IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.105 ⁜ Vol. 9, Issue 6, June 2022

DOI: 10.17148/IARJSET.2022.96153

EMISSION CONTROL ANALYSIS ON SINGLE CYLINDER 4-STROKE DIESEL ENGINE

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Abstract: Biodiesel is a renewable diesel replacement fuel that is manufactured from domestically produced oils such as neem seed oil, soybean oil, recycled cooking oils, or animal fats. To manufacture biodiesel, these fats and oils are chemically reacted with a short chain alcohol (such as methanol) and a catalyst to produce biodiesel and a glycerin co-product. Biodiesel can be used alone (B100) or blended with petroleum diesel in any proportion. Biodiesel can be legally blended with petroleum diesel in any percentage. This project deal with the analysis of emission properties and performance characteristics of biodiesel. Pollutants like CO (Carbon monoxide), HC (Hydro Carbon), PM (Particulate matters) etc. can be reduced by using biodiesel blended with diesel. Increment in NOx emission has been a problem in biodiesel but it can be overcome by various methods like Cetane no improver. Additives play a crucial role in minimizing NOx emission that could be a sigh of relief for the researcher who are opting biodiesel as an alternative fuel. Mainly animal fats and vegetable oils are used for the production of biodiesel.Several types of fuels can be derived from triacylglycerol-containing feedstock. Biodiesel which is defined as the mono-alkyl esters of vegetable oils or animal fats. Biodiesel is produced by trans esterifying the oil or fat with an alcohol (methanol/ethanol) under mild conditions in the presence of a base catalyst.

Keywords: Biodiesel, Animal Fats, Transesterification, Biodiesel, Petro Diesel, Blends

1. INTRODUCTION

Global air-pollution is a serious problem. Much of this pollution is caused by the use of fossil fuels for transportation. Therefore, engine manufacturers have designed alternatively fuelled engines and fuel systems, which provide sufficient power while staying within regulatory emission-limits. At the same time, a great deal of research and development on internal-combustion engines has taken place in finding an appropriate fuel. Many researchers have concluded that biodiesel holds promise as an alternative fuel for diesel engines. Therefore, biodiesel can be used in diesel engines with few or no modifications

Diesel-fuel blends with biodiesel have superior lubricity, which reduces wear and tear on the diesel engine and makes the engine components last longer. Biodiesel has a higher cetane number than petroleum diesel fuel, no aromatics, and contains 10–11% oxygen by weight. These characteristics of biodiesel reduce the emissions of carbon monoxide (CO), and hydrocarbons (HC), in the exhaust gas compared with diesel fuel.

However, NOx emissions of biodiesel increase because of combustion and some fuel characteristics. The fuel properties of biodiesel such as cetane number, heat of combustion, specific gravity, and kinematic viscosity influence the combustion and so the engine performance and emission characteristics because it has different physical and chemical properties than petroleum-based diesel fuel.

2. BIODIESEL PREPARATION:

Biodiesel is produced from the triacylglycerol containing material by means of a transesterification reaction. In this process, alcohol (methanol/ethanol) and animal fats are mixed in the molar ratio of 6:1, heated at 60-650C for 1hr and the ambient pressure in the presence of catalyst such as NaOH/KOH. Before that, animal fat gets heated up to 105-110^{0}C so that it will be converted into fat oil then in the separate flat bottom flask, alcohol and NaOH/KOH (2% of fat) are mixed exothermic reaction take place. This mixer is then added to heated fat and keep it at **60-65^{0}C** for 1hr. After this, it

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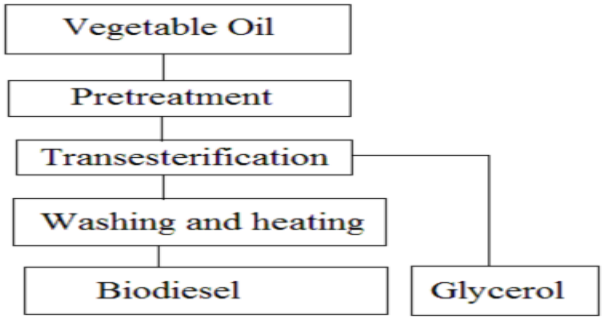
is poured into a bottle so that biodiesel and glycerol get separated as shown. This biodiesel is used in diesel engine as a solvent in ethanol-diesel mixer for avoiding a phase separation. The increasing % of biodiesel in ethanol-diesel blends results in the increase of emissions NOx but it reduces the emissions of CO, HC, Sulphur and particulate matter (PM) considerably. The preparation of biodiesel by transesterification process can be shown as in below fig.



Biodiesel is being produced from many of vegetable oils and animal fats. If it is produced from high quality edible oil and fats, it will result in high prices of raw material and biodiesel is more expensive than petroleum diesel fuel also shortage of edible oil for food purpose. Biodiesel may also be produced from less expensive animal fats including inedible tallow, pork lard and yellow grease. Animal fats are highly viscous and mostly in solid form at ambient temperature because of their high content of saturated fatty acids. The high viscous fuel leads to poor atomization of the fuel and result in incomplete combustion.

Transesterification and emulsification are two main solutions that have appeared as effective methods for using animal fats in diesel engine. Animal tallow generated biodiesel offers a wide range of energy, environmental and economic advantage as stated by Nelon and Schrock.

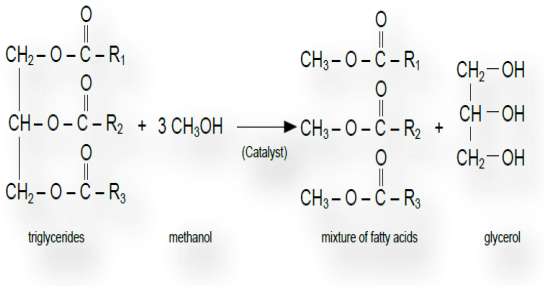


Fig 1.CHEMICAL REACTION

3. MIXING OF BIODIESEL BLENDS

Blending biodiesel with petroleum diesel may be accomplished by:

1. Mixing in tanks at manufacturing point prior to delivery to tanker truck
2. Splash mixing in the tanker truck (adding specific percentages of biodiesel and petroleum diesel)
3. In-line mixing, two components arrive at tanker truck simultaneously.
4. Metered pump mixing petroleum diesel and biodiesel meters are set to X total volume; transfer pump pulls from two points and mix is complete on leaving pump.

Blends of biodiesel and conventional hydrocarbon-based diesel are produced by mixing biodiesel and petroleum diesel in suitable proportions under appropriate conditions. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix:

· 100% biodiesel is referred to as B100, while
· 20% biodiesel, 80% Petro diesel is labelled B20
· 10% biodiesel, 90% Petro diesel is labelled B10
· 5% biodiesel, 95% Petro diesel is labelled B5

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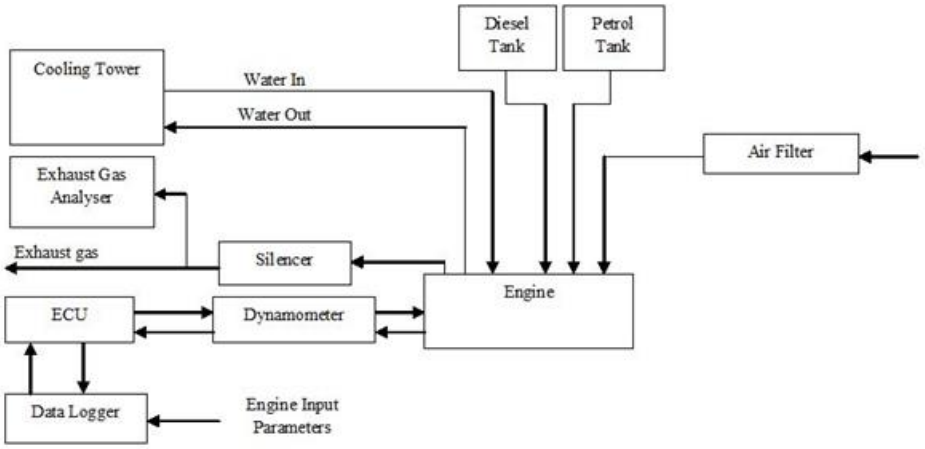
4. EXPERIMENTAL SET UP:

The engine shown in plate.1 is a 4 stroke, vertical, single cylinder, water cooled, constant speed diesel engine which is coupled to rope brake drum dynamometer arrangement to absorb the power produced. To vary the load on the engine, necessary dead weights and spring balance are included. Suitable cooling water arrangement for the brake drum is provided. Separate cooling water lines fitted with temperature measuring thermocouples are provided for engine cooling. A measuring system for fuel consumption consisting of a fuel tank, burette, and a 3- way cock mounted on stand and stop watch are provided.



RATED POWER	**6 HP**
BORE	**80 mm**
STROKE LENGTH	**110 mm**
SWEPT VOLUME	**562 cc**
COMPRESSION RATIO	**16.5: 1**

5. PROCEDURE:

1. Fill oil in the oil sump of the engine. It should be in between the marks provided on the oil dipstick. If oil level is reduced, add clean oil (SAE-40) to the crankcase by the opening of the valve provided, at the top of the engine.
2. Fill the diesel in diesel tank.
3. Fill the manometer up to half of the manometer with water.
4. Fill the burette with diesel by opening of the valve and close it after filling.
5. Supply the diesel to the engine by opening the valves provided in the fuel supply line. Supply the main power
6. Open continuous cold-water supply to the engine jacket.
7. Start the engine with starting handle and left it run for 15 minutes under no load condition.
8. When engine starts running smoothly, firstly load the engine with electrical loading.
9. Run the engine for 15 mins so that it can stabilize.
10. Close the diesel supply valve and open the valve of burette.
11. Now open the diesel supply valve which refills the burette.
12. Close the burette valve and continue the diesel supply.
13. Note down the reading of manometer to calculate the air intake by the engine.
14. Note the temperature of inlet and outlet of the water circulating through the engine jacket from thermometer.
15. Measure the flow rate of water with the help of water meter and stop watch.
16. Note down the reading of spring balance and rpm with the help of 100% tachometer.
17. Repeat the experiment for different electric load.
18. Note down the emission readings from the multi-gas analyzer.
19. Reduce the load on engine and press the liver provided on the right-hand side of the engine to stop the engine.
20. Then close the fuel and cooling water supply to the engine.

The following parameters are used to evaluate the performance of diesel engine using biodiesel and its blends:
(a) Brake specific fuel consumption
(b) Power and Mechanical Efficiency

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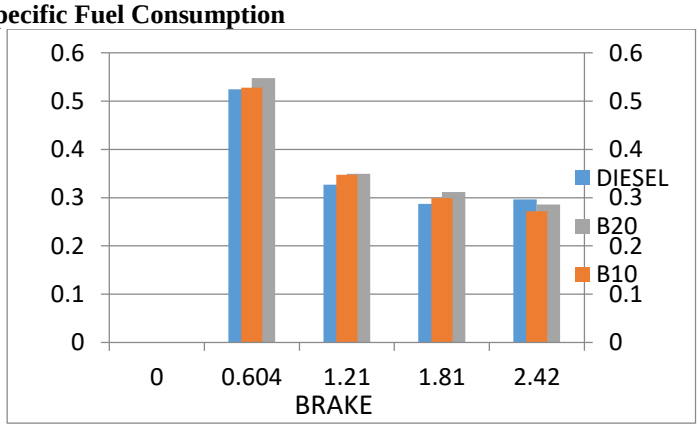
(c) Torque
(d) Brake thermal efficiency

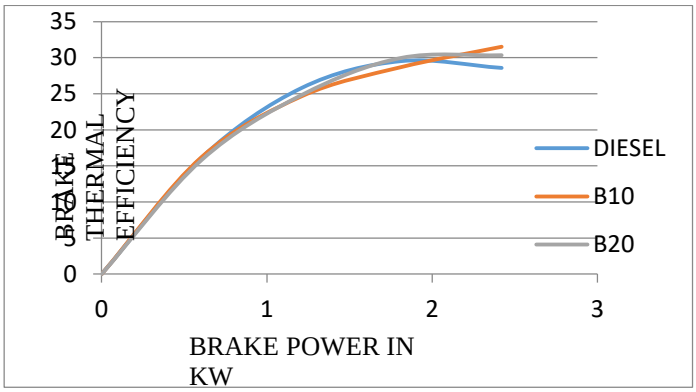
6. PERFORMANCE GRAPHS:

Brake Power Vs Brake Specific Fuel Consumption



Above graph shows specific fuel consumption for the 10% blending of biodiesel has the lower value comparatively with pure diesel at full load condition, but specific fuel consumption is increasing with increase in blending of biodiesel.

Brake Power Vs Brake Thermal Efficiency



The above graph we have taken brake power on x axis and brake thermal efficiency on y axis.in above graph b10 is increased gradually up to full load condition whereas for b20 brake thermal efficiency was increased up to one fourth load and decreased at the full load when compared with the b10.hence finally b10 will have higher brake thermal efficiency

7. EMISSION ANALYSIS FOR DIFFERENT BLENDS OF BIODIESEL

Different emissions are
Carbon dioxide (CO2) - This is one product of combustion. The carbon in the fuel bonds with the oxygen in the air. •
Water vapor (H2O) - This is another product of combustion. The hydrogen in the fuel bonds with the oxygen in the air.
Carbon monoxide (CO) - a poisonous gas that is colorless and odorless•
Hydrocarbons (HC) or volatile organic compounds (VOCs) - produced mostly from unburned fuel that evaporates Sunlight breaks these down to form oxidants, which react with oxides of nitrogen to cause ground level ozone (O3), a major component of smog. •
Nitrogen oxides (NO and NO_2, together called NO_x) - contributes to smog and acid rain, and also causes irritation to human mucus membranes

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Table of readings

For B10:

Emissions	At 0kg load	At 5kg	At 10kg	At 15 kg	At 20kg
CO	0.035	0.036	0.033	0.025	0.016
HC	3	5	3	0	0
CO2	0.40	2.11	2.55	3.71	5.06
O2	18.12	17.57	16.95	15.33	13.25
NOX	159	147	251	597	893

For B20:

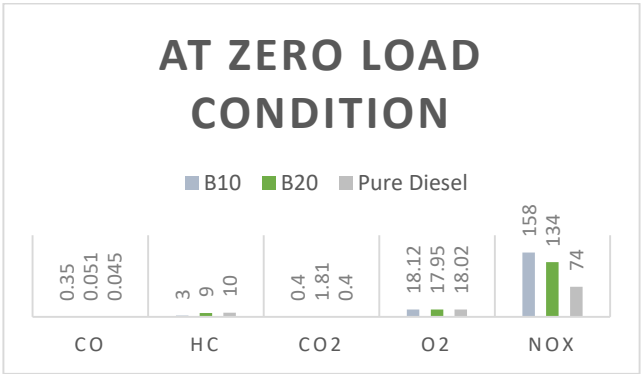
Emissions	At 0kg load	At 5kg	At 10kg	At 15 kg	At 20kg
CO	0.051	0.056	0.047	0.028	0.028
HC	9	16	17	7	10
CO2	1.81	2.24	2.86	3.63	4.99
O2	17.95	17.33	16.41	15.45	13.51
NOX	134	163	277	460	703

For PURE DIESEL:

Emissions	At 0kg load	At 5kg	At 10kg	At 15 kg	At 20kg
CO	0.045	0.048	0.042	0.026	0.027
HC	10	4	5	3	4
CO2	0.40	2.23	2.90	3.65	5.77
O2	18.02	17.55	16.51	15.40	12.25
NOX	74	250	367	562	801

8. EMISSION CHARTS

AT ZERO LOAD CONDITION



AT FULL LOAD CONDITION:

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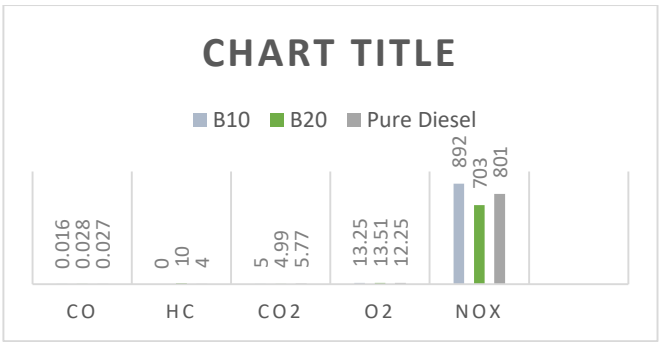
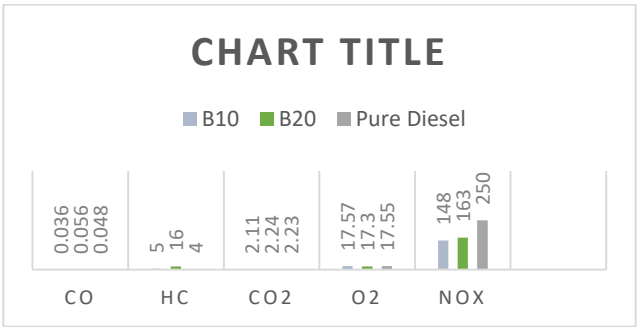
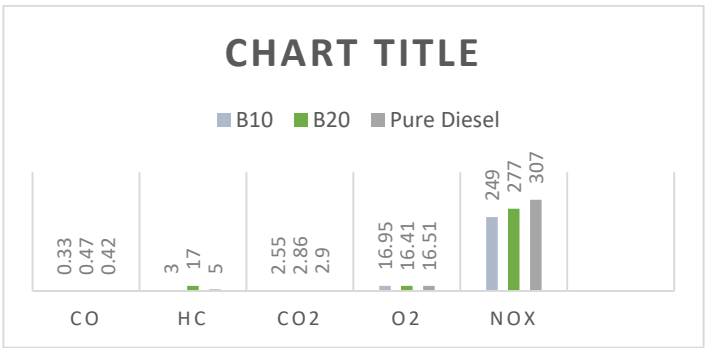


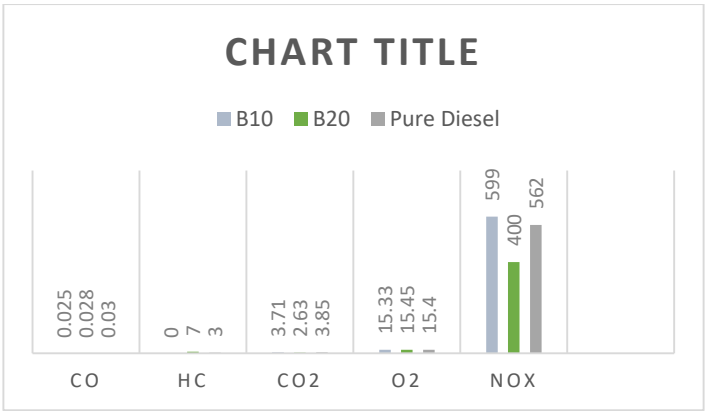
AT 5 KG LOAD CONDITION:



AT 10 KG LOAD:



AT 15 KG LOAD:



9. RESULTS AND DISCUSSION

An experimental investigation was conducted to explore the performance and emission analysis of animal tallow oil and its fuel blends with a diesel in direct injection single cylinder 4-stroke water cooled diesel engine and the results obtained

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suggest the following for increase in load conditions conclusions
1) Engine works smoothly on biodiesel blends with performance comparable to diesel engine operation
2) Biodiesel blends results in a slightly increased thermal efficiency as compared to that of diesel
3) Biodiesel blends results in a slightly decreased in brake specific fuel consumption when compared with pure diesel.
4) There is a significant difference in exhaust emissions when biodiesel blends are used.

10. CONCLUSIONS

Based on the above performance and exhaust analysis
1)B10 blend has been observed to be more preferable over diesel regarding Brake Thermal Efficiency and Brake Specific Fuel Consumption
2)Based on the exhaust emission analysis B10 blend has been observed to be preferred as NOx, CO, CO_2, HC Emissions decreased relative to diesel at full load condition

11. SCOPE FOR FURTHER WORK

Our current work mainly focuses on performance analysis of only animal tallow oil as biodiesel. Whereas there are many such oil out there which we can use as an alternative fuel source. Research says there are thousands of species of plants available in nature from which we can extract the fuel, it just needs to be found out.
One such oil is animal tallow oil which has excellent properties like jatropha. Adequate research must be done on the choosing the right biofuel and the right proportion of its blend with diesel. Some research paper also shows that using the ethanol and methanol also affects the performance of the engine. So, to make biofuel more accessible and effective in the market a wide variety of research must be carried on.
Also, one has to consider the economic point of view the thus the viability of the biofuel. Considerable amount of work must be done in determining the affect the biodiesel can cause in the world fuel market. The future BIODIESEL is growing. More companies are offering this solution to the consumers. At this stage, only diesel-powered automobiles can use the new fuel. This is expected to change in the upcoming years. The mounting concern of off – shore oil as well as the environment issues has groups in a uproar.
Already there are several types of companies using BIODIESEL as their main source of transportation. The Yellowstone nation park bus system uses a mixture of BIODIESEL and petroleum to run the whole feet. Test by the govt. have proven this type of fuel is overall more functional and safer than petroleum-based products. As fossil beds run dry, everyday scientists come closure to new alternatives.
Soon BIODIESEL will become the new source of power. Through the research and constant testing, BIODIESEL is more productive than the petroleum-based fuel. it has been discovered that this type of products will become the new source of power. Not only for diesel automobiles but for the other power sources individuals desperately require living and surviving. Before long, this type of supply will not only be used in vehicles but also in our homes and factories.

Nomenclature:
BHP:Brake horse power
BSFC: Brake specific horse power
B_{th} :Brake thermal
Cc : Cubic centimeter
CI: Compression ignition
Cm: Centimeter
CR: compression ratio
D: bore of a engine
g: gram
H: hour
Kg: kilogram
KJ: kilo joule
KW: kilo watt
RPM: revolution per minute
Sec,s : seconds
Vs : versus

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