Performance Test on Compression Ignition Engine by using Diethyl ether as fuel additive

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Abstract— **Biodiesel from non-edible vegetable oils might help India reduce its dependence on petrodiesel, which in turn reduces crude oil import costs and addresses environmental issues, as a rising economy. It was found that soapnut (Sapindus Mukorossi) biodiesel may be used in diesel engines as an alternative fuel to petro-diesel, and the performance of a single cylinder, four-stroke diesel engine was evaluated using engine fuels made from pet-ro and lean soapnut biodiesel. Soapnut biodiesel has been shown to be a viable alternative fuel for diesel engines via experimental study. Additional to that, engine performance was adequate for all loads, with low soapnut biodiesel blends exceeding B10's, a 10 percent mix of soapnut bio-diesel and petro-diesel, being somewhat superior to that of petro-diesel and other blends.**

Keywords-EmissionCharacteristics; Non Edible oils; Bio diesels; Blend; Soapnut lean mixture

I. INTRODUCTION

Diesel engines are now the most powerful and efficient primary movers that are accessible. More than any other kind of technology, they are responsible for the transportation of a sizeable share of the world's products, the powering of a significant amount of its machinery, the support of agriculture and the rural sector, and the generation of energy. As our country's transportation and rural agricultural sectors have used more gasoline in recent decades, we should expect the present fuel issue to worsen in the future. It is possible to increase engine performance and minimise hazardous exhaust emissions by improved engine design, the use of alternative fuels, or effective fuel formulation. Because of this, the overall thermal efficiency will improve, and there will be less emissions.

In diesel engines, the air is subjected to high pressures, and then a little quantity of fuel is injected into this highly compressed air. The combination of these two processes results in diesel engines having increased performance while using less fuel. The large emissions of particulate matter (PM) and nitrogen oxides (NOx) that are produced by diesel engines continue to be a cause for concern. These days, diesel engines are up against a variety of different technological obstacles. Post-combustion emission control devices for fuels will contribute in the creation of future emission laws as a result of evolving technology. [1,8]. In order to reduce particles smaller than 2.5 micrometres, gasoline additives were shown to be a cost-effective solution. The optimal dose rate, as determined by an experiment in which organic manganese was used to cause a maximum reduction in freezing point of 15 degrees Celsius, was found to be 54.2 mol Mn/L, which is equal to 700 ppm. [4.5] The freezing point saw a noticeable drop with the addition of metals to the mixture. Several different types of metal additives are mixed in with diesel in order to raise the fuel's quality while simultaneously reducing the quantity of exhaust gases generated by the combustion process. The catalytic effect it exerts on the combustion of hydrocarbons is the basis for its additive activity. The ignition temperature of soot is reduced by fuel additives containing transition (or noble) metals.

Fig: Soapnut Tree

Fig. Production of Oil

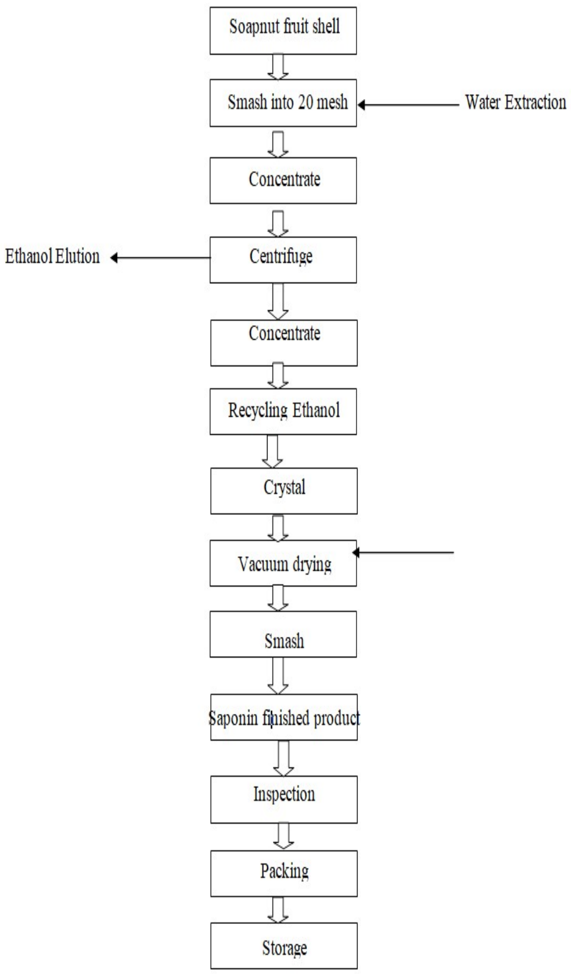


Fig. Soapnut Oil Extraction Process

II. LITERATURE REVIEW

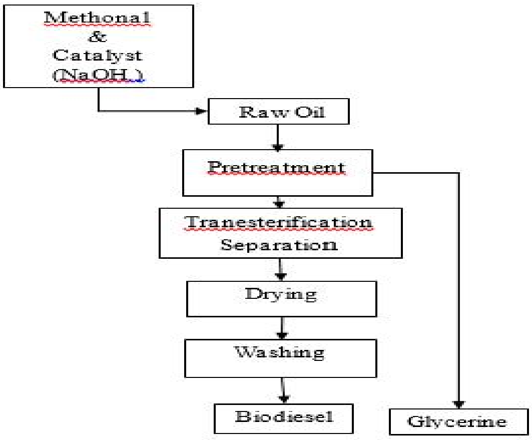
ARIHARAN V et.al the kernel contains 30 percent fatty acids, 85 percent triglycerides, and 5 percent sterol, according to recent studies. The kernel oil is a biofuel. Up to a 20 percent mix with fossil fuels is allowed. As a biocorrosion inhibitor for mild steel and copper alloys, the soap nut seed shows great potential. Brushing your teeth with fruit and shining your jewellery are just two of the many possible uses for fruit. It's probable that the oil mix B20 might be a source of the physicochemical property.

P. Jyothi Phaneendra et al. Employing the transesterification method, soap nut seed oil was transesterified into biodiesel at concentrations of 5%, 10%, and 15% (v/v). Biodiesel-diesel blends were investigated for performance and exhaust emissions in CI engines later. In order to establish a benchmark, the test results were compared to mineral diesel. The most significant consequences are as follows: BSFC for biodiesel blends is equal to diesel fuel at varying loads. S15 bio-diesel blends perform best with BTE. In each and every one of the mixtures that were examined, diesel-like fuel efficiency was achieved. Diesel's mechanical efficiency is superior than that of blends in almost every way. The S15 demonstrated greater mechanical efficiency when subjected to a secondary load. Combinations of biodiesel and diesel yield higher levels of carbon dioxide and carbon monoxide emissions compared to either fuel type operating alone, with diesel emitting the lowest levels of the three. In the long run, it was determined that the blend-wise ideal was the best option. The S15 has a reputation for being a car with excellent mechanical efficiency.

S. Padmanabhanand others studied the subject, in order to provide safe, clean, and affordable energy, alternative fuels must be easily available, economical, and ecologically friendly. Biofuel blends derived from soapnut kernels have been evaluated in this research. Researchers tested the engine in its original configuration. CI engines were tested with three different mixes of soapnut oil and diesel. For engines, soap nut oil has been shown to have equivalent performance and emissions as pure diesel. This makes it a respectable alternative fuel.

III. METHODOLOGY AND EXPERIMENTAL WORK

In this procedure, an alcohol and fat or oil undergo a chemical reaction with the help of a base catalyst. Ethanol and methanol make up the majority of the alcohol consumed. Sodium hydroxide or potassium hydroxide is often used in industrial settings in the role of a catalyst (KOH). Glycerine is the most abundant byproduct of the transesterification process, despite the fact that it is a secondary product of the process.



EGR. In this we use 480 ml of conventional diesel and 120 ml of Biofuel. The Biofuel used is Soapnut Oil it is extracted from the tree sapindus marganatus.

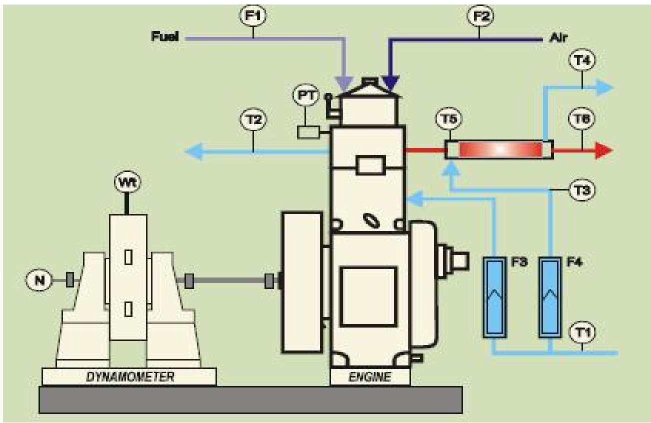
- 20% biodiesel, 80% petrodiesel is labelled B20.

Using a 1000ml jar, we pour 480ml of conventional diesel (petro-diesel) first, followed by 120ml of biofuel (Soapnut oil).

600ml is considered to be 100 percent, so 10 percent of additive equals 60ml; therefore, the remaining 540ml is considered to be 100 percent. 20 percent of bio diesel (soap nut) equals 108ml, and 80 percent of conventional diesel equals 432ml; all of these ingredients are combined in a 1000ml jar and thoroughly stirred for a perfect blend.

The following are the tests we come across by this project, they are

- Conventional diesel engines were tested at 0-100 percent load and 20% exhaust gas return (EGR) for performance assessment (EGR).
- Performance study of B20 at 0-100% load and 20% EGR
- With 0-100 percent load and 20% EGR, we tested the B20+TiO2 nanoparticles' performance.



IV. Results

A. *Observation data for Conventional Diesel under 0-100 % load and 20% Exhaust Gas Return (EGR).*

Compression Ratio 17.50

Stroke Length 110.00(mm)

Area of piston (A) = 0.36 m^3

Calorific value (CV) = 42500 KJ/Kg

Swept volume 661.45 (cc)

Dynamometer Arm Length (mm) : 185

Density (ρ) = 840 Kg/m^3

Cylinder Bore 87.50(mm)

Observation table:

Table: Observation table conventional diesel

Load (Kg)	Speed (RPM)	Indicated Mean effective pressure (Pim) (bar)	Applied Force (N)	Air Flow (mmWC)	Fuelflow (cc/min)
0.01	1571.00	2.15	0.09806	95.86	7.00
4.50	1504.00	3.62	44.1299	86.11	11.00
9.01	1488.00	4.92	88.3579	82.28	16.00
13.50	1474.00	6.33	132.3897	79.00	21.00
18.02	1463.00	7.63	176.7158	75.66	26.00

Result data table 1:

Table: Result table for conventional diesel table

Torque (Nm)	BP (kW)	FP (kW)	IP (kW)	BMEP (bar)	IMEP (bar)	BTHE (%)	ITHE OF PURE DIESEL (%)	Mech Eff.OF PURE DIESEL (%)
0.02	0.00	1.86	1.86	0.00	2.15	0.09	44.63	0.19
8.17	1.29	1.72	3.00	1.55	3.62	19.66	45.89	42.84
16.35	2.55	1.49	4.04	3.11	4.92	26.76	42.41	63.10
24.50	3.78	1.36	5.14	4.65	6.33	30.27	41.16	73.54
32.70	5.01	1.15	6.16	6.21	7.63	32.39	39.80	81.38

Result data table 2:

Table: Result table for conventional diesel

Air Flow (kg/h)	Fuel Flow (kg/h)	SFC (kg/kWh)	Vol Eff.(%)	A/F Ratio	HBP (%)	HJW (%)	HGas (%)	HRad (%)
31.88	0.35	98.47	87.13	90.38	0.09	23.71	22.02	54.18
30.22	0.55	0.43	86.26	54.51	19.66	22.65	20.29	37.41
29.54	0.81	0.32	85.22	36.63	26.76	20.71	18.53	34.00
28.95	1.06	0.28	84.30	27.35	30.27	19.90	18.07	31.76
28.33	1.31	0.26	83.12	21.62	32.39	22.44	19.58	25.60

B. Graphs

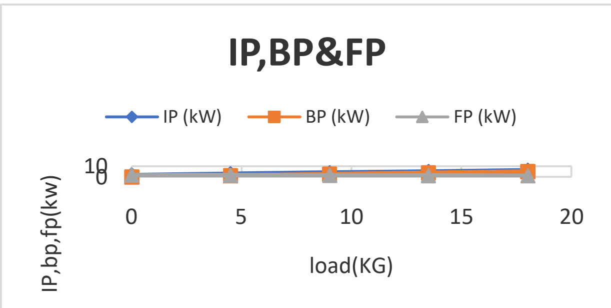


Fig. Break power, Indicated power& Friction power:

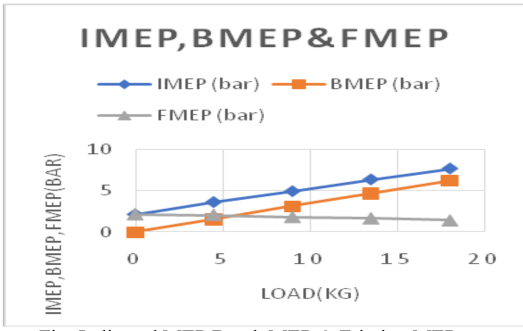


Fig. Indicated MEP,Break MEP & Friction MEP

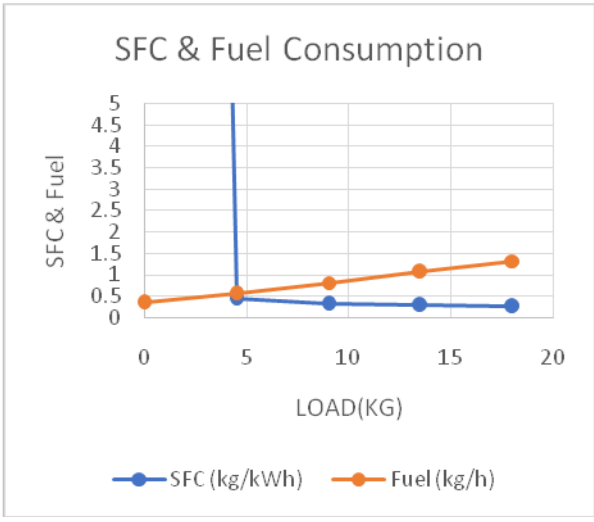


Fig. SFC & Fuel consumption:

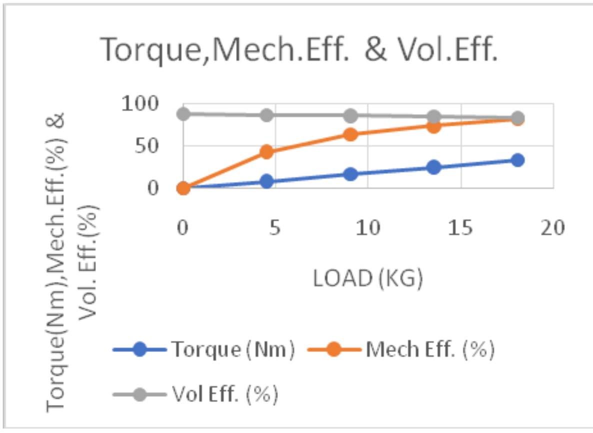


Fig. Torque, Mechanical efficiency, Volumetric efficiency:

C. Exhaust Gas Emission Data

Table: Exhaust gas analysis table for conventional diesel

Load (Kg)	CO %	HC PPM	CO2 %	O2 %	NOX % OF PURE DIESEL	Lambda	Opacity %
0.011	0.038	28	2.01	18.06	128	7.131	1.7
4.5	0.036	30	3.83	15.43	521	3.784	5.7
9.01	0.042	52	5.56	13.11	1047	2.627	16.7
13.5	0.049	58	7.45	10.42	1496	1.964	31.8
18.02	0.142	67	9.49	6.89	1794	1.475	62.5

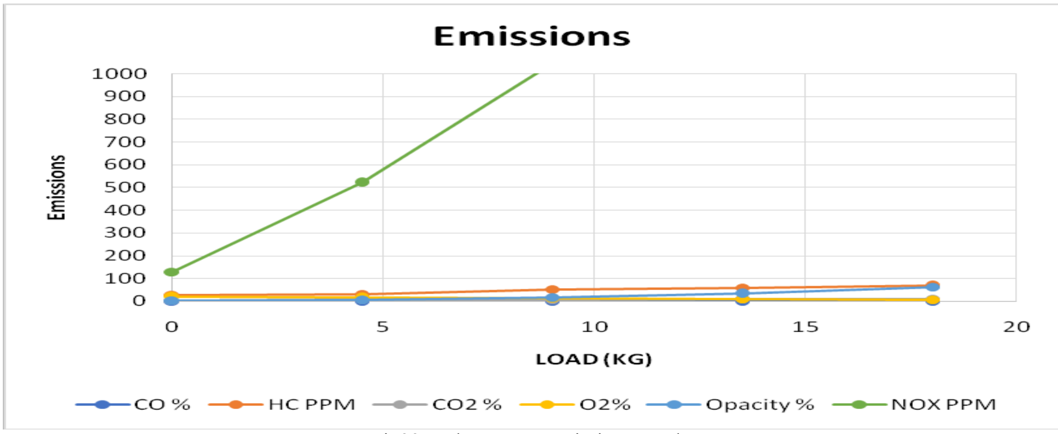


Fig22. Exhaust Gas Emissions graph:

Table: Observation table for B20+DIETHYL ETHER

Speed (rpm)	Load (kg)	Comp Ratio	T1 (deg C)	T2 (deg C)	T3 (deg C)	T4 (deg C)	T5 (deg C)	T6 (deg C)
1509	0.19	17.50	43.70	45.43	43.70	42.24	126.21	105.32
1494	4.51	17.50	43.80	49.13	43.80	43.23	165.63	132.39
1476	9.15	17.50	43.81	52.21	43.81	44.52	217.14	170.07
1465	13.44	17.50	43.83	55.17	43.84	45.94	273.98	212.15
1451	18.00	17.50	43.86	58.09	43.86	47.60	344.45	261.33

V. CONCLUSION

- Indicated thermal efficiency under the load at 13.50
- Diesel – 41.16%
- B20 - 39.54%
- B20+DIETHYL ETHER - 43.67%
- As compared with diesel B30 gives more Indicated thermal efficiency

REFERENCES

[1] John W. Goodrum, S. Edward Law (2012) "Rheological properties of Peanut Oil-Diesel Fuel Blends'' ASAE Transactions paper, p.p.897-900.

[2] Prasad C.M.V., M.V.S.M. Krishna, C.P. Reddy and K.R. Mohan (2013) "Performance evaluation of non-edible vegetable oils as substitute fuels in low heat rejection diesel engines'' Proceedings of the Institution of Mechanical Engineers, Vol. 214, No.D2, p.p.181-187.

[3] Dennis L. Siebers. (2012) "Ignition Delay characteristics of Alternative Diesel Fuels: Implications on cetane number'', SAE Transaction paper, p.p.673-686.

[4] Kenton R. Kaufman, George L.Pratt, Mariusz Ziejewski Hans J. Goettler (2013) "Fuel injection anomalies observed during Long-term Engine Performance Tests on Alternate Fuels'', SAE Transaction paper, p.p.591-601

[5] Bhattacharyaa S., C.S. Reddy (2014) "Vegetable oils as fuels for Internal Combustion Engines: A Review'', Silsoe Research Institute Transaction paper, p.p.157-165.