Performance and Emission Characteristics of VCR Diesel Engine with Pre Heated Lemon Grass Biodiesel as Fuel

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Abstract. Under this experimental analysis the lemon grass oil was considered, it’s converted into biodiesel as lemon grass biodiesel methyl ester (LGB) through transesterification process. The Kirloskar TV1 was used as the reference fuel in the fuel injection system 4-stroke diesel engine. The lemon grass biodiesel methyl ester (LGB B20) blend B20 is selected because it nearest to the diesel value. The lemon grass biodiesel is preheated at 60°C temperature that is (LGB B20 preheating @ 60°C). The results of the test showed that LGB B20 kinematic viscosity and density gradually decreased with fuel temperature rise. The performance characteristics of Preheating biodiesel is increased the BTE and slightly reduce the BSFC at noted in the full load condition. And the emission characteristics at full load condition of CO, HC and smoke density as decreased, it was observed slight increase of NOx emission.

Keywords: LGB, Preheating, VCR engine, performance and emission

1. Introduction
The fossil-fuel vehicle population increases annually, leading to high emission rates. Fossil fuels are a threat in the long run because of their inconsistencies in demand and supply and their fluctuating fuel prices and their pollution problems. Similar physical, molecular and thermal features are contained in the edible and inedible oil near the diesel engine. However, the diesel engine is not used specifically because of its high viscosity in edible and inalienable oils. The preheating biodiesel data was referred Abdulfatah Abdu Yusuf et.al. [1] A preheated gasoline is processed at various temperatures (65, 75 & 80 ° C) in order to achieve better performance and pollution characteristics. Fish Oil Ethyl Ester (FOEE) tested in diesel without altering the engine setup. There are numerous attempts to examine the characteristics of a preheated biodiesel from various vegetable oils that are divided into edible and non-edible oils. V. Rambabu et.al [2] & Said M. A. Ibrahim et.al [3] reported that the preheated biodiesel which leads to higher brake thermal efficiency and slightly decreased in BSFC of performance declared, Co & HC pollution characteristics have reduced and improved significantly in the pollution of NOx. The Cottonseed Methyl Ester (CSME) & jatropha oil as used for this experiment. The inbuilt biodiesel oxygen lowers the adiabatic flame temperature, resulting in a linear reduction in NOx emission. M. Saravanakumar et.al. [5] & Krishnamoorthi S et.al [9] reported that potassium hydroxide (KOH) catalyst
and cooking oil biodiesel were examined for emission characteristics. Biodiesel viscosity obviously exceeds that of diesel, especially at low temperatures. The biodiesel relative gravity is around 6.1 percent more than that of diesel. Dinesh P et.al. & Prabhahar M et.al [4, 10] investigates the efficiency & pollution characteristics at B40 at 60, 75, 90 and 110o C preheated pongamia ester & Jatropha Biodiesel and B40 mixtures, Jatropha Biodiesel and its blends with Ethanol were used. The preheating of high-temperature biodiesel mixture thus increases viscosity & other characteristics dramatically and enhances performance and pollution. Prabhahar M et.al [6] reported the dual biodiesel (pine & Palm). [7, 8] Vegetable oil for the elimination of toxic emissions, as tested by direct injection diesel engine the oils consist primarily of triglycerides (90 to 98 per cent) and minor quantities of mono- and di-glycerides. Triglycerides contain three groups of fatty acids and one of glycerol. Methyl ester Vegetable Oils for better results for thermal efficiency and diesel fuel consumption have been recorded [9, 11] for potassium hydroxide (KOH), sodium hydroxide, and dimethoxy-methane (C3 H8O2) catalytic ester. Edible oil, for comparative efficiency and emission studies, like vegetable oil, Eucalyptus oil, pumpkin seed oil biodiesel pre-heated gasoline and gasoline free. [12, 14]. Amir Khalid et.al [13] was studied the comparison of preheats fuel characteristics of biodiesel and straight vegetable oil, Applied Mechanics and Materials. Mixing vegetable oil with diesel decreases the viscosity and increases stability. This enhanced property lead to better mixture formation and penetration of the spray. A variety of researchers tested the vegetable oils with diesel in different amounts. Prakash et.al [14] studied the efficiency and pollution profiles of biodiesel engine comportments with specific exhaust gas pollution recirculation levels (10%, 20% and 30%), describe a decrease in BTE, BSFC and NOx emissions, but marginally increase in other emissions. [16, 17] were examined Combustion, efficiency & pollution characteristics of a biodiesel & diesel fuel combination without fuel modifications. They revealed that decline in BTE, increment in nitrogen oxides (NOx) emission and decrease in particulate issue (PM), carbon monoxide (CO) and hydrocarbons (HC) discharges when contrasted with diesel. The problems associated with low volatility and high viscosities are compensated by subjecting the oil to the transesterification cycle, and the high viscosity can be minimized. Methyl and ethyl esters in vegetable oil (called biodiesel) have identical physical and chemical properties to those of ethanol. The different investigations describe the similarities of the single cylinder diesel engines fuelled with Jatropha biodiesel traditional diesel fuel for four stroke direct injection. Pre heating the vegetable oil reduces the viscosity and improves combustion characteristics. From the literature it was observed that very less work carried out with lemon grass biodiesel methyl ester, in these experimental studies the LGB B20 with unheated/preheating condition. The preheating fuel intake as 60°C temperature of LGB B20 is used in this experimental work. The goal was to define the LGB B20 pre-heating temperature that provides better efficiency & polluting characteristics.

2. Materials and methods

Right now, Lemongrass oil methyl ester delivered from lemon grass oil. Lemongrass (Cymbopogon flexuous) is a local sweet-smelling tall sedge (family: Poaceae) which develops in numerous pieces of tropical and sub-tropical South East Asia and Africa. It develops to around 2 meters and has red base stems. The pollutions present in lemon and lemon grass oil will be evacuated including 10 percent of hexane. The lemongrass oil is mixing it for 15 min at 85°C and leaves an undesirable natural issue to make due with 30 minutes. The properties of test fuel as shown in Table 1.

| Characteristics              | ASTM Std | Diesel | LGB   |
|------------------------------|----------|--------|-------|
| Kinematic Viscosity @ 40°C (cSt) | D445     | 3      | 4.34  |
| Calorific value (MJ/kg)      | D240     | 40     | 38.79 |
| Fire point (°C)              | D93      | 63     | 58    |
| Cetane Number                | D976     | 45     | 64    |
| Flash point (°C)             | D93      | 55     | 50    |
| Specific gravity             | D1298    | 0.8    | 0.87  |
| Density (kg/m³)              | D4052    | 840    | 830   |
3. Experimental test setup

Fig 1 shows the test engine setup. A single chamber, quad strokes and the pressure ratio with the vortex current dynamometer is used in the engine configuration. A Kirloskar motor converts to a diesel engine with a variable pressure proportion. The principal components of the frame include a fuel infusion siphon, gas exhaust analyser, dynamometer & turbocharger. Burning temperature, cylinders and fuel flow and load calculations are a critical tool. The rotary meter is calculated to use water to cool and calorimeter water to detect the flow of water. The engine was executed with a brake power, torque, showed power, grinding power, explicit fuel brake use, explicit use of fuel, warm brake skills, warm effectiveness & high productivity. The engine was executed.

4. Results and discussion

4.1. Performance Characteristics

Fig 2 gives the Brake thermal efficiency varies with the pre-heating of BGB B20, LGB and LGB B20 at 60 °C. In maximum conditions of load, BTE is 30%, 25% & 29% respectively for preheating diesel, LGB B20 & LGB B20. The preheating of LGB B20 shows higher BTE than without preheating of biodiesel. Heating the LGB B20 at 60°C will stronger affect how it burns in the cylinder than how
much energy it adds to the framework by recouping waste heat. Preheating of LGB B20 at 60°C rely on pressure to heat and light the fuel including heated fuel would make it disintegrate sooner and predetermination would be conceivable. The BTE was increased due to preheating temperature and lower heating value.

![Figure 3. BSFC for diesel, LGB B20 and LGB B20 preheating at 60°C](image)

Figure 3 indicates the discrepancy in the usage of diesel fuel, LGB B20 & LGB B20 preheating at 60°C. The BSFCs for diesel preheating, LGB B20 & LGB B20 respective were measured at full load condition as 0.22, 0.25 & 0.20 Kg / Kilowatt-hr. BSFC has been seen to decline as the engine load rose. The results show that the use of unheated LGB B20 by the BSFC is higher over varying rate. The preheating LGB B20 was decreased by 20% respectively as compared to the BSFC of unheated LGB B20. This is primarily due to decreased kinematic viscosity and improved atomization of fuel.

4.2. Emission Characteristics

![Figure 4. CO Emission for diesel, LGB B20 and LGB B20 preheating at 60°C](image)

Figure 4 demonstrates CO emission difference at 60°C respectively in the pre-warming processes LGB B20 & LGB B20. At maximum load the CO emission for petrol, LGB B20 and LGB B20 preheating respectively was measured as 0.8 and 0.68 and 0.58 (percent volume). It’s clearly shows the preheating LGB B20 as decreased the CO emission as compared to the unheated LGB B20. At varying loads, CO emissions using unheated / heated LGB B20 were found to be lower than diesel. The presence of oxygen
molecules in LGB B20 decreases the efficiency of preheated LGB B20 in combustion. LGB B20 emissions were reduced by heating due to improved fuel atomization, distributing, vaporization and mixing levels of injected fuel, resulting in better air-fuel mixing.

Figure 5. HC Emission for diesel, LGB B20 and LGB B20 preheating at 60°C

Figure 5 shows the max power conditions for petrol, LGB B 20 and LGB B20 preheating the hydrocarbon emissions were measured as 46, 43 & 40 ppm. It was observed that the preheating LGB B20 as decreased the HC emission as compared to the unheated LGB B20. Such reductions state that additional combustion of the fuel occurs at high load and thus the HC level drops significantly. It is mostly due to higher biodiesel oxygen content. Decrease in HC emissions was due to increased fuel atomisation and full preheated combustion of LGB B20.

Figure 6. NOx Emission for diesel, LGB B20 and LGB B20 preheating at 60°C

Figure 6 shows the NOx emission as plays major role in the atmospheric condition as increase the risk of respiratory condition of poisonous emission. Figure 6 indicates the NOx pollution difference of the 60 °C preheating LGB B20 & LGB B20. NOx emissions for diesel, LGB B20 & LGB B20 pre-heating at full load were found as 494, 520 & 540 ppm. This is because NOx formation is based on the temperature of the cylinder gas. It is observed that the preheating LGB B20 as increased 17% compare to the unheated LGB B20. At varying loads, NOx emissions using unheated / heated LGB B20 were found to be higher than diesel.
Figure 7 illustrates a difference of the density of smoke preheating gasoline, LGB B20 & LGB B20 at 60°C. At full load condition the Smoke Density was observed as 3.7, 3.3 and 2.7 BSU for diesel, LGB B20 and LGB B20 preheating respectively. He noticed that because of the presence of water in biodiesel, the smoke density is reduced. The Preheating LGB B20 shows lower smoke density as compared to the diesel and unheated biodiesel LGB B20. It shows the smoke density as reduced due to low fuel viscosity at preheating time.

The state of the art in diesel engine efficiency and emission characteristics fuelled with lemongrass biodiesel methyl ester (LGB) and its blends as alternative diesel engine fuels. LGB B20 preheating @ 60°C experimental work has been conducted and it is believed that it is used in diesel engine with little to no modifications. Compare to the other biodiesel such as Jatropha oil, Pongamia pinnata, Algae oil, Pine oil methyl ester, Fish oil methyl ester etc. Lemongrass biodiesel preheating and its blends contain the higher BTE and BSFC is lowered in diesel fuel. The comparative analyses indicate that biodiesel and its mixtures contain reduced exhaust emissions such as CO, HC and particulate matter / smoke and higher levels of NOX than diesel fuel due to higher levels of cetane and enriched oxygen content contributing to better combustion.

5. Conclusion
Under this experimental study the lemon grass oil was considered, it’s converted into biodiesel as lemon grass biodiesel methyl ester (LGB) through transesterification process. The lemon grass biodiesel methyl ester (LGB B20) blend B20 is selected because it nearest to the diesel value. The lemon grass biodiesel is preheated at 60°C temperature that is (LGB B20 preheating @ 60°C). The following findings were taken on the basis of laboratory studies:

- Diesel which has higher BTE compared to biodiesel, however BTE was increased 29.5% due to preheating temperature and 28% for unheated biodiesel.
- BSFC is lowered in diesel compared to biodiesel, however the BSFC was decrease by preheating Biodiesel LGB B20 preheating @ 60°C
- The emission characteristics at full load condition of CO, HC and smoke density as decreased, it was observed slight increase of NOx emission.
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