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Experimental Investigation of Performance Characteristics on a Single Cylinder C.I Engine Fueled with Simarouba glauca as BioDiesel

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Abstract: -- **In the recent years, there has been a drastic increase in the automobile production all over the world as a result of increasing dependence on transportation mediums. Whatever might be the medium of transportation, it all needs energy and most of them depend on the petroleum products as fuels. Technically speaking Alternative fuel is nothing but any material other than fossil fuels, coal and its by-products or anything from earth crust that could be used as a fuel to power a vehicle. Bio-diesel can be extracted from different raw materials like vegetable oil, biomass, algae, milk scum etc. In which Simarouba glauca is one the promising among them. This is being considered as they are cheap, renewable and are less polluting.**

Key words: C.I Engine, bio diesel, Simarouba.

1. INTRODUCTION

Over a hundred years ago Rudolf Diesel, the inventor of the C.I engines that still bear his name, demonstrated at a World Fair that agriculturally produced seed oil (peanut oil) may be used as fuel [1]. The use of these agriculturally derivative oils as a fuel was phased out by petroleum-based diesel fuels that became more widely available because they are cheaper in price as a result of government subsidies in the 1920's [1]. In the present scenario with the depletion of the petroleum-based diesel, the demand for alternatives to petroleum-based fuels continues to increase. The increase in the awareness of these alternative biofuels is not only because of the depletion of fossil fuels, but also because these bio-energy resources have lower emissions than conventional fuels and more over they are made from renewable resources. Biofuels refer to any kind of fuel generated which is made mostly from biomass or biological material collected from living or recently living resources. Transportation sectors have shown particular interest in biofuels because of the potential for rural development. In a country like India where it is observed that biodiesel can be a viable alternative automotive fuel. Biodiesel is a fastest growing alternative fuel and India has better resources for its production.

II. LITERATURE REVIEW

The use of vegetable oil as an alternative to conventional diesel fuel

There has been a consensus among many researchers for several years that vegetable oils could serve as an alternative to conventional fuels in C.I engines [3, 4]. Many articles have been published showing that vegetable oil could be used to fuel a diesel-powered engine under normal conditions. In a case one researcher taken a trail on tractor run on sunflower seed oil for 1000 hours with an 8% power loss [5], and another researcher demonstrated that rapeseed oil had similar energy output to diesel [6]. However, further researcher documented that there are problems associated with the use of vegetable oil such as heavy wax and gum deposits in diesel engines and carbon build up in the combustion chamber when sunflower oil was sued [7, 8]. Plus, engines run on rapeseed oil reportedly had some difficulties on account of carbon deposits on piston rings, valves and injectors after 100 hours [6]. A more promising study in the support of using vegetable oil evaluated several chemical and physical properties of various types of oils and found that the deposition of carbon was reduced when the oil was heated prior to combustion and also it was found that the carbon deposits were a function of oil composition such as high viscosity [9]. Research has demonstrated that blending biodiesel with conventional diesel fuel at different proportions can minimize deposits and extend the life of the engine [10, 11]. They observed that one could run the engines on the blend of biodiesel/diesel without any immediate adverse effects and long-term lifecycle effects that were similar to those found on engines that have been operated with pure diesel. However, the percent of biodiesel in the blends was a large variable in many of the studies; blends with higher percentage of biodiesel to diesel results increased carbon deposits. The studies on blending biodiesel with conventional diesel fuel suggested that the increase in carbon deposits could be as a result of the different atomization and injection characteristics that are very much

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likely because of high viscosity and low volatility of the biodiesel [12, 13].

The development of biodiesel from vegetable oil.

Vegetable oil has all the potential to be considered as an alternative diesel fuel, but it has short comings like high viscosity, low volatility, poor cold flow properties, and the carbon buildup in engines [14, 15]. The drawbacks have directed the investigation to search for various derivatives of the fuel of which biodiesel seem to be the most popular one. The word biodiesel was presented to the U.S. mainstream in 1992 by the National Soy Diesel Development Board presently known as the National Biodiesel Board, which has been a pioneer in commercialization of biodiesel in the United States [2]. The chemical definition of biodiesel is the mono alkyl esters of long chain fatty acid that comes from a renewable resource or lipid [2]. Lipids or oils are insoluble in water, hydrophobic substances that consist of one mole of glycerol and three moles of fatty acid, and are usually referred to as triglycerides [16]. The composition of oils contains 90-98% triglycerides. Oils and fats derived or collected from different sources have diverse fatty acid compositions [16].

III. METHODOLOGY

Biodiesel is the name given to that clean burning alternative produced from domestic, renewable resources. Biodiesel does not contain petroleum, but it can be blended at some optimum level with conventional diesel to create a biodiesel blend. Biodiesel can be used in C.I (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and are free from sulphur and aromatics.Biodiesel is prepared through a chemical process called transesterification in which the glycerin is separated from the fat or vegetable oil.

Process of extracting Biodiesel

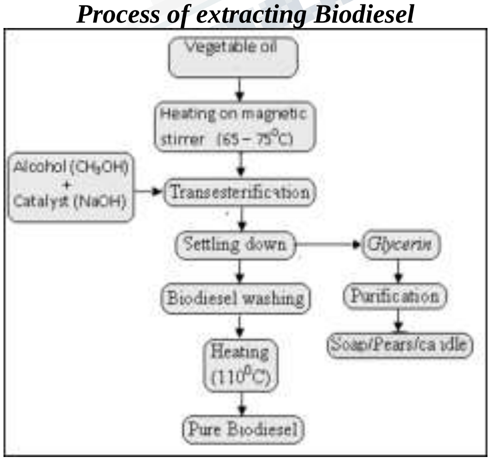

Fig.1 Flow chart of Biodiesel production.

Transesterification

There are three main forms of biodiesel production: pyrolysis, micro-emulsification and transesterification [17]. However, out of this transesterification has been proven to be the easiest and most effective process for production of biodiesel. In transesterification, the free fatty acids and triglycerides are reduced to fatty acid esters and glycerin [17, 18]. The process of transesterification for biodiesel is the reversible consecutive stepwise organic reaction of a triglyceride with an alcohol to create glycerol and esters, where alcohol is in excess pushes the reaction towards the formation of esters because of its reversible nature [19]. In other words, in the transesterification process triglycerides are converted from diglycerides, to monoglyceride, and then glycerol, releasing or freeing a mole of ester at each step [20, 21]. Fig. 2 has the general equation for transesterification.

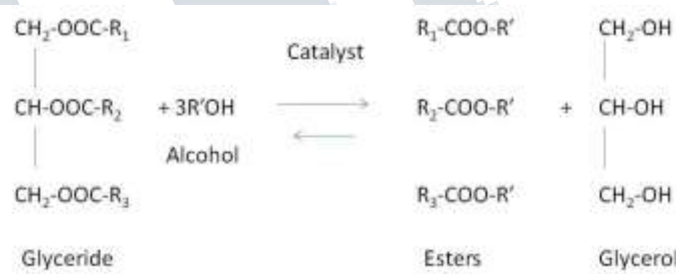

Fig. 2 Transesterification of triglycerides with alcohol in presence of catalyst, where R is the alkyl group.

A catalyst is commonly added to increase the yield and improve the rate of reaction. In transesterification there are a few options for catalyst. The most common method is alkali catalyzed transesterification. In this reaction the anion of the alcohol and the catalyst attacks the carbonyl carbon atom of the triglyceride molecule forming a tetrahedral intermediate that reacts with the alcohol to regenerate the ion of the alcohol and catalyst. The rearrangement of the tetrahedral intermediate results in the formation of a fatty acid ester and a diglyceride. The process is repeated freeing two more esters from diglyceride to monoglyceride and then monoglyceride to glycerol. For this type of transesterification, the glycerides and alcohol must be anhydrous state because the presence of water turns the reaction into saponification.

IV. EXPERIMENTAL SET UP

The procedure involves setting up a test generator in a matter that allows to measure exact fuel consumption per unit of time and the output generated for a given fuel blend. Then the overall output efficiency was determined by dividing the energy output by the consumption of biodiesel. The engine can be seen in Figure 3. and the engine specifications in Table 1. Four blends of biodiesel were tested and their performance was compared with conventional diesel. The four blends of biodiesel were at dilution levels of 5%, 10%, 20% and 50%.

Fig. 3 Test Ring of C.I Engine for Experiment.

Table 1: Engine and Dynamometer Specification

Sl.no	Parameters	Specification
1	Type	TV 1 (Kirloskar made)
2	Nozzle opening pressure	200 to 225 bar
3	Governor type	Mechanical centrifugal type
4	Number of cylinders	one cylinder
5	Number of strokes	Four
6	Fuel type	Diesel
7	Compression ratio	16.5:1
8	Cylinder diameter (Bore)	80mm
9	Stroke length	110mm
Electrical dynamometer		
10	Type	Foot mounted, continuous rating
11	Alternator rating	3KVA
12	Speed	2800-3000RPM
13	Voltage	220 V AC

V. RESULTS AND DISCUSSIONS

Fuel properties

Table 2 shows the fuel properties obtained for Simarouba glauca biodiesel and oil. All fuel properties were determined in triplicate and the result shown is the average of the three trials.

Table 2. List of fuel properties obtained for Simarouba glauca biodiesel and oil.

Properties	S. Glauca biodiesel	S. Glauca Oil
Acid Value (mg KOH/g) -	0.24905	2.2465
Viscosity at 40C (mm2/s)-	12.609	60.535
Calorification (MJ/kg) -	32,143	
Saponification-	179.561	185.9317
Density-	867	
Cloud point (Celsius)-	18	Room temperature
Pour point (Celsius)-	15	
Iodine number-	56.03	54.28
Flash point (Celsius)-	160	
Ash content (%)-	0.00485	

OBSERVATIONS AND RESULTS

Using the data recorded from the engine test and the energy conversion lab manual the following parameters were calculate. Brake power (BP), break thermal efficiency (BTE), and break specific fuel consumption (BSFC) at each load for all the blends and conventional diesel fuel and also recorded the exhaust gas temperature (EGT) at every load for every blend, plus the conventional diesel fuel. The results were graphed the BP versus the BSFC (Figure 4), BTE (Figure 5), and EGT (Figure 6).

BSFC VS BP

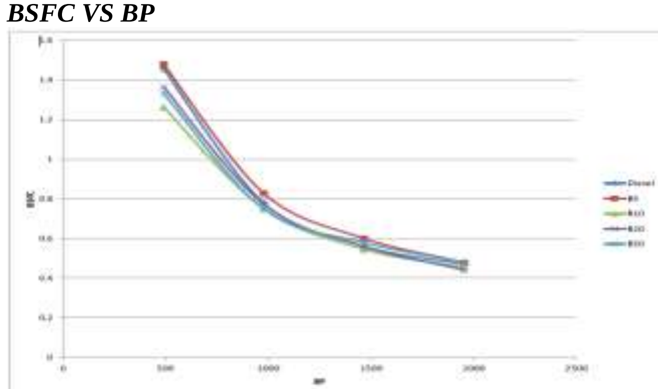

Fig. 4 Break specific fuel consumption Vs Break power.

BTE VS BP

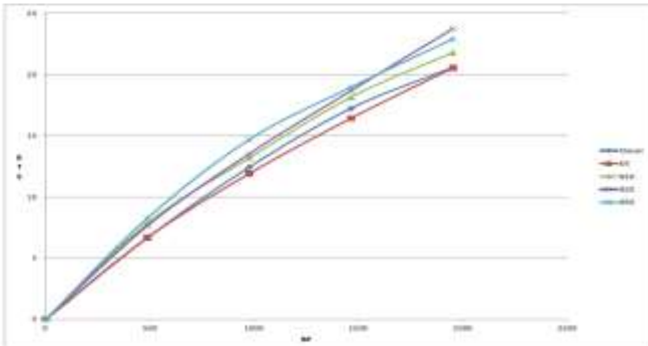

Fig. 5 Break Thermal Efficiency Vs Break power.

EGT VS. BP

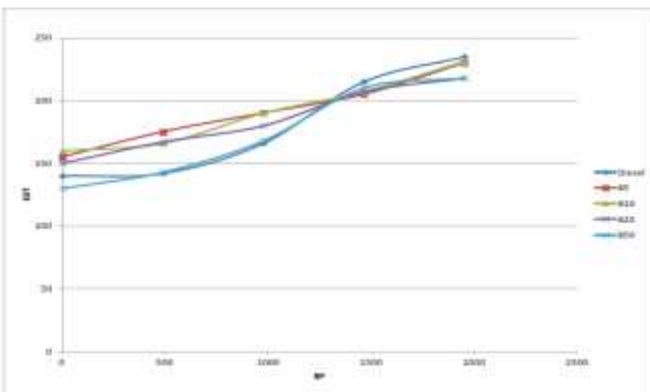

Fig. 6 Exhaust gas temperature Vs Break power.

CONCLUSION

Simarouba glauca biodiesel satisfies the important fuel properties that are required as per ASTM specification for biodiesel. During the test Engine works smoothly on simarouba methyl ester and the performance was comparative to that of diesel operation. The simarouba biodiesel is a promising biodiesel and can be a substituted as alternative fuel for CI engine in future

REFERENCES

[1] Lim, S., & Teong, L. K. Recent trends, opportunities and challenges of biodiesel in Malaysia: An overview. Renewable and Sustainable Energy Reviews 2010; 14, 938-954

[2] Singh, S., & Singh, D. Biodiesel production through the use of different sources and characterization of oils and their esters as the substitute for diesel: A review. Renewable and Sustainable Energy Reviews 2010;14, 200-216.

[3] Goering CE, Schwab AW, Daugherty MJ, Pryde EH, Heakin AJ. Fuel properties of eleven oils. Transactions of the American Society of Agriculture Engineers 1982;25:1472–83.

[4] Bagby MO. Vegetable oils for diesel fuel: opportunities for development. In: International winter meeting of the American Society of Agriculture Engineers; 1987.

[5] Bruwer JJ, Boshoff BD, Hugo JC, Du Plessis LM, Fuls J, Hawkins C, et al. The utilization of sunflower seed oil as a renewable fuel diesel engines. Agriculture Energy 1981;2. pp. 4–81 [Biomass Energy/Crop Production, St. Joseph, MI, American Society of Agriculture Engineers, American Society of Agriculture Engineers Publication].

[6] Schoedder C. Rapeseed oil as an alternative fuel for arriculture. Beyond the energy crises—opportunity and challenges, volume III. . In: Fazzolre RA, Smith CR, editors, The Third international conference on energy use management, Berlin (West). Oxford: Pergamon Press; 1981. p. 1815–22.

[7] Tahir AR, Lapp HM, Buchanan LC. Sunflower oil as a fuel for compression ignition engines. In: Vegetable oils fuels: Proceeding of the international conference on plant and vegetable oils fuels. St. Joseph, MI: American Society of Agriculture Engineers; 1982.

[8] Bacon DM, Brear ID Moncrieff, Walker KL. The use of vegetable oils in straight and modified form as fuel for diesel engine. Beyond the energy crisis—opportunity and challenges, volume III. In: Fazzolre RA, Smith CR, editors, Third international conference on energy use management, Berlin (West). Oxford: Pergamon Press; 1981. p. 1525–33.

[9] Reid JF, Hensen AC, Goering CE. Quntifying diesel injection coking with computer vision. Trans American Society of Agriculture Engineers 1989;32(5):1503–6.

[10] Engelman HW, Guenther DA, Silvis TW. Vegetable oil as a diesel fuel. Diesel and gas engine power division of ASME paper number 78-DGP-19. New York, NY: ASME; 1978.

[11] Quick GR. Development in use of vegetable oils as a fuel for diesel engine. American Society of Automotive

Engineers paper number 801525. St. Joseph, MI: ASAE; 1980.

[12] Pestes MN, Stanislao J. Piston ring deposits when using vegetable oil as a fuel. Journal of Engine Test Evaluations 1984;12(2):61–8.

[13] Ryan III TW, Dodge LG, Callahan TJ. The effect of vegetable oil properties of injection and combustion in two different diesel engine. Journal American Oil Chemists Society 1984;61(10):1610–9.

[14] Zhang Y, Dube MA, McLean DD, Kates M. Biodiesel production from waste cooking oil: 2. Economic assessment and sensitivity analysis. Bioresource and Technology; submitted for publication.

[15] Perkins LA, Peterson CL. Durability testing of transesterified winter rape oil (Brassica napus L.) as fuel for small diameter bore, multi-cylinder, DI, CI engines. Society of Automotive Engineers Paper 911,764; 1991.

[16] Sonntag NOV. Structure and composition of fats and oils. In: Swern D, editor.4th ed., Bailey's industrial oil and fat products, vol. 1, 4th ed. New York: John Wiley and Sons; 1979. p. 1.

[17] Ma, F. and M.A. Hanna. Biodiesel production: A review. Bioresources and Technology 1999; 70: 1-15.

[18] Fjerbaek, L., K.V. Christensen and B. Norddahl. A review of the current state of biodiesel production using enzymatic transesterification. Biotechnology Bioengineering 2009; 102: 1298-1315.

[19] Ranganathan, S. V., S.L. Narasimhan and K. Muthukumar. An overview of enzymatic production of biodiesel. Bioresource Technology 2008; 99: 3975-3981.

[20] Noureddini H, Zhu D. Kinetics of transesterification of soybean oil. Journal of American Oil Chemists Society;74:1457–63.

[21] Schwab AW, Dykstra GJ, Selke E, Sorenson SC, Pryde EH. Diesel fuel from thermal decomposition of soybean oil. Journal of American Oil Chemists Society 1988;65:1781–6.