Such fuel scan is used as substitute of conventional fuels.

As the coconut, coconut shell, coconut oil is having much demand in India. It is use as alternative fuel for I.C. Engine. Hence the availability of coconut and its feasibility as a fuel for diesel engine is to be studied. Therefore literature review deals with first Coconut fruit, History, Cultivation Pattern and Availability of coconut. Second feasibility as a fuel for diesel engine. Coconut is the large hard fruit of the coconut palm tree, brown in color, which has husk like fiber surroundings a large seed. The fruit is known by the name of *Cocas nucifera* botanically.

1) Preparation of CME:

The coco oil can be converted into biodiesel in following steps.

- Step 1: Removal of water from oil.
- Step 2: Determination of FFA
- Step 3: Esterification process
- Step 4: Transesterification process
- Step 5: Methanol recovery
- Step 6: Separation of bio-diesel from glycerol
- Step 7: Bio diesel refining

C. Transesterification of CME

Transesterification, on the other hand, is the displacement of the alcohol from an ester by another alcohol in a process similar to hydrolysis, except that an alcohol is used instead

of water. This reaction, cleavage of an ester by an alcohol is specially called alcoholics. Oil containing less than 4% free fatty acids is filtered

II. EXPERIMENTAL SETUP

The setup consists of a single cylinder, four stroke, and diesel engine. Engine is connected to eddy current type dynamometer for loading, fuel supply network, cooling water mixing chamber. Provision is made for interfacing airflow, fuel flow, temperatures, Speed and Torque measurement. The setup has stand-alone panel box consisting of air box, fuel tank, manometer, and fuel measuring unit, transmitters for air and fuel flow measurements

A. Properties of Coconut Biodiesel to Petro-Diesel

Sr. No	Properties of coconut biodiesel to petro-diesel			
	Property	Unit	Petrodiesel	Coconutbiodiesel
1	Density	Kg/cm ²	0.847	0.96
2	Viscosity	cst	2.43	3
3	Flash Point	°c	127	150
4	Calorific value	Mj/kg	39.17	44.12
5	Ash Content	%w/w	0.006	0.01
6	Sulfur Content	%w/w	0.25	0.87
7	Specific gravity	g/cm ²	0.81	0.87

Table 1: Properties of Coconut Oil

B. Description of Engine

The engine used is single cylinder, Water- cooled, vertical, 4 stroke cycle, direct injection, naturally aspirated diesel engine the engine and eddy current dynamometer are mounted on 4'M.S. Channel frame. The engine is directly coupled to an eddy current dynamometer. The load on the engine can be varied by opening the torque control knob. Technical Specification of engine and specification eddy current dynamometer.

C. Stages of Experiment

- 1) Preparation of the CME.
- 2) Baseline performance of diesel engine.
- 3) Performance of engine with diesel blended with 20% CME i.e. B20 (mixture of 20% CME and 80% diesel. Proportion by volume).
- 4) Performance of engine with diesel blended with 60% CME i.e. B60 (mixture of 60% CME and 40% diesel proportion by volume).
- 5) Performance of engine with 100% CME completely substituting diesel.

1) Break Thermal Efficiency (%)

Fig 1 shows the engine performance at various load provided, such as 0 N-m to 45 N-m. As the load increases Brake, thermal efficiency increases. It was observed that all the CME blends give similar Brake Thermal Efficiency as conventional diesel Brake thermal efficiency (BTE) of diesel is higher than CME blends. As the blends, increase the BTE decreases. Still the efficiencies are comparable with diesel. This is because of the small and medium carbon

chain of CME and it is expected due to it has level of saturated carbon 91%, small and medium carbon chain and oxygen content in CME which contribute to better atomization. It is due to its measure of the level of unsaturated fatty acids. Coconut has iodine value of only 710.

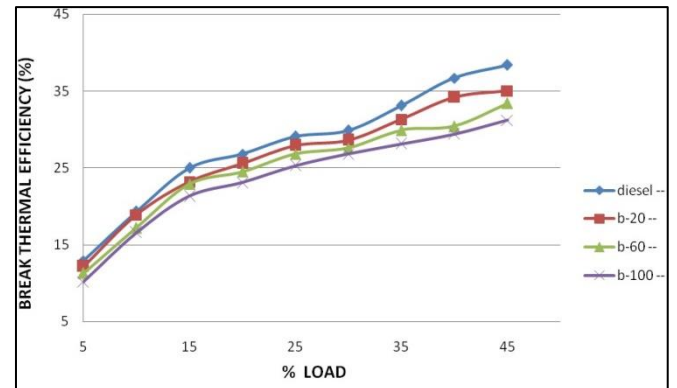


Fig. 1: Variation of Break Thermal Efficiency with Load

2) Specific Fuel Consumption (kg/kwh)

Fig 2 shows variation of brake specific fuel consumption with Load. Specific fuel consumption increases with increasing CME in blends. It is clear that BSFC decreases as the load increases.

BSFC for B100 is higher than B60, B20 and diesel. This is mainly due to fuel specific gravity viscosity and calorific value. As a result, more CME blends are needed to produce the same amount of energy due to its higher specific gravity and lower calorific value in comparison to Conventional diesel.

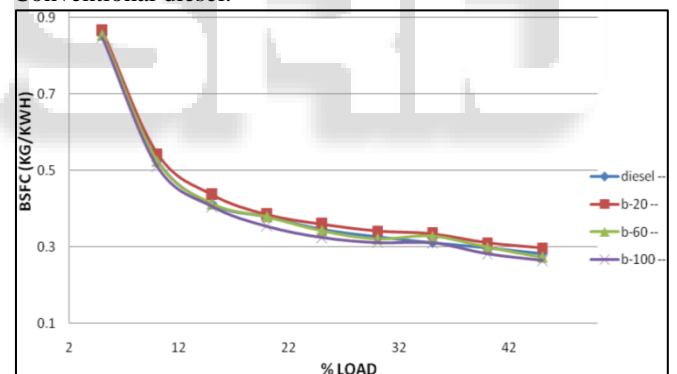


Fig. 2: Variation of Specific Fuel Consumption with Load

3) Exhaust Temperature (°C)

Fig 3 shows variation of exhaust temperature with load. Exhaust temperature depends on the load on the engine at low load exhaust temperature is less and vice versa. Exhaust 5) Oxides of Nitrogen (NO_x-ppm) temperature of each fuel followed some common nature. The exhaust temperature for the diesel is higher than CME blends. Calorific value of diesel is higher than the CME blends hence more energy is produced and higher temperature generated

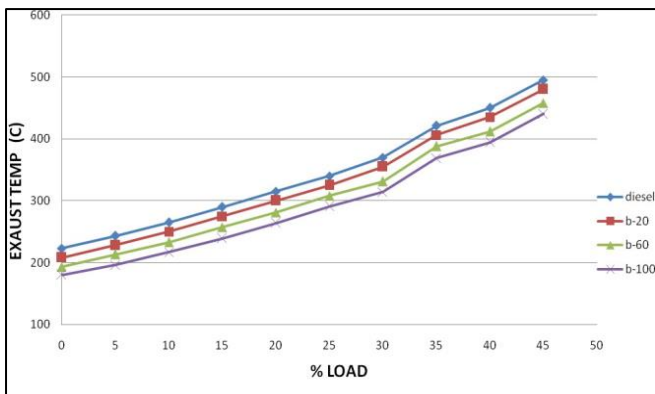


Fig. 3: Variation of Exhaust Temperature with Load

4) Air Fuel Ratio

Fig 4 shows that variation of A/F ratio with load. As the load increases more fuel will be required by the engine according to load but amount of change in air is negligible. Therefore A/F ratio decreases when load is increasing.

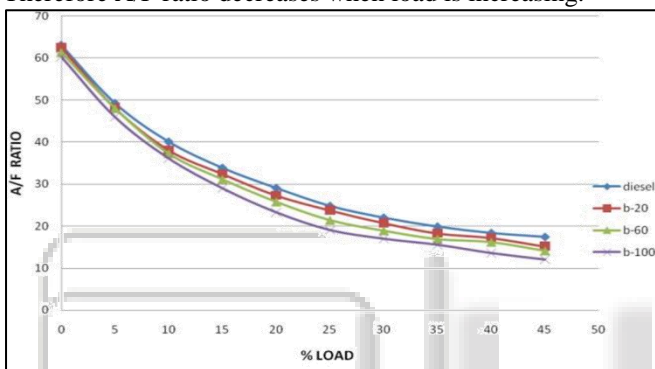


Fig. 4: Variation of A/F with Load

The A/F ratio for diesel is higher than CME blends this is because of calorific value of diesel is higher than the CME amount of energy as diesel fuel.

5) Oxides of Nitrogen (NO_x-ppm)

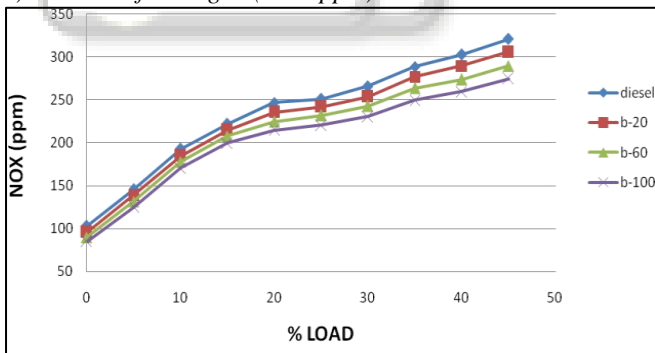


Fig. 5: Variation of NO_x Emissions with Load

Fig 5 shows variation of NO_x emissions with load. It is clear that NO_x emission increases with increase load. NO_x emissions are lower for CME and higher for Diesel.

NO_x emission combustion temperature. Low temperature combustion depends upon the maximum of CME blend is the main reason to reduce NO_x. The production of lower combustion temperature by CME is due to their chemical bond and its properties and the calorific value of reduction in exhaust

CME is lower than diesel. Therefore, total heat developed is comparatively low and maximum reduction in NO_x. It was observe that maximum 10.9% NO_x concentration is reduce by 100% CME blend with 18%

6) Hydro Carbon (HC-ppm)

Fig 6 Shows variation of HC emissions with load. It is observed that exhaust emissions such as HC are reduced with increasing CME in blends. As the percentage of CME in blend increases, there is reduction of HC and CO emission. CME contains oxygen molecule due to this complete combustion take place.

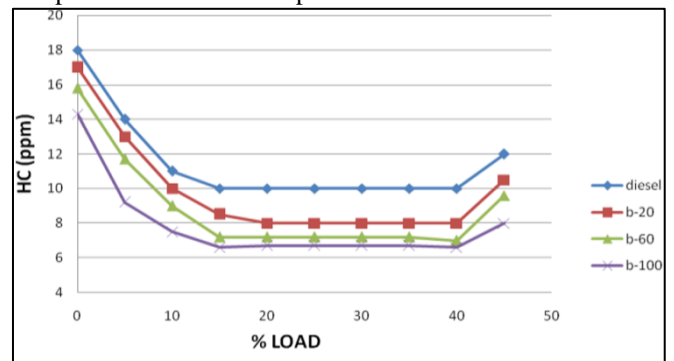


Fig. 6 : Variation of HC emissions with Load

7) Carbon Dioxide (CO₂-ppm)

Fig. 7 shows variation of CO₂ emission with load. Co₂ emissions are increases with increase in load. At full load CO₂ emission are higher. It is clear that CME blends produce higher CO₂ emission than diesel fuel. It is observed due to O₂ content in CME blends CO₂ increases with increasing CME blends.

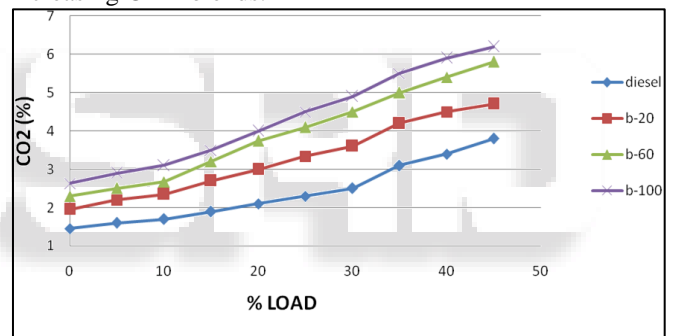


Fig. 7: Variation of CO₂ Emissions with Load

III. RESULT & DISCUSSION

The Fuels (Petro-Diesel and coconut-Biodiesel) were analyzed for several physical and chemical.

Density and pour point of coconut biodiesel was found higher then petro diesel. Higher pour point reflects unsuitability of coconut biodiesel as petro-diesel fuel in cold climatic condition. The flash point of coconut biodiesel was high compare to petro-diesel. Hence, coconut biodiesel is safe to handle. Coconut biodiesel has higher calorific value is 44.12Mj/ kg compared to petro-diesel 39.17Mj/kg.

IV. CONCLUSION

Following are important conclusions drawn from the work carried out.

- 1) CME is a promising & eco- friendly alternative fuel for diesel engine. Results obtained from CME on performance parameters and emission parameters are comparable with diesel & better in some extent.
- 2) The properties of CME blends are area comparable with those of conventional diesel.
- 3) CME can be adopted as an alternative fuel for the existing conventional.

- 4) CME blended fuels produce similar brake thermal efficiency as conventional diesel.
- 5) BSFC increase with increasing CME in blends.
- 6) Exhaust emission reduce with increasing CME blends except co₂. It is observed that maximum 10.9% NO_x concentration is reduced by 100% CME blend with 18% reduction in exhaust temperature.
- 7) It also replaces the exhaust odor of petroleum diesel with a more pleasant smell of popcorn and French fries.

V. FUTURE SCOPE

Following are the some future scope for this work.

- 1) Study of injection parameter such as injection timing and injection pressure. Future scope can be focused at improving the performance of CME by optimizing injection timing and injection pressure and even other fuel injection equipment parameter.
- 2) Study of wear and tear of an engine using CME and compare with Diesel.
- 3) Optimization of Biodiesel making process of COCO oil.

REFERENCES

- [1] B. Vijaychandran Pillai; "Marketing Problems of Rural Coil Co-ops in Kerala – "A Comparative study with Private Sector. Unit Indian Cooperative Review, July 2003, 64-70".
- [2] C.V. Sairam S. Arul Raj and Rajagopal "Perspectives of Marketing Research for Coconut and its products"; (CPCRI, Kasargod Kerala)
- [3] K. Ramaraju, S. Palani Swaraj, P. Annakodi, M. K. Varadarajan, M. Muthu Kumar and V. Bhaskaran, "Impact of coconut mite, *aceria guerzzK.*(Acari: Eriophydoe) on yield parameters of coconut. Indian Coconut Journal, Vol.25, No.9, Page 12-15" [4] M.M. Thomas, "Coconut Industry in India, an overview, Indian Coconut Journal, Vol.2, No.7 Page 313"
- [4] M. Poduval, M. D. Abu Hasan and P. K Chattopadhyad, "Evaluation of coconut cultivars for tender nut water for West Bengal, Indian Coconut Journal, 20, No.1 Page-36".
- [5] M. Thomas, Mathew, B.L Anand, and M.K. Sukumaran Nair, "The Mite and Coconut Economy of India. Indian Coconut Journal, Vol. XXXIV No. 9 January 2004, 6 – 14".
- [7] N. H. Jayadas, G. Ajit Kumar and K.K. Saju "Coconut Oil as on Alternative to Automobile Lubricants Indian Coconut Journal. Vol. XXXIV No. 5 September, 2003 3-7".
- [8] P.C. Malu, A.G. Desai & Joshi G.D "Evaluation of Coconut (*Cocos nucifera* L.) Cultivars for Tender Nut water Indian Coconut Journal Vol. XXXIV No. 11 March 2004 5-12"
- [9] P.M. Jacob, K. Samsudeen, & H. Moosa, "Prospects of Cultivating Dwarf Orange Coconut Cultivar for Tender Nut Production in Lakshadweep Island, Indian Coconut Journal Vol. XXXIV No. 11, March, 2004 3-4".
- [10] Rethinam, Ponniah, "Virgin Coconut Oil Applications 2004, Indian Coconut Journal Vol. XXXIV No. 12 5-7"