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PERFORMANCE AND EMISSION ANALYSIS ON CI ENGINE USING SOAPNUT OIL AS BIOFUEL

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ABSTRACT

Identifying the substitute fuels for the internal combustion engines has been explored all over the world of research. Many alternative fuels such as Alcohols, Hydrogen, Bio gas and various Bio fuels have proved the suitability via performance investigations. In the transportation and agriculture sector, many biological based bio-fuels have showed to be better substitutes for fuels derived from crude oils. In Indian context, due to the surrounding degradation, energy needs, rural development and agricultural growth, these bio-fuels are attains global recognition as an alternative. In this research paper, blends from soapnut oil are investigated in performance and emission characteristics on diesel engine and results are compared with pure diesel.

Keywords: soapnut oil, bio-diesel, diesel engine, emission characteristics.

INTRODUCTION

Nowadays world is facing the major problems of fast degradation of petroleum fossil fuels and environmental pollution. Hence, there is a need for an alternative resources to cut necessity on petroleum based fuels for enhanced economy and environment. Conversion into of bio-origin unconventional fuels can focus the above problems. To tackle the pollution problem due to carbon emissions from automobiles, the most suitable solution is using the biofuels produced from the food crops such as sunflower oil, jatropha, rubber seed oil, rapeseed oil and cotton seed oil etc. and in an efficient and economical method. Now days the major tasks to save the surroundings from the global warming are the greenhouse gases emitted to atmosphere and the related climate change every year. The solution includes the evaluating of the carbon footprint, examination and reduction by enhancing energy efficiency and followed by modifying carbon emissions.

Hossain. A.K *et al.* (2012) has tested on a multi-cylinder diesel engine with karanja oil. In this, Biodiesel was preheated by hot coolant by modified cooling water system and fuel supply circuit. Compared to fossil diesel, the specific fuel consumption was slightly higher for the bio fuels and the brake thermal efficiency was nearly comparable which resulted in higher CO_2 and NO_x emissions. Ibhanshu. V *et al.* (2013) prepared blends of jatropha oil and ethanol of 5, 10, 15 and 20% by volume and the test results shows that, performance are relatively similar to pure diesel fuel. It has been found that at part load condition, energy consumption of blends of biofuel jatropha ethanol were immaterial. Mofijur Rahman Md *et al*. (2014) was investigated on diesel engine performance by using the blends of J. curcas and Moringa oleifera and compared with diesel fuel. From the results, the curcas and the oleifera fuels produced slightly little lower on brake power and higher values on brake specific fuel consumption. Ashfaque Ahmed. S *et al.* (2013) was examined the lemongrass oil blends with diesel with different proportions of 20%, 40%, 60%, 80% and 100% of lemongrass oil. The performance tests gives improved fuel consumption and also better emission results compared with diesel.

Senthil Kumar.S *et al*. (2012) have investigated the performance and emission characteristics of a blended rubber seed oil based biofuel. The experimental outcomes with an engine performance with biodiesel not vary significantly from that of pure diesel fuel. Ibrahim Khalil Adam (2016) has made a rubber seed and palm oil combination at equal blended ratio was used to test a biodiesel. Response Surface Methodology used to studies the parametric effect on transesterification. Sivaganesan S and M Chandrasekaran (2015) have tested turpentine oil blended with diesel. Combustion and emissions characteristics were investigated on diesel engine with functional graded material coated piston, cylinder head and valves with modified cylinder pressures.

Mathiarasi R *et al.* (2017), discussed a study on soap nut oil is used for the making of fatty acid methyl ester by using a novel catalyst. In this work, the catalyst used for transesterification reaction was the residue collected from coal burnt boilers from industries. Yi-Hung Chen *et al.* (2013), has discussed a practicability of bio-diesel creation from soapnut oil was examined. The raw and blended fuel properties also listed out. The soapnut oil was blended with diesel at several volume ratio and for fuel properties in evaluation with the applicable conditions. Misra R. D and M. S. Murthy (2011), was examined on single cylinder direct injection constant speed diesel engine with soapnut oil, and also non-edible vegetable oil was blended with petroleum diesel in various proportions and performance and emission characteristics were studied.

From the literature study, it is observed that many researchers have used variety of biodiesel along with the fossil diesel fuel in the analysis of performance, combustion and emission characteristics of a wide range of diesel engines with little or without modification. In

this research work,bio-fuel blends from soapnut oil is explored in its performance and emission characteristics in single cylinder diesel engine to observe a substitute fuel by comparing the blended fuel results with base pure diesel.

SOAPNUT OIL AS BIOFUEL

The soap nut tree is used in building construction and oil and agricultural outfits. The soap nut plant grows in deep loamy soil areas and leached soil areas. Hence, farming of soap nut trees in such soil avoids possible erosion. Soap nut tree generally found in humid and subtropical weathered areas in Europe, Asia and America. Totally different species (Sapindus mukorossi and genus Sapindus trifoliatus) area unit wide accessible in India, Nepal, Bangladesh, Asian nation and plenty of different countries.

Figure-1. Soap nut seeds.

Soap nut has many applications from healthful treatments to soap and chemical agent. It has huge amount of surfactant, hence soap nut seeds shells are in use as natural and home laundry detergents. It also used in bathing and ancient medicines. The oil from soapnut has been extracted as a non edible oil having a large prospective for biodiesel production from the seeds shells. The biodiesel have high viscosity and density compared to the conventional petroleum fuels. The esterification process was introduced to decrease the viscosity and density and rise the combustion efficiency of the biofuel. The biodiesel produces considerably less destructive emissions than fossil petroleum diesel when burned in an internal combustion engine but, produces little higher levels of nitrogen oxides. The property of soapnut oil is tabulated in Table-1.Soapnut oil blends are prepared in the different proportions of diesel and soap nut oil. That is, B10 (D90%+Soapnut10%), B20 (D80%+Soapnut20%) and B30 (D70%+Soapnut30%) on volume based.

Table-1. Properties of soapnut oil.

S.No	Property	Values
1	Density	0.930g/cc
2	Kinematics viscosity@40 ℃	9.99cSt
3	Flash point by PMCC method	238 ℃
4	Fire point by PMCC method	254 ℃
5	Calorific value	38212 kJ/kg

Experimental setup

A Single cylinder, Direct Injection engine, Constant speed was used to investigate the engine performance and emission characteristics of the blended soapnut oil. The diesel engine assessed under various engine load conditions with the different blends of soapnut proportions. The experimental diesel engine was directly coupled with an eddy current dynamometer for varying the loads from zero load (0%) to full load (100%). Based on the engine power produced, the engine load range is varied from zero load condition of 0%, 25%, 50%, 75% and full load condition of 100%. The engine loads are varied manually with help of an eddy current dynamometer. AVL gas analyzer and smoke meter was attached for measuring the smoke density and exhaust gas temperatures. AVL five gas analyzer was used to evaluate the emission characteristics such as hydro carbon, carbon monoxide, carbon dioxide and oxides of nitrogen values from the exhaust gas.

Figure-2. Experimental setup.

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Table-2. Specifications of the test engine.

Engine Type	Single Cylinder, 4 Stroke, Water Cooled Engine
	Stoke 110mm, Bore 87.5mm, 661 cc
Power	5.20 kW @ 1500 rpm
Compression ratio	17.5
Injection variation	0-25 deg bTDC
Dynamometer	Eddy current, Water cooled with Loading unit
Fuel tank	15 lit, Duel compartment with fuel metering

RESULTS AND DISCUSSION

The engine tests were carried out for the different proportions of bio fueled soapnut oil blended with the pure diesel fuel. Brake Specific Fuel Consumption (bSFC) and Brake Thermal Efficiency (BTE) was performed on the engine at different rated power or load. The emission characteristics analysis of was evaluated in terms of HC, CO, CO_2 and $NO_x$for the various blends of soapnut oil. The results of performance and emission characteristics were shown in Figure-3 to Figure-8 for the blends of soapnut oil.

Performance characteristics of soapnut oil

The performance of the brake thermal efficiency for different loads with blended fuel at different ratios of diesel, soapnut oil was shown in Figure-3. The higher viscosity of the blended fuel reduced the brake thermal efficiency and the blended fuel was similar to that of the diesel performance. It was observed that, at maximum load condition and it was only 2% variation from that of the pure diesel performance.

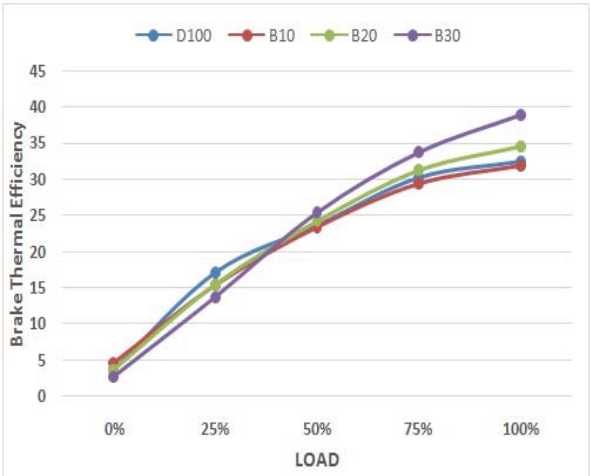

Figure-3. Performance of brake thermal efficiency.

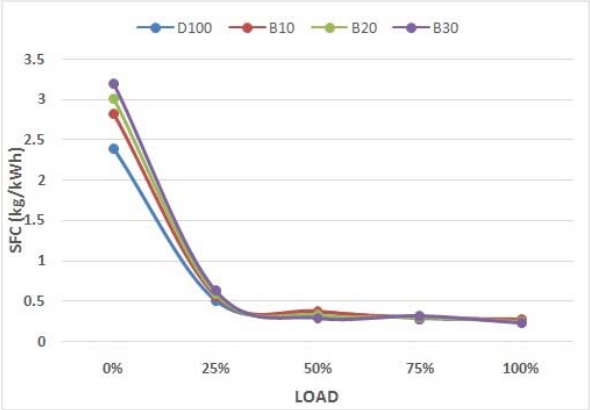

Figure-4. Performance of specific fuel consumption.

From the Figure-4, the specific fuel oil consumption of blended soapnut oil is marginally higher than diesel fuel. It is derived that the diesel has a lower Specific fuel oil consumption because of high calorific value, with blended fuelB10 the equivalent SFC was very closer but higher than that for the pure diesel. This was detected due to the a little lower calorific value and higher viscosity of the soapnut oil.

Emissions characteristics of soapnut oil

At different load conditions, the unburned hydrocarbon emission was lower for the diesel fuel with respect to the blends of soapnut oil as shown in Figure-5. This is because of the higher calorific value of diesel and due to which less amount of fuel was injected when compared to bio fuel. Because of oxygen enrich environment, combustion is complete. Hence lower unburned hydrocarbon emission was observed with diesel fuel.

The various Carbon Dioxide levels for varying blends were shown in Figure-6. From the readings, it is inferred that emission of Caron dioxide is littlemore than pure diesel. The CO emission can be reduced by providing surplus oxygen in to the combustion chamber. There by converting CO into CO_2 this is possible by complete combustion.

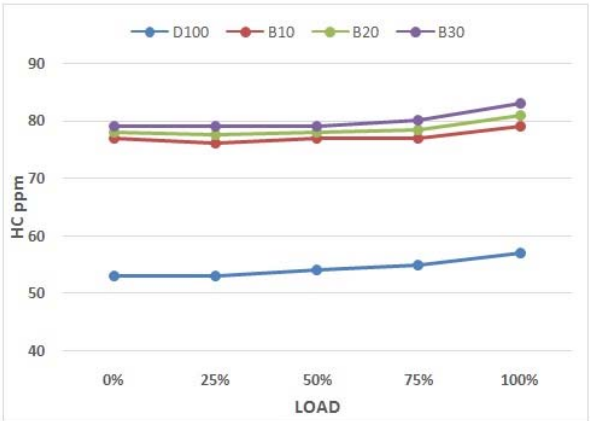

Figure-5. Emission characteristics of HC.

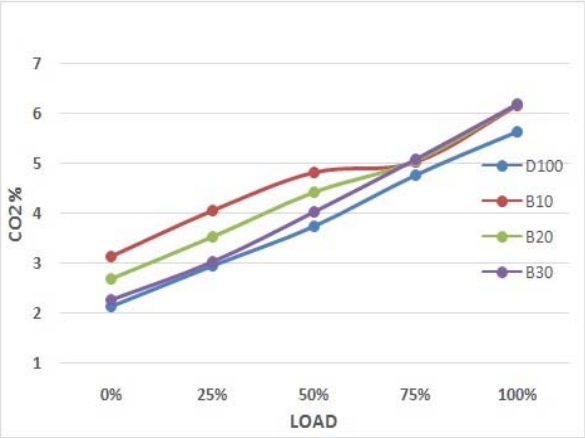

Figure-6. Emission characteristics of CO_2.

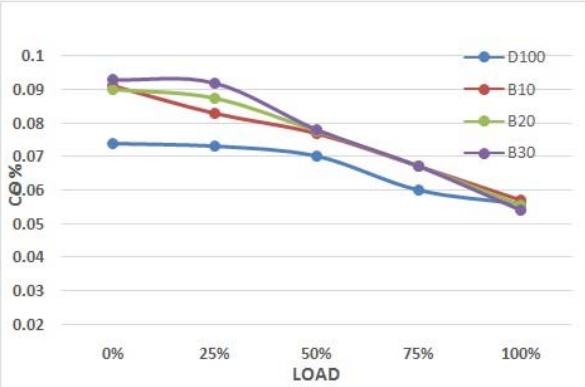

Figure-7. Emission characteristics of CO.

The various Carbon Monoxide emissions for varying blends were shown in Figure-7. The Carbon Monoxide emissions from blended fuel are a bit more than the normal diesel fuel at all loads. Diesel engines produce little amount of CO when compared to NO_x and particulate emission as the engine was not loaded.

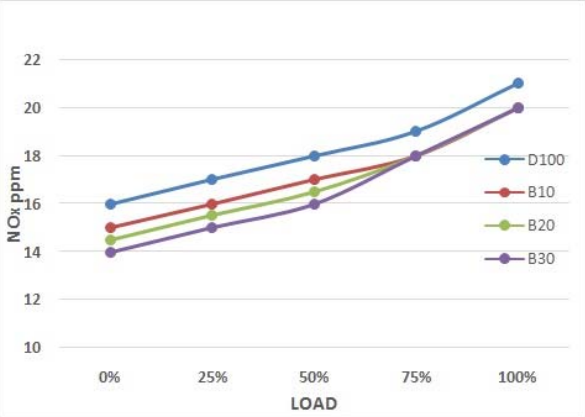

Figure-8. Emission characteristics of NO_X.

The study of nitrogen oxide emission from diesel, soapnut oil blends are slightly lower than the pure diesel fuel performance at maximum loads and it was shown in Figure-8. Because of more air action, much elevated than stoichiometric values, diesel engines produce more NOx at part load conditions and at higher loads. Diesel has higher calorific value than that of soapnut oil, so a lesser amount of diesel was injected into the combustion chamber.

CONCLUSIONS

Alternative fuels should be available at easily and at low cost, should be atmosphere friendly and provide safe energy needs without compromising diesel engine's operational performance. In this work, bio fuel from soapnut blends has been attempted as an alternative fuel. The experiments were conducted without any modification on the engine. CI engine performance tests were conducted with three blend ratios of soapnut oil with diesel. Based on the engine performance and emission characteristic test of the soap nut oil an admirable substitute fuel which gives better performance and similar emission characteristics results compared with base pure diesel.

REFERENCES

[1] Ashfaque Ahmed., Prabhakar. S., and Binu. K. Soloman and Soloman. K. (2013) "Performance Test For Lemon Grass Oil In Twin Cylinder Diesel Engine", ARPN Journal of Engineering and Applied Sciences, Vol. 8, No .6,pp.435-437.

[2] Hossain. A.K., and Davies. P.A. (2012) "Performance, emission and combustion characteristics of an indirect injection (IDI) multi-cylinder compression ignition (CI) engine operating on neat jatropha and karanj oils preheated by jacket water" Biomass and Bioenergy, Vol.46, pp. 332-342.

[3] Ibhanshu. V., Kumar. N., Mishra. C., and Sinha. S. (2013) "Experimental Investigation of Diesel Engine Fueled with Jatropha Oil Blend with Ethanol," SAE Int. J. Fuels Lubr. Vol. 6(3), pp 951-958.

[4] Ibrahim Khalil Adam, A. Rashid A. Aziz, and Suzana Yusuf (2016), "Response surface methodology optimization of palm Rubber seed combined oil based biodiesel and idi diesel Engine performance and emission", ARPN Journal of Engineering and Applied Sciences, Vol. 11, no. 24, pp 1819-6608.

[5] Mathiarasi R, C. Mugeshkanna, N. Partha (2017), "Transesterification of soap nut oil using novel catalyst", Journal of Saudi Chemical Society, Vol 21, Issue 1, pp 11–17.

[6] Misra R.D., M.S. Murthy (2011), "Performance, emission and combustion evaluation of soapnut oil–diesel blends in a compression ignition engine" , Fuel, Vol 90 , pp 2514–2518.

[7] Mofijur Rahman Md., MasjukiHj., Hassan and AbdelazizEmad Atabani. (2014) "Performance and emission analysis of Jatrophacurcas and Moringaoleifera methyl ester fuel blends in a multi-cylinder diesel engine", Journal of Cleaner Production, Vol. 65, pp 304-310.

[8] Senthil Kumar. S., and Purushothaman. K. (2012), "High FFA Rubber Seed Oil as an Alternative Fuel for Diesel Engine – An Overview" International Journal of Engineering and Science ISBN: 2319-6483, ISSN: 2278-4721, Vol. 1, Issue 10, pp.16-24.

[9] Sivaganesan S, M Chandrasekaran (2015), "The Influence of Thermal Barrier Coating on the Combustion and Exhaust Emission in Turpentine Oil Powered DI Diesel Engine", ARPN Journal of Engineering and Applied Sciences , Vol 10 (22), pp 10548-10554.

[10] Yi-Hung Chen, ,Tsung-Han Chiang, Jhih-Hong Chen (2013), "Properties of soapnut (Sapindusmukorossi) oil biodiesel and its blends with diesel" , Biomass and Bioenergy, Vol 52, pp 15–21.