Performance and Emission Characteristics of Double Cylinder Diesel Engine Fuelled With Diesel, Citronella Oil & Grape Seed Oil

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Abstract - Bio diesel is an alternative fuel produced from edible & non-edible vegetable oils. In place of petroleum based diesel fuels, Bio diesel can be used, without any modifications in the engine. Due to the thickness of oil, straight vegetable oil can’t be used in diesel engine. By using Transesterification process crude oil is converted into bio diesel. And we conducted experiment on compression ignition double cylinder diesel engine fuelled with citronella oil & grape seed oil. The performance & emission characteristics of citronella oil, grape seed oil are compared with pure diesel, at zero load and at full load.

Key words: bio diesel, citronella oil, grape seed oil, performance, emissions.

I. INTRODUCTION
The energy demand increases every year, with the fast development of world economy. The combustion of petroleum and diesel based fuels leads to global climate change due to increase of carbon monoxide & other emissions. There is convincing evidence that the oil rates may increase over the next two decades and this would significantly reduce household income, economic growth and real consumption. Expansion of bio energy is one solution for the above problems. Bio energy is a sustainable renewable energy that helps in promoting regional and rural development. And also reduces carbon dioxide emissions. Bio diesel can be produced from a variety of feedstock that includes vegetable oils (ex: palm, peanut, rape seed and coconut oils.), animal fats and waste oils. Bio diesel has no aromatics, no sulfur and contains oxygen and high cetane number compare to diesel.

II. IMPORTANCE OF BIODIESEL

- Biodiesel is a substitute or extender for traditional petroleum diesel and you don't need special pumps or high pressure equipment for fueling. In addition, it can be used in conventional diesel engines, so you don't need to buy special vehicles.
- Biodiesel also produces fewer particulate, carbon monoxide, and sulfur dioxide emissions, all targeted as public health risks by the Environmental Protection Agency. Biodiesel contains only trace amounts of sulfur, typically less than the new EPA standards that will go into effect in 2006 for diesel fuel.
- Biodiesel is an oxygenated fuel, so it contributes to a more complete fuel burn and a greatly improved emissions profile. The more biodiesel used in a blend, the higher the emission reductions.

- One of the unique benefits of biodiesel is that it significantly reduces air toxic that is associated
with petroleum diesel exhaust and is suspected of causing cancer and other human health problems. NOx emissions are an exception to the rule, since biodiesel tends to increase NOx emissions. Recent research has shown a number of ways to mitigate this problem.

- Biodiesel mixes readily with petroleum diesel at any blend level, making it a very flexible fuel additive.
- Since biodiesel can be used in conventional diesel engines, the renewable fuel can directly replace petroleum products, reducing the country's dependence on imported fuels.

### III. LITERATURE REVIEW

M. Senthil Kumar et al. [1] used preheated animal fat as bio diesel in diesel engine. And they found that HC exhaust releases are high & CO also high. At low temperature NOx emissions are low compared to diesel.

Amit et al. [2] blended citrullus colocynthis oil as bio diesel they found that at 30% blend, high Break thermal efficiency and decrease in BSEC. Smoke density also reduced.

As per Solomon et al. [3] esters of egusi melon seed oil as fuel, they observed that fuel properties are almost same as methyl esters of sunflower and soya been oil. But kinematic viscosity is lower compared to most of the bio diesel.

Gulab N. Jham et al. [4] used wild mustard oil as a fuel, And found that kinematic viscosity and cetane number and oxidative stability is 61, 5 mm2 s-1and 4.8h. they discussed other properties of wild mustard oil i.e., specific gravity, Gardner color, iodine value, glycerol content and phosphorus and sulfur content in bio diesel standards EN 14214 ASTM D6751. And they concluded that it can be a used as fuel substitute.

Hamed M.E1-Mashad et al. [5] prepared bio diesel from salmon oil which is produced from salmon by-products. Preparing bio diesel from salmon oil is two step process due to high acid content in salmon oil. Using Sulphuric acid catalyzed pretreatment the acid value of salmon is reduced. And then by Transesterification process it is converted into bio diesel. And it was found that the cost of producing bio diesel from salmon oil is twice that of producing bio diesel from soya been oil.

Jomir hossian, et al. [6] conducted experiment on small diesel engine fuelled with methyl esters of mustard oil. To find the properties of blended mustard oil. First they converted mustard oil into bio diesel by Transesterification process using KOH as catalyst and they used as fuel in diesel engine and at different blends they measured properties of bio diesel and it was found that the parameters of mustard oil is slightly different than diesel fuel.

P.K. Sahoo et al. [7] used esters of polanga oil. It is produced by triple Transesterification process. At different loads and at different blends the experiment is conducted and it was found that less bsfc, high bfc compared to pure diesel. Exhaust emissions are low compared to pure diesel.

G lakshmi narayana rao, et al. [8] they prepared bio diesel from used waste cooking oil are disposed from restaurants. Because of high viscosity of the fuel we can’t use directly. After dehydrating of oil, by Transesterification process with alkaline catalyst it is converted into bio diesel. The combustion characteristics of MEUC are same as pure diesel. And the properties of MEUC are same as diesel. But
the performance parameters like $\eta_{th}$ are lower. & the exhaust emission characteristics are significantly reduced when compared with pure diesel. Using blended used cooking oil as bio diesel will certainly reduces dependence on fossil fuels.


N.R.Banapurmatha A, et.al [10] bio diesel is an ethyl or methyl esters (both edible and non edible oils) of fatty acids, is prepared from animal fats & vegetable oil. They prepared bio diesel from three oils i.e., honge oil, sesame oil, jatropha oil. The performance & combustion parameters like thermal efficiency, ignition delay, HC NOX CO are compared with pure diesel. Methyl ester of sesame gives best $\eta_{Bth}$ and less unburnt hydrocarbon emissions, co emissions & lower NOx emissions, compared to methyl esters of jatropha oil, and honge oil.

IV. METHODOLOGY

- Selecting the engine setup is first run by pure diesel and note down the readings of torque, fuel consumption, and exhaust gas emissions at zero load and 100% load conditions to set the benchmark for other alternative fuels.
- Selecting the citronella oil and Grape seed oil as a fuel in CI engine.
- Now suitable arrangements are made for the test, to measure HC, NOx, CO & torque and FC of the fuel with required measuring tools.
- Finally the experiment is conducted on CI engine with diesel, citronella oil, grape seed oil as a fuel. And also compare the BTE, BSFC of citronella & Grape seed oil with pure diesel at zero load and at full load conditions.

V. EXPERIMENTAL SETUP

The engine is a four stroke double cylinder diesel engine. At 1500rpm it produces around 15Kv of power with a displacement volume of 660cc and a compression ratio 17.5:1. The oil is injected at 27$^\circ$ before top dead centre, and engine is cooled using oil. And the nozzle opening pressure is 170 bar. By using governor the engine speed can be controlled. In order to measure cylinder pressure piezoelectric pressure transducers is used. By using push rods overhead valves is operated. And the combustion chamber has a hemispherical cavity.
Step: 1 The engine is started by cranking the flywheel (with battery). Initially CI engine runs on pure diesel. The engine has to run until it reaches its steady state condition i.e. at least it should run 30 minutes before taking the readings. After 30 minutes suitable valve mechanism diesel fuel is terminated and citronella oil is allowed to flow into the inlet of the engine.

Step: 2 Switch on the circuit once the circuit connections are made. And the loading called water loading is of special type is arranged and then circuit is closed. Now the CI engine is made to run at zero load conditions. And the engine has to run at least 30 minutes to achieve steady state conditions then loading is done by adding salt to the water.

At zero load and at full load conditions the following parameters are noted

- Current
- Voltage
- Fuel consumption in mg/stroke
- Speed
• Torque
• CO and NOX and unburnt HC measured

**Step: 3** At zero loads, initial readings were taken and the same procedure is repeated for 100% loads.

**Step: 4** similar procedures are followed for Grape seed oil by replacing citronella oil.

**Step: 5** if we use straight vegetable oil as a fuel, the engine must be run with pure diesel before and after the experiment. Since straight vegetable oil is high in viscosity it might damage the engine parts. And choking of CI engine can also be avoided.

**Step: 6** computer system is integrated with the CI engine, torque, the fuel flow rate and speed are taken from the software.

### VII. RESULTS & DISCUSSIONS

**Brake thermal efficiency**

![Fig. 3 Load versus Brake thermal efficiency](image)

Fig. 3 shows BTE for diesel, citronella oil, grape seed oil, with respect to zero load and full load. At zero load, BTE of Grape seed oil, citronella oil, is higher when compared with diesel. At full load, brake thermal efficiency of citronella oil is higher when compared with Grape seed oil.
Break specific energy conversion

Fig.4 Load versus BSEC

Fig.4 shows break specific energy conversion of diesel, citronella oil, grape seed oil, with respect to zero load and full load. BSEC of citronella oil, Grape seed oil is lower when compared to diesel at zero load and at full load.

NOX Emissions

Fig.5 comparison of Load versus NOx emissions

Figure.5 states that, at zero load condition NOx formation of both citronella oil and Grape seed oil is lower. But at full load condition, NOx formation of Grape seed oil is higher when compared to pure diesel and citronella oil.
CO emissions

![CO emissions graph](image)

*Fig.6 Load versus CO*

From the figure it is clear that at zero load condition, the carbon monoxide emissions of both citronella oil and Grape seed oil is higher. But at full load conditions, carbon monoxide emissions of both the oils are lower.

HC emissions

![HC emissions graph](image)

*Fig.7 Load versus HC*

Based on the graph above, at zero load unburnt hydro carbons emissions of citronella oil and Grape seed oil are higher when compared to pure diesel. But at full load condition, the emissions of both citronella oil and Grape seed oil are decreasing.

VIII. CONCLUSION

- Brake thermal efficiency of citronella & grape seed oil is higher compare to pure diesel.
- Break specific energy conversion of both grape seed oil & citronella oil is lower compared to diesel.
- At full load NOx emissions are high for both citronella & grape seed oil.
- Carbon monoxide & unburnt hydrocarbon emissions for both citronella oil & grape seed oil is higher compared to diesel.
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