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A Study of the Performance, Emission and Combustion of Characteristics Lemon Grass Methyl Ester in CI Engine

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ABSTRACT: In India has the largest automobile sector that generates pollution to the environment. Many researchers fully focused on reduction of exhaust emission from the CI engine. Many of alternate fuels are invented for the reduction of air pollution and make up deficiently of fossil fuel, the alternate fuel such as 1st generation 2nd generation and 3rd generations. In the third generations like algae and other biological plants are used for production of Biodiesel. The algae and other plants have high oil content and commercially available and easily cultivated in land and garden. In this study Lemon grass has been chosen for the production of biodiesel. After 60 to 70 days growth of lemon grass plant harvested from the garden or cultivated land and converted into small pieces. The small pieces dried in shadows 3 to 4 days after that dried small pieces converted into power form. The power form lemon grass subjected into a chemical solvent such as N-Hexane about 70 to 80 hours. The 92% of oil was extracted with help of chemical solvent. The separating funnel was used for separating of oil and chemical solvent. The oil is converted into biodiesel through the Transesterification process and the physical and chemical properties of biodiesel were analyzed. Esterified biodiesel blended with neat diesel with various proportions such as 20%(B20), 40%(B40), 60%(B60), 80%(B80), and 100%(B100).The fuels investigated in the Kirloskar AVI diesel engine. 20%(B20) of biodiesel shows higher brake thermal efficiency compared to other blends, 100%(B100) of biodiesel shows lower No_x emission. Smoke density and HC 20% shows lower emission, the 20%(B20) of biodiesel gives max heat release rate(HRR)

Keywords: Fuel, Lemon-Grass, Biodiesel, Automobile, HRR.

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I. INTRODUCTION

Usage of fossil fuels in various industries, especially transportation and petrochemical sectors were reported to the primary source for the release of higher level of CO_2 in the open atmosphere that leads to increased risk of global warming and also increase exhaust emission. Biodiesel is an alternate fuel to CI engine that can reduce the use of fossil fuel. It having higher calorific value and carbon content (1) The day by day increases the diesel engine's use associated with the aspiration of an undeveloped or developing countries to improve their economic status as lead to increase the demand for fossil fuel supply. (2) The fuel atomization in diesel CI engine is significantly affected on the performance, evaporation, self-ignition and emission of engine. (3) Compression ignition engine enjoy importance among the internal combustion engine because of relatively better fuel economy lower emission of HC and CO compared to spark ignition engine. However the PM and No_x emission are high compression ignition emission engine was generate lower HC and No_x emission. Using algae methyl ester and Brake thermal efficiency was similar to sole fuel, cylinder pressure was increase using algae methyl ester on compression ignition engine (4,5).

The requirement of alternate fuel for CI engine is reduce cost, develop the performance and reduction in emission. The biomass is one of the one of best feed stock for the renewable energy. Biomass can utilized air, water and soil through photo synthesis to produce Bio energy. Bio energy can be extracted from plant, vegetable, seeds, microorganisms, animal fat, animal manure and algae etc., (6,7). The vegetable oils are low cetane number, high viscosity. High ignition temperature causes increase the emission.

Micro algae serves as an alternate fuel it has lower calorific value and lower cetane number and also lower oil content that increase the smoke opacity. But reduced HC and No_x in production. Because of the content of its high-value essential oil, the cost for production of biomass for biofuel may be low, since the biomass would be a by-product of essential oil production(8). Lemongrass may prove to be a new high-value specialty crop

and a good source for biofuel in the southeastern United States, a region known for its hot, humid climate, abundant and cheap water, and well-established irrigation infrastructure(8). , Lemon grass (Cymbopogan flexuous) is discussed as newer sources of oil for biodiesel production. Lemongrass is native to India and tropical Asia. In India, it is cultivated along Western Ghats (Maharashtra, Kerala), Karnataka and Tamil Nadu states besides foot-hills of Arunachal Pradesh and Sikkim i.e., it can be cultivated on wide range throughout India and may favor easy availability. This study investigates the performance of Lemongrass oil and its blends as fuel for a CI engine (9,10).

Lemon grass used feed stack for biodiesel for CI engine. It has high oil content compared to other biodiesel and also easily cultivate in the garden and waste land. The 90% of oil was extracted from the lemon grass dry and powder sample through chemical extraction the chemical such as N Hexane. The extracted oil converted to biodiesel through the Transesterification process and also analyzes the physic chemical properties of lemon grass oil. The LGME blended with diesel with various properties such as20%(B20), 40%(B40), 60%(B60), 80%(B80), and 100%(B100). The Blended biodiesel can utilized in Kirlosker AV-I diesel engine and study the performance, emission and combustion characteristics.

II. MATERIAL AND METHOD

Lemon grass biomass sample was collected, dried in the shadow, powdered in pulverizer and powdered sample subjected in to chemical extraction with help of chemical solvent such as N-hexane. The chemical solvent extracted oil from sample. The lemon grass oil converted in to lemon grass methyl ester (LGME) through the transestrification process and physio-chemical properties were analysed as shown in table 1. The LGME blended with diesel with various properties such as 20%(B20), 40%(B40), 60%(B60), 80%(B80), and 100%(B100). The Blended LGME can utilized in Kirlosker AV-I diesel engine and study the performance, emission and combustion characteristics.

Properties	**Diesel**	**Lemon Grass**
Specific gravity @ 15/15^{o}C	0.823	0.886
Kinematic viscosity at 40°C (CSt)	3.06	4.11
Flash Point (°C)	44	56
Fire Point (°C)	48	61
Pour point (°C)	-22	-20
Gross calorific value (kJ/kg)	44000	43942
Density at 15°C (gm/cc)	0.8381	0.8858
Cetane number index number	52	50.3

Table-1. Properties of Lemon Grass Methyl Ester and Diesel

Experimental Setup

The experimental investigations were conducted in a Kirloskar TV-I DI diesel engine. The specification of the test engine was given in table 2. A single cylinder 4-stroke water cooled diesel engine with 3.2 kW brake power at constant of 1500 rpm was used in this study. The engine was coupled to an eddy current dynamometer with control systems. The engine is equipped with crank angle sensor, piezo-type cylinder pressure sensor, thermocouples to measure the temperature of the water, air and exhaust gas. Di-gas analyzer was used to measure the emissions from the exhaust gas. AVL smoke meter was used to the smoke density from the engine exhaust gas. The schematic view of the experimental setup was shown in the figure 1.

Type	**Vertical, Water Cooled, Four stroke**
Number of cylinder	one
Bore	87.5mm
Stroke	110mm
Compression ratio	17.5:1
Maximum Power	5.2kw
Speed	1500rev/min
Dynamometer	Eddy current
Injection timing	23(before TDC)
Injection pressure	230kgf/cm^2

Table- 2. Specification of Test Engine

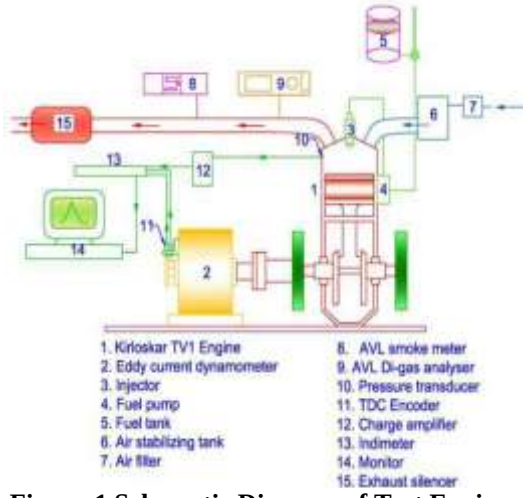

Figure-1 Schematic Diagram of Test Engine

III. RESULT AND DISCUSSION

The experiment is carried out in the single cylinder, four stroke, water cooled diesel engine The experiment is conducted with neat diesel fuel and LGME blends such as B20,B40,B60,B80 and B100 with standard injection timing and pressure.

Performance Characteristics

The brake thermal efficiency is indication with input chemical energy is converted into useful work. The Brake power against brake thermal efficiency as shown in figure 2. Among all the blends of LGME B20 gives better brake thermal efficiency compared to other blends. The B20 LGME Brake thermal efficiency is 25.5% .But brake thermal efficiency of diesel is 27%.So 1.5% of brake thermal efficiency decreases in B20LGME compared to diesel the reason is higher viscosity, higher density and lower calorific value.

The SFC of diesel and brake power is shown in figure 3.when Increase the brake power decrease the SFC. All the blends of LGME shows higher SFC than that of diesel. All the blends of LGME like B20, B40,B60,B80 and B100. B20 LGME shows lower fuels consumption. But compared to diesel is B20 LGME higher SFC reason is poor atomization of characteristics of B20 LGME and other blends.

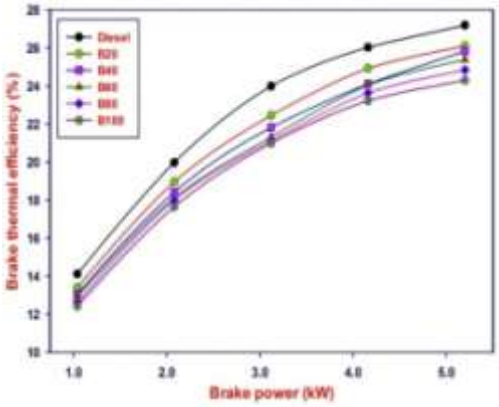

Figure -2 Brake Power against Brake Thermal Efficiency

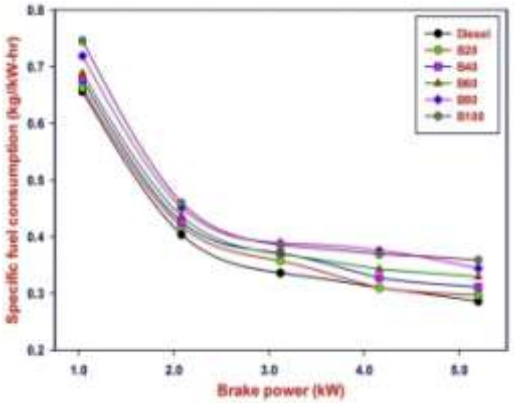

Figure-3 Brake Power against Brake Specific Fuel Consumption

Emission Characteristics

Figure 4 shows the variation of hydrocarbon emission with brake power of the engine for diesel fuel, B20, B40, B60, B80 and B100. Hydrocarbon emission is mainly due to incomplete combustion of fuel. The hydrocarbon emission level at maximum load is 128 ppm for diesel fuel, and increases for all blends of the LGME, specifically 132 ppm for B20 LGME. The diesel is 3.12% decreases hydrocarbon emission compare to B20LGME for the all loads. This is due to the lower oxygen content and poor atomization characteristics of LGME blends.

The Brake power against smoke opacity as shown in Figure-5, Smoke opacity varies according to the type of fuel used, its composition, its carbon content and C/H ratio. The smoke opacity diesel fuel is 76HSU .It is lower than that of all blends of LGME. But B20 LGME is 78HSU .It is slightly higher than diesel the reason is heavy molecular structure and higher viscosity of LGME fuel.

The oxides of nitrogen results are presented in the Figure 6, It is observed that oxides of nitrogen for all the blends of LGME shown lesser value when compared to that of diesel fuel. At maximum load, NOx emission is 1143 ppm for

diesel fuel, all the blends of LGME shows lesser value and the maximum reduction is for B100 LGME, which is 852 ppm. Generally higher combustion temperature shows higher NOx emission in CI engine. But all the blends of LGME shows lesser combustion temperature than that of the diesel fuel which reduces the NOx emission.
Maximum load for diesel is 0.25 % In Figure 7 the CO emission at vol., 0.36 % vol. for B100. The LGME blends shows higher value compared to diesel, whereas B20 shows 0.26 % vol. higher than that of the diesel fuel. This is due to the lower carbon content of the LGME

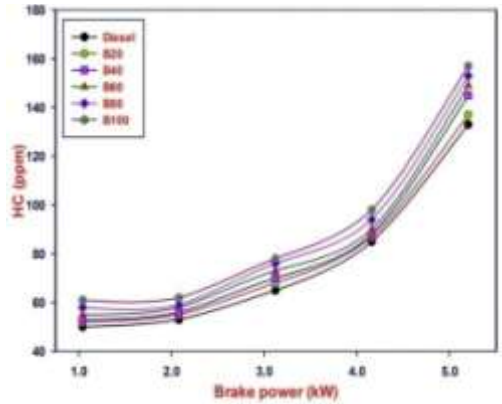

Figure-4 Brake Power against Hydrocarbon

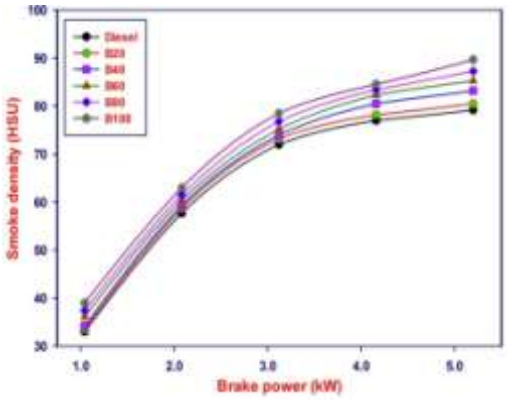

Figure-5 Brake Power against Smoke density

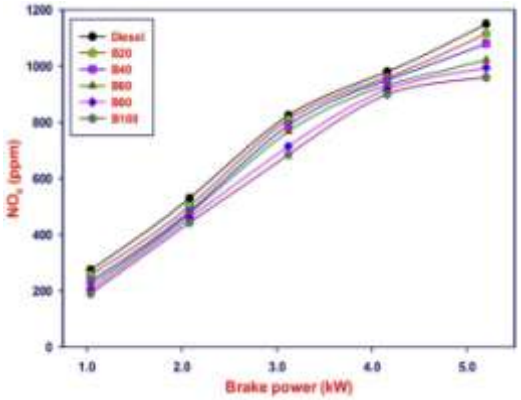

Figure-6 Brake Power against Oxides of Nitrogen

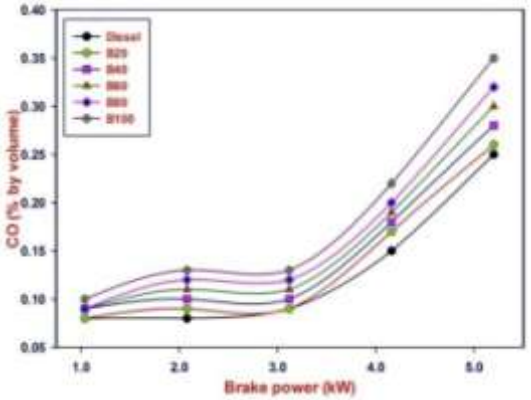

Figure-7 Brake Power against Carbon Monoxide

Combustion Characteristics

Figure-8 shows the cylinder pressure for diesel fuel and LGME blends against brake power (maximum load) of the engine which is operating at different loads at constant speed of 1500 rpm. The maximum cylinder pressure for diesel fuel is found to be 57.25 bar which is lower than that of B20, whereas other blends of the LGME shows lesser value than that of the diesel fuel. The lower value of the cylinder pressure for LGME blends lead to reduction in NOx emission. The reason for decrease in-cylinder pressure for LGME blends is due to poor spray characteristics and atomization.
Figure-9 shows the comparison of heat release rate for diesel fuel, LGME blends against brake power. The maximum heat release rate for diesel fuel is 132 kJ/m^3 deg. It is observed from the graph that diesel fuel shows maximum heat release rate than that of all the blends of LGME. This is due to the higher calorific value of the diesel fuel which increases the combustion rate and thus increases the heat release rate.

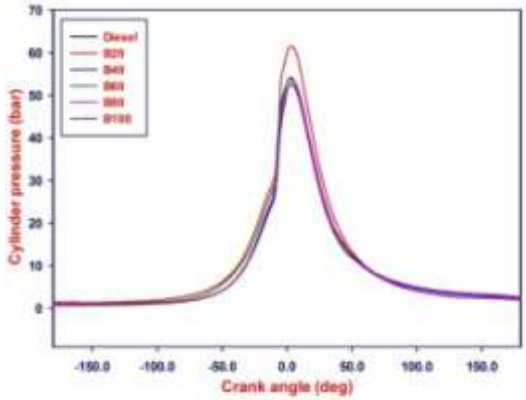

Figure-8 Crank Angle against Cylinder Pressure

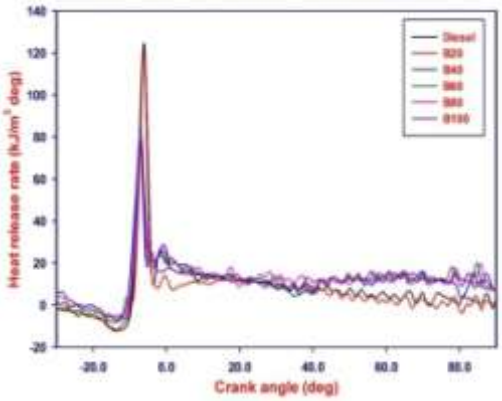

Figure-9 Crank Angle against Heat Release Rate

IV. CONCLUSION

The lemon grass plant was chosen for the suitable alternate fuel, and the study was conducted in Di diesel engine. The following results are obtained from Dl diesel engine by using lemon grass methyl ester.

- Performance wise B20LGME show the higher brake thermal efficiency than that of other blends.
- Emission wise NO, emission was decreases in the all blends, but smoke opacity, HC and CO were increases for all blends of LGME, so B20LGME show better emission compares other blends.
- Combustion wise B20LGME gives better results than that of other blends.
- On whole B20LGME suitable alternate fuel for diesel.

REFERENCES

[1]. Kannan, G.R. and R. Anand "Biodiesel as An Alternative Fuel for Direct Injection DieselEngines: A Review." Journal of Renewable and Sustainable Energy 4 (2012).
[2]. https://doi.org/10.1063/1.3687942
[3]. Kumaran, P., Jibin K P, Mohammed Gazel, and Kiranlal V. "Performance Analysis ofLemongrass Oil Added with Additive Blended with Diesel at vcr-diesel Engine." International Journal of Pure and Applied Mathematics 119.16 (2018): 2045-2051.
[4]. Meher, L.C., D.Vidya Sagar, S.N.Naik. "Technical Aspects of Biodiesel Production byTransesterification - A Review.''Renewable and Sustainable Energy Reviews 10 (2006): 248-68.
[5]. Noor, M. Jasim. "Comparative Analysis Of Atomizing Spray From Diesel Injectors UsingAnd Biodiesel Fuels." Journal of Engineering ,Researchgate 2019.
[6]. Sandeep, Kumar Duran, Pramod Kumar, Sarbjot S Sandhu. "Prospect of Algal Biodiesel as aFuel in Engine" International Journal of Engineering and Advanced Technology 8.6 2019.
[7]. Seung Hyun Yoon and Chang Siklee. "Experimental Investigation of the Combustion and Exhaust Emission Characteristics of Biogas Biodiesel Dual Fuel Combustion in a CI Engine." Fuel Processing Technology 92 (2011): 992-1000.
[8]. Shailendra Sinha, Avinash Kumar Agarwal and Sanjeev Garg. "Biodiesel Development from Rice Bran Oil: Transesterification Process Optimization and Fuel Characterization." Energy Conversion and Management 49 (2008): 1248-1257.
[9]. Sharif Hossain, A.B.M., Aishah Salleh, Amru Nasrulhaq Boyce, Partha chowdhury and Md Naqiuddin. "Biodiesel Fuel Production from Algae as Renewable Energy." American Journal of Biochemistry and Biotechnology 4.3 (2008): 250-254.
[10]. Valtcho D Jeliazkov (Zheljazkov, Charles L Cantrell, Tess Astatkie, Jeffery B. Cannon. "Lemongrass Productivity, Oil Content, and Composition as a Function of Nitrogen, Sulfur, and Harvest Time." Agronomy Journal 103.3 (2011):805-812.
[11]. Velappan, R., S. Sivaprakasam, and M. Kannan "Analyzing the Characterization of Biodiesel Extracted from Microalgae." International Journal of Applied Engineering Research 10.55 (2015):3923-3926.
[12]. A. Kerihuel,"Ethanol animal fat emulsions as a diesel engine fuel – Part – I: Formulations and influential parameters", Journal of Fuels 85 (2006) 2640-2645.
[13]. M. Senthilkumar, "Experimental investigations on the use of preheated animal fat as fuel in a compression ignition engine,

Journal of renewable energy 30(2005) 1443-1456.

[14]. J. Patterson,"Experimental study of DI diesel engine performance using three different biodiesel fuels". SAE. Paper No. 2006-01-0234.

[15]. C.D. Rakopoulos, "Comparative performance and emissions study of a direct injection diesel engine using blends of diesel fuel with vegetable oils or bio-diesels of various origins" Journal of Energy Conversion and Management47 (2006) 3272-3287.

Dr. R. Velappan, "A Study of the Performance, Emission and Combustion of Characteristics Lemon Grass Methyl Ester in CI Engine." *International Journal of Engineering Research and Applications (IJERA*), vol.9(12), 2019, pp31-36.