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Experimental on Eucalyptus Oil with Additives Blend as A Fuel for Diesel Engine

N. S. Senthur, H. Imamul Hasan, S. Shafquath ibn sulthan, S.Balamurugan, M. Maheshkumar

Abstract*— Oils extracted from vegetables exist as future fuel full or partial alternate diesel fuels. Experiments have been done on using ethanol and diethyl ether as additives of eucalyptus ester to find out the impact of the fuel on the release of toxic gas, and engine effectiveness of using fuel directly in the engine without altering. Varied proportions of eucalyptus composition have been used as fuel. The proportion of the fuel in B20 has 20% of eucalyptus ester fuel and 80% of diesel,. The second 90% of B20 and 10% mass of ethanol is B20+E10 whereas B20+D10 has 90% of B20 and 10% mass of diethyl ether. Experiments has been carried out using varied composition of eucalyptus oil to find the impact on the engine feature such as engine power, brake specific fuel consumption, brake thermal efficiency, exhaust gas temperature, has been determined with the help of performance tests. The impact on the smoke opacity has also been done to find out the release of toxic gas such as CO, CO_2, HC and NO. The outcome of such tests show that using B20 fuel lessens release 10% of diethyl specifically release of NO lessens by 51% in contrast to diesel. Mixture of B20+D10 offers enhanced engine effectiveness and lesser release of toxic gas in contrast to B20+E10 and B20 blends.

Keywords: Green fuel, Eucalyptus oil, Emissions, Ethanol, Diethyl ether.

I. INTRODUCTION

The bio-fuels are pretty clean propellant that is used as an substitute for petrol and diesel. It is made using domestic and sustainable substances. Green fuel does not consists of any petroleum elements in it however the fuel could be mixed at varied proportions along with petroleum and diesel for creating a green fuel blend. The same green fuel could be utilized as fuel for compression-ignition (diesel) engines without changing the blends. Green fuel is uncomplicated raw material for the engine, it is decomposable, harmless and does not have sulphur and aromatics [1] elements in it. A trans-esterification process is used to produce biofuel fuel. Biofuel is acceptable to the environment as the resources are renewable and there is lesser release of toxic gas in contrast to petroleum diesel. The benefit of using green fuel that it does not harm the environment as the release of toxic gas is reduced. Green fuel enhances lubricity and lessens wearing of fuel pumps before its expiry date. [2]. The release of toxic gas and engine effectiveness of diesel engines that use green fuels have been analyzed by several investigators.

The green fuels have been produced using varied vegetable oil such as sunflower, rapseed, soybean and karanja. These oils are utilized to carry out to tests them in the diesel engines to find out the impact of using the fuel on the engine effectiveness. Certain empirical studies results evidently state that there is higher power output and release of NO_X lessens on using biofuel. The dissimilarities in power and release of NO_X could be due to the changes done in the engine, the technique used to fuel the engine, treating exhaust gas, testing methods, and testing environments. The investigators found that the fuel is best for CI engine but the engines effectiveness did not shown an improvement however it can be utilized as substitute fuel instead of petroleum or diesel engine [3].

II. EMPIRICAL METHOD AND EQUIPMENT

There has been analysis of the direct injection diesel engine ignition and effectiveness using eucalyptus oil green fuel. The research has concluded with the result that with 20% blend of green fuel does give a positive effect hence 20% eucalyptus fuel blend has been used for analyzing [4]. Because of lesser calorific value and high level of stickiness, the proportion of eucalyptus fuel blend has been restricted 20%. For the investigations of ethanol-blend and diethyl ether-blend have been used as supplements and the impact the changes in engine effectiveness and release of toxic gas in diesel engine. High proportion of ethanol-blend and diethyl ether-blend results in cooling of the combustion chamber hence the proportion has been restricted to 10 percentage [5]. The prime purpose of this empirical study has been done to enhance the green fuel characteristics with addition of additives and to use high proportion of green fuel in diesel without modifying the diesel engine.

Eucalyptus oil fuel has been used to make the blends, the proportion of eucalyptus oil green fuel and diesel is 20:80 B20, the proportion in B20 blend and the ethanol 10% is B20E10, The proportion in B20 blend and diethyl ether 10% is B20D10.

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***Correspondence Author(s)**
N. S. Senthur, Department of Mechanical Engineering, Einstein College of Engineering, Tirunelveli, Tamilnadu, India.**(e**-mail: senthur.ns@gmail.com)
H. Imamul Hasan, Department of Mechanical Engineering, Einstein College of Engineering, Tirunelveli, Tamilnadu, India.**(e**-mail: imamulhasan2014@gmail.com)
S. Shafquath Ibn Sulthan, Department of Mechanical Engineering, Einstein College of Engineering, Tirunelveli, Tamilnadu, India.**(e**-mail: sulthanibn96@gmail.com)
S.Balamurugan, Department of Mechanical Engineering, Einstein College of Engineering, Tirunelveli, Tamilnadu, India.**(e**-mail: mechbalamuruga@gmail.com)
M. Maheshkumar, Department of Mechanical Engineering, Einstein College of Engineering, Tirunelveli, Tamilnadu, India..**(e**-mail: mmaheshkumar008@gmail.com)

Table 1. Fuel properties

Properties	The Diethyl ether	Diesel fuel	The Ethanol
The Kinematic Viscosity (40^0C) cst	-	2.83	1.36
The Density (kg/$m^{3)}$	720	839	798
The Calorific value (MJ/kg)	37.2	42	26.9
The Flash Point (^{0}C)	- 43	75	15
Cetane Number	-	45	7

Main apparatus used to conduct the experiment is Kirloskar engine with certain parameters.

The single cylinder engine and naturally aspirated and four stroke, water cooled engine. The 16.5:1 compression ratio and direct injection diesel engine, maximum engine power is 3.7 kW and 1500 rpm. All the investigations have been done using standard temperature and pressure conditions. Exhaust gas and cooling water that are vented out of the engine are checked by thermocouples (Cr Al) attached to the correspondent passages. A computer with relevant application in it receives all the data measured from the apparatus used.

Outlet gases from the engine emission have been measured using AVL-444 Di gas analyzer). The smoke opacity has been measured using AVL-437C smoke meter. A steady state of the engine and the speed of the engine has to be at a particular speed hence the engine start at no load , feed control have been adjusted. A gradual load on the engine had been applied such that the speed is kept in the allowed range. The pressure and crank angle images of the engine used for the investigation using diesel and fuel blends with full load had been taken, and engine effectiveness and release of toxic gas have been measured. An evaluation of the measured parameters has been done and has been compared with diesel propellant. Readings of data from each experiment have been taken thrice and the average value of 3 has been used.

III. RESULT AND DISCUSSION

3.1 Pressure verses Crank Angle

An illustration of the deviation in the cylinder pressure verses crank angle while using diesel, B20D and B20 E10 fuel blends at extreme engine loads have been shown in Figure 1. It is obvious that the peak cylinder pressure is high while using diesel. One of the prime inputs for ignition is the delay in ignition. While using green fuel ignition imitates early in contrast to diesel. While using green fuel there is a shorter period of ignition delay and advanced injection timing [6].

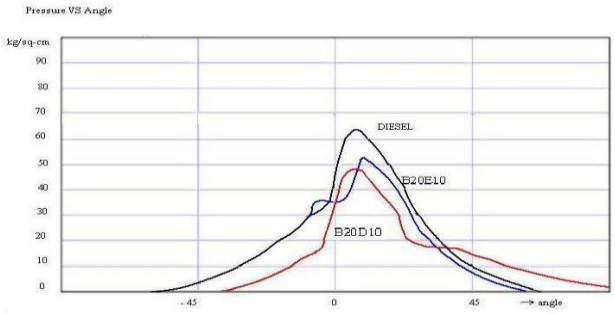

Figure 1: Deviation in cylinder pressure

Though there is high stickiness and lower flammable nature of green fuel, the lateness in the ignition is lesser while using green fuel in contrast to diesel [7]. This empirical study is used to calculate the ignition delay in terms of the crank angle among the start of fuel injection and the start of combustion. The highest pressure has been noted at 64 bar, 52.9 bar and 48.2 bar while using diesel, B20E10 and B20D10 fuel by applying full load. Nevertheless the peak cylinder pressure has been achieved by using the same crank angle positions 6 to 9 degree after top death centre by using all the discussed fuels. Due to the lengthier delay in ignition, the peak cylinder pressure is lessened. [8].

3.2 Break Thermal Efficiency

There is an increasing trend of BTE in engine with increase in load while using diesel and green fuel blend. It has been noticed that BTE level is higher when there is an increase in power developed while there is a high load. The deviation in BTE at full load operation is 25.37, 23.5, 24.2 and 24.4 while using B20D10, B20E10, diesel and B20 blends.

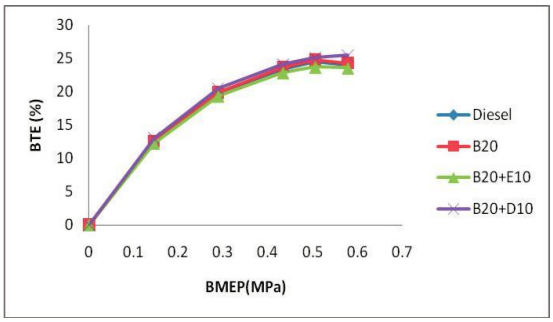

Figure 2: Deviation in BTE on full load and varied fuel blends

From the empirical study data a lesser extent of benefit has been observed while using the blend B20D10 above another blend proportion.

3.3 Brake Specific Fuel Consumption

The deviation in Brake Specific Fuel Consumption (BSFC) is lesser while using green fuel blends in contrast to diesel moreover observed a reduction in BSFC on increasing the load for all fuels. The reason must be as more energy is needed per kilowatt in contrast to lower load condition. A diagrammatic illustration shows the deviation in BSFC while using B20D10 as low, and while using B20E10 fuel is same as that of B20 is shown in Figure 3

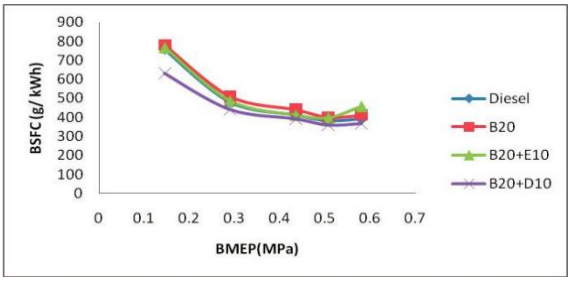

Figure 3: Deviation of BSFC with load and varied fuel blends

3.4 Exhaust Gas Temperature

Modification to delay in ignition impacts the exhaust gas temperature. When the delay in ignition is high there is a delay in combustion and the level of exhaust temperature is high [9]. The delay in the ignition is much lesser in contrast to diesel. The impact of lesser delay in ignition is reduction in the premixed combustion that in-turn augments combustion when the fuel is reheated. A diagrammatic illustration of the high level of exhaust gas temperature in contrast to diesel is shown in Figure 4.

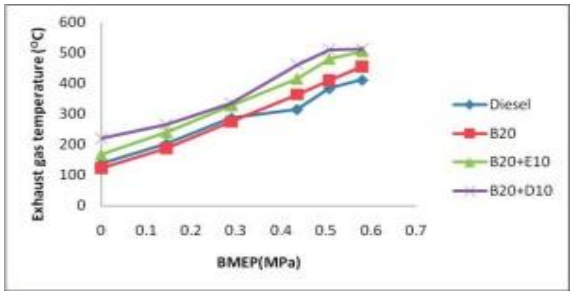

Figure 4: Deviation in exhaust gas temperature

3.5 Release of Toxic gas

3.5.1 Carbon Monoxide

A diagrammatic representation of the deviation in release of carbon monoxide under varied engine load condition using varied fuel blends is shown in Figure 5. Least and maximum levels of emission has been 0.01and 0.31% by volume. On applying 80% of the load the release of carbon monoxide is less but on applying higher load the release is also high. On applying higher load on the engine there will not be time for complete combustion therefore higher release of carbon monoxide. Lesser release of carbon monoxide has been noted while suing B20D10 blend of fuel, the level of release is 19% lesser than that of B20E10 on full load condition.

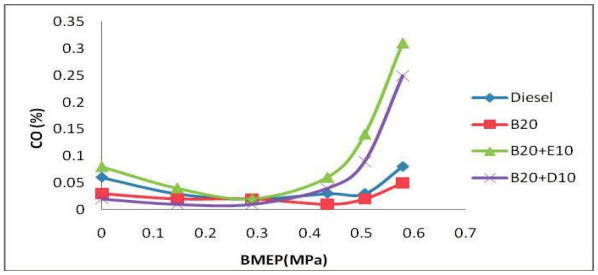

Figure 5: Deviation in release of carbon monoxide

3.5.2 Hydrocarbons

Green fuel has improved the release of hydro carbons due to high ratio of green fuel in the premixed combustion stage as there is delayed ignition. A diagrammatic representation of deviation in release of toxic gas by applying varied load is shown in Figure 8. Using B20D10 blend of fuel emitted lesser levels of toxic gas in contrast with all other blends of fuel also he level lessened to about 35% in contrast to B20 by applying full load on the engine. Presence of oxygen in green fuel lessens the release of toxic gas that helps for complete combustion.

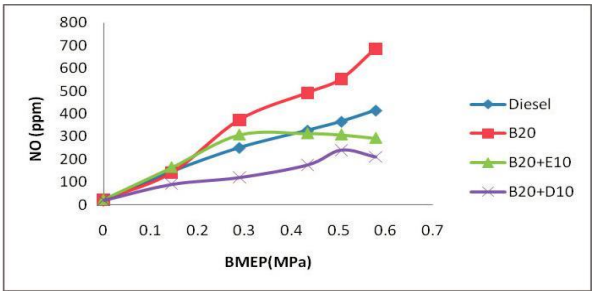

Figure 6: Deviation in hydro carbon release

3.5.3 Nitrogen oxide

A diagrammatic represention depicting deviation in release of nitrogen oxide is shown in Figure 7. It has been noted that oxygeneated components in the fuel is not affected by varying the load on the engine and doens not affect the release of nitrogen oxide. The release was higher when a medium to high level of engine load was applied on the engine by using B20 blend of fuel whilst the level of release was less with diesel. The reason for higher release of nitrogen oxide is due to high fuel combustion temperature (10). On adding ethanol and diethyl ether to the green fuel the release of nitrogen oxide reduces to the extent of 57% by using B20E10 blend of fuel and 69% of emission by using B20D10 blend of fuel in contrast to B20 blend of fuel.

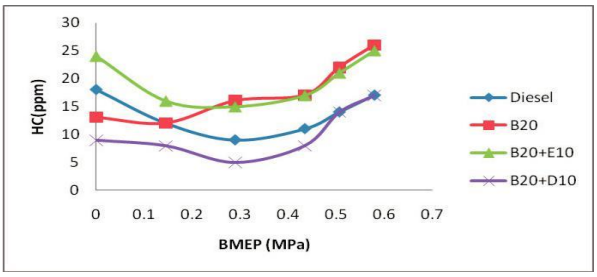

Figure 7: Deviation in release of Nitrogen Oxide

3.5.4 Smoke

Presence of particulate matter in the exhaust gas indicates the level of smoke opacity. Soot forms because of high level of temperature in the fuel and high level of pressure precisely inside the core region of fuel spray that is because of decomposition of high temperature(11). A partially oxygenated fuel reduces it to local regions of fuel that reduces smoke formation. A diagrammatic representation of the smoke opacity levels in the tested fuel is depicted in Figure 8. B20 blend of fuel produces lesser level of smoke in contrast to pure diesel, by applying medium load on the engine the release of smoke was better by using B20D10 blend of fuel. The least and maximum smoke densities generated using blend of B20D10 and diesel by applying full load has been 76% and 92%, the level of reduction has been 17%. The reason for lesser level of smoke may be because of oxygen molecule in the chain of green fuel that completes the burning of the fuel in contrast to diesel.

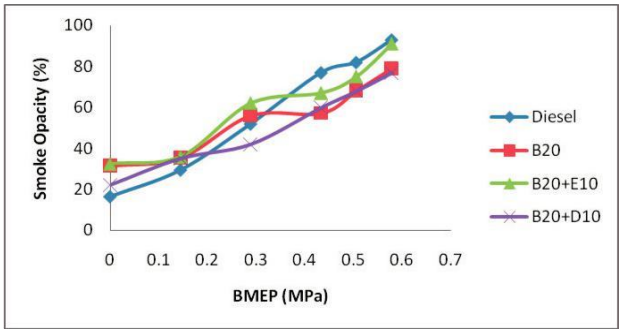

Figure 8: Deviation in Smoke opacity

IV. CONCLUSIONS

Main benefit of using eucalyptus oil to produce green fuel is the cost of the oil as it s much lesser than any other kind of edible oils. The properties of B20 blend of fuel such cetane number, Calorific value, sulphur content, and flash point perform better in contrast to diesel. Diethyl ether and ethanol are the supplements to reduce the thickness and stickiness of the blends. With B20D10 the BSFC level is less than that of B20E10 and is same as in blend of B20. The B20E10 and B20D10 blends, have more oxygen content than B20, hence smoke emission is less specially at higher level of engine load. Diethyl ether has more volatility than ethanol, hence B20D10 release less amount of smoke. The release of nitrogen oxide using B20D10 is less to the extent of 28% in contrast to the blend of B20E10, whereas there is no higher level in the release of nitrogen oxide on using blend of B20. While using B20D10 the release of hydro carbon is lesser in contrast to B20E10. A better way of using green fuel in diesel engine without modifying the engine is by adding higher level of oxygen content and high volatility fuels, such as diethyl ether and ethanol in the green fuel. Hence Eucalyptus oil blends can be used in CI engines in rural area for meeting energy requirement in various agricultural operations such as irrigation, harvesting, threshing, etc; Therefore it is concluded that eucalyptus oil is an alternate fuel for a diesel engine. Therefore 20% of eucalyptus oil green fuel and 10% of diethyl ether as supplements in the oil can be efficiently used in diesel engines without altering the engine.

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