Performance of UNDI Oil Biodiesel with Diesel in VCR Compression Ignition Engine under Variation in Engine Load & Compression Ratio

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Abstract— The world is facing many problems like energy, fuel, global warming and pollution. Petroleum diesel fuel which play very important role in the regular life for industries, transportation & any domestic sector, finding a suitable alternative (biodiesel fuel) to diesel is urgent need for this country. Undi based biodiesel is a non-edible fuel suitable for petrol & diesel engines. Transesterification process is used for preparation of Undi biodiesel. The physical & chemical properties of Undi biodiesel is nearly same as diesel. Experimental investigation of Undi oil has been carried out to analyze emission, performance characteristics in diesel engine with blends in diesel (0%, 20%, 40%, 60%) by changing compression ratio and engine load. The emissions from the diesel engine calculated with the help of smoke meter & gas analyzer. We can change compression ratio & engine load of diesel engine without any major modifications in variable compression ratio (VCR) diesel engine.

Key words: Undi Oil, Emission, Performance, VCR Diesel Engine, Smoke Meter, Gas Analyzer, Compression Ratio, Engine Load

I. INTRODUCTION

CI Engines are well known as better power source due to high thermal efficiency, fuel economy, high compression ratio, lean air-fuel mixture operation, good reliability, higher performance and fuel economy compared to Spark Ignition (SI) Engines. Due to these merits, CI Engines are predominantly used to drive tractors, heavy Lorries, Trucks, Buses, moving machinery etc. The large increase in number of automobiles in recent years has resulted in great demand for petroleum products. With crude oil reserves estimated to last only for few decades, there has been an active search for alternate fuels. The depletion of crude oil would cause a major impact on the transportation sector**.** Of the various alternate fuels under consideration, biodiesel, derived from vegetable oils, is the most promising alternative fuel to conventional diesel fuel (derived from fossil fuels; hereafter just "diesel") due to the following reasons.

- Biodiesel can be used in existing engines without any modifications.
- Biodiesel is made entirely from vegetable sources; it does not contain any sulphur, aromatic hydrocarbons, metals or crude oil residues.
- Biodiesel is an oxygenated fuel; emissions of carbon monoxide and soot tend to be reduced compared to conventional diesel fuel.
- Unlike fossil fuels, the use of biodiesel does not contribute to global warming as CO2 emitted is once again absorbed by the plants grown for vegetable oil/biodiesel production. Thus CO2 balance is maintained.
- The Occupational Safety and Health Administration classify biodiesel as a non-flammable liquid.
- The use of biodiesel can extend the life of diesel engines because it is more lubricating than petroleum diesel fuel.
- Biodiesel is produced from renewable vegetable oils/animal fats and hence improves fuel or energy security and economy independence.

II. LITERATURE REVIEW

C. Srinidhi et. al. [1] performed an experiment analysis of performance parameter (such as brake power, break specific fuel consumption, brake thermal efficiency and Exhaust Gas temperature) and emission characteristics (NOx, HC, CO. etc.) is obtained for various bio diesel and diesel blends and compared with ordinary diesel at various loads on a modified variable compression ratio CI engine. The results of the investigation shows that the performance and emission characteristics of the engine fuelled with Honne oil methyl ester – diesel blends is comparable to the ordinary diesel.

Bawane et. al. [2] performed experimental work to obtain the operating and emission characteristics of Undi Oil Biodiesel on Variable Compression Ratio (VCR) engine run on various blends of biodiesel, compression ratios and load conditions. From the comparison of results, it is inferred that the engine performance is improved with significant reduction in emissions for the chosen oils without any engine modification.

Bawane et al. [3] conducted experimental Investigation of Performance Characteristics of Calophyllum Inophyllum Biodiesel in CI Engine by Varying Compression Ratio. An experiment was conducted to obtain the operating characteristics of the variable compression ratio (VCR) engine run on biodiesel made from calophyllum inophyllum oil, at various compression ratios, and the results are compared with diesel. From the comparison of results, it is inferred that the engine performance is improved with significant reduction in emissions for the chosen biodiesel without any engine modification. The effective compression ratio can be fixed based on the experimental results obtained in the engine since the findings of the present research work infer that the biodiesel obtained from Calophyllum Inophyllum oil is a promising alternative fuel for direct-injection four-stroke VCR engine.

Anil .K. Rajvanshi [4] evaluated the prospect of biofuel in India for energy purposes, using agricultural material. A strategy is developed so that from a given piece of land maximum bio-energy and remuneration to the farmer's results. Thus the values of the product of bio-energy and net returns (BENR) were estimated for the different cropping systems evaluated. It is shown that with

this strategy not only the country can become self-sufficient in edible oil but will also have the potential of taking care indigenously of a substantial proportion of its energy need.

S.Sundarapandian and G. Devaradjane [5] experimental work done and evaluate the performance characteristics, combustion parameters and emissions of vegetable oil esters like Jatropha, Mahua and Neem Oil esters. From the results, it is found that the heat release and work done are reduced by about 4% for Jatropha, 5% for Mahua and 8% for Neem oil esters when compared to diesel. From the investigation, it is concluded that the performance of vegetable oil esters are good. Thus the developed model is highly compatible for simulation work with bio diesel as an alternative fuel.

R. Sarala et al. [6] performed study which deals with artificial neural network (ANN) modelling of a diesel engine using biodiesel fuel to predict the exhaust emissions of C.I. engine. To acquire data for training and testing the proposed ANN, single cylinders, four-stroke diesel engine was fuelled with using nakthamala oil biodiesel and diesel fuel blends and operated at different engine loads. The properties of biodiesel produced from nakthamala oil was measured based on ASTM standards. The experimental results revealed that blends of nakthamala oil methyl ester (NOME) with diesel fuel provide improved emission characteristics. Using some of the experimental data for training, an ANN model was developed based on standard Back- Propagation algorithm for the engine. Multi-layer perception network (MLP) was used for non-linear mapping between the input and output parameters. Different activation functions and several rules were used to assess the percentage error between the desired and the predicted values. ANN results showed good correlation between the ANN predicted values and the desired values for various engine exhaust emissions. The R values were very close to 1 and the mse values were less than 10-5.

Sudharshan Raghupati et. al [7] Compression ignition engine are preferred prime movers due to excellent drivability and higher thermal efficiency. In order to meet the emission norms and also the fast depletion of petroleum oil reserves lead to the research for alternative fuels for diesel engines. Biodiesel from vegetable oils are alternative to diesel fuel for diesel engines. The use of biodiesel in diesel engines does not require any engine modification. Biodiesel gives considerably lower emissions of particulate matter (PM), carbon monoxide (CO) and hydrocarbon (HC) without any fuel consumption or engine performance penalties. Many researchers have found that with biodiesel fueled engine produces higher NOX emissions compared to diesel.

III. BIODIESEL BLENDS

At present the amount of biodiesel available is less than that of diesel. The biodiesel blended with diesel by volume as B20 (20% Undi biodiesel & 80% diesel fuel), B40 (40% Undi biodiesel & 60% diesel fuel), B60 (60% Undi biodiesel & 40% diesel fuel), B00 (0% Undi biodiesel & 100% diesels fuel).Then the samples were proceed for their property testing.

Sr.	Parameter	Test Standard	Diesel (B00)	Undi Oil
1	Density at 15ºC (gm/cc)	IS 1448 (P16) 2007	0.836	0.9362
2	Kinematic Viscosity at 40ºC (cst)	IS 1448 (P25) 2007	3.51	51.59
3	Calorific Value (MJ/Kg)	IS 1448 (P6) 2007	43.10	40.26
4	Flash Point(ºC)	IS 1448 (P69) 2013	44.1	219

Table 1: Characteristics of Undi Oil with Diesel

IV. TESTING PROCEDURE

A single cylinder 4-four stroke, water cooled diesel engine is used for evaluation of the performance & emission characteristics of the Undi oil blending with diesel, which is used for an alternative fuel for diesel engine. The performance of diesel fuel and Undi oil blending at a different loading & compression ratio condition were evaluated. The exhaust gas coming out from the engine is first passed to the calorimeter and then to the exhaust gas analyzer.

The diesel engine having bore 87.5mm & stroke 110mm. The diesel engine works at a compression ratio of 16:1, 17:1, 17.5:1. Eddy current dynamometer is used for applying load on variable compression ratio (VCR) diesel engine. Brake specific fuel consumption (BSFC), inlet & outlet temp, mass flow rate etc. are measured computerized in VCR diesel engine. After this the load on the engine was increased 0%, 20%, 40% and 60% by adjusting the current flowing through the load circuit 6.25 amp,12.5amp, 18.75 amp and 25amp respectively while keeping the fuel injection pressure 210bar and fuel injection angle unchanged. After the stable condition the observations were taken at all above mentioned operating points. The engine was run for sufficient time duration to ensure that the diesel fuel is over and the engine has started running with Undi blends (0%, 20%, 40%, 60%) as fuel. The entire process followed in phase I was repeated while engine running with combination of Undi blends as a fuel.

V. RESULT AND DISCUSSION

A. Engine Performance

The performance parameters such as BP, BSFC, SFC, Brake Thermal Efficiency, and Volumetric Efficiency obtained with B0, B20, B40, and B60 are found to be affected by fuel blend and engine loading and are discussed in the following graphs.

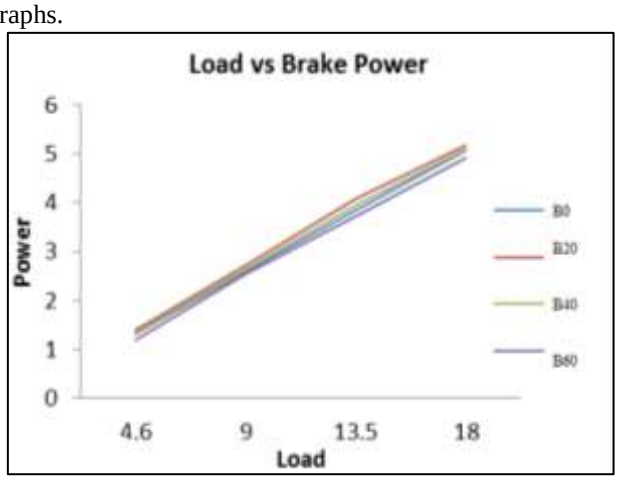

Fig 1 From the above graph Load vs Break power it is concludes that Break Power of B20 and B40 is improved as compare to pure diesel (B0).

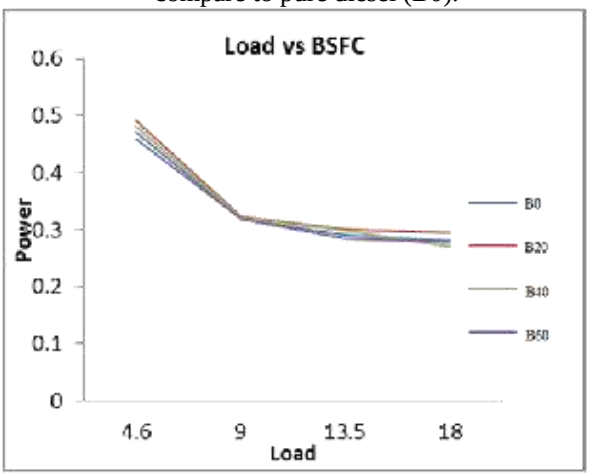

Fig. 2: From the above graph Load vs BSFC it is observed that Break specific fuel consumption of B20 and B40 is improved as compare to pure diesel (B0).

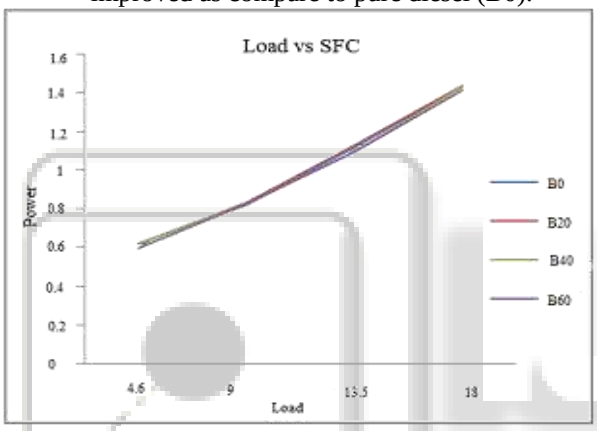

Fig. 3: From the above graph Load vs SFC it is observed that Specific Fuel consumption of B20 and B40 is improved as compare to pure diesel (B0).

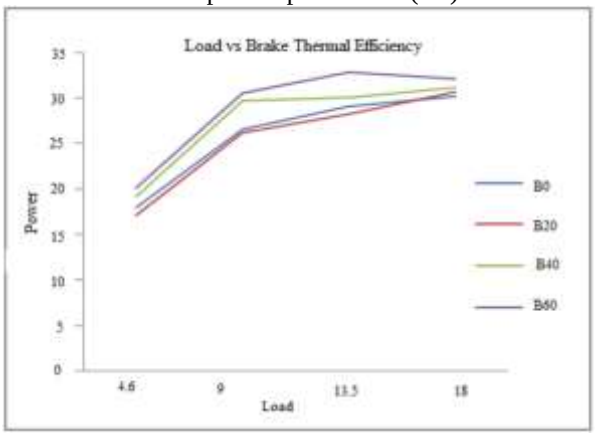

Fig 4 From the above graph Load vs Brake Thermal Efficiency it is observed that Brake Thermal Efficiency of B60 and B40 is improved as compare to pure diesel (B0).

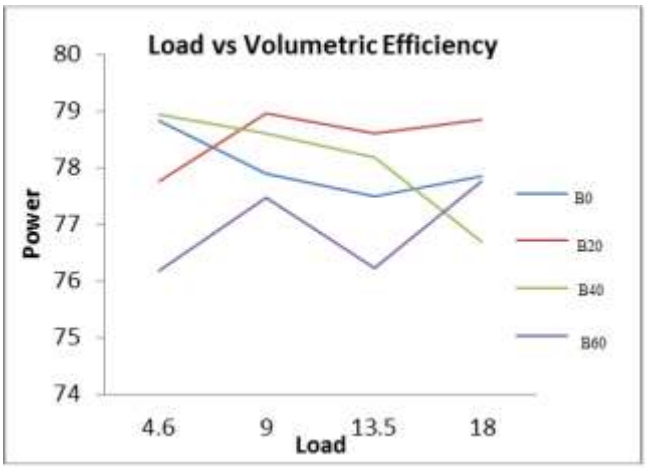

Fig 5 From the above graph Load vs Volumetric Efficiency it is observed that Volumetric Efficiency of B60 and B40 is improved as compare to pure diesel (B0).

B. Exhaust Emissions Performance Analysis

The performance parameters such as CO(%), CO2(%), HC(ppm), Nox(ppm), O2 obtained with B0, B20, B40, and B60 are found to be affected by fuel blend compression ratio and engine loading are discussed in the following graphs.

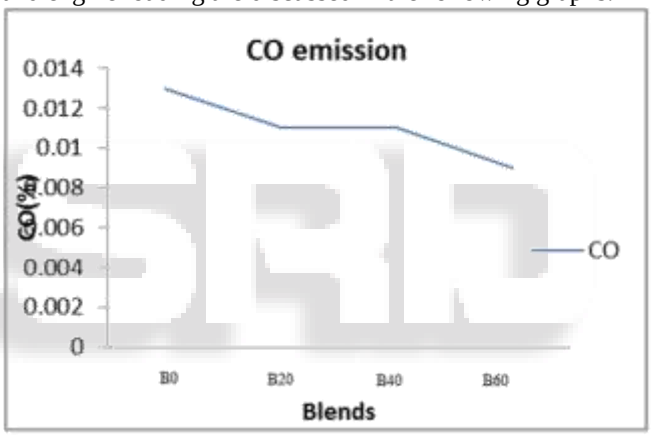

Fig. 6: From the above graph CO emission it is observed that CO emission decreases in compare with pure diesel (B0) as percentage of blends diesel with Undi oil increases from B20 to B60 respectively.

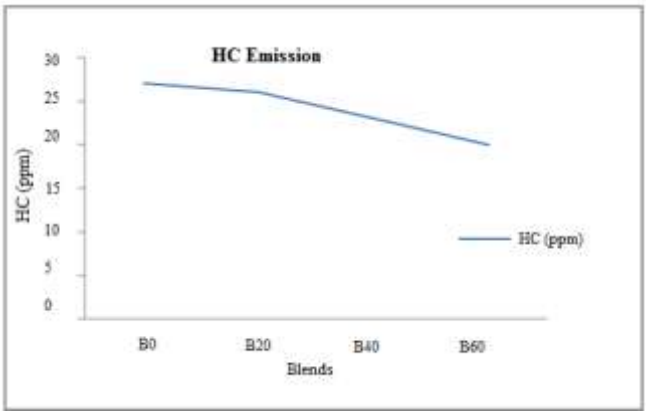

Fig. 7.From the above graph HC emission it is observed that HC emission decreases in compare with pure diesel (B0) as percentage of blends diesel with Undi oil increases from B20 to B60 respectively.

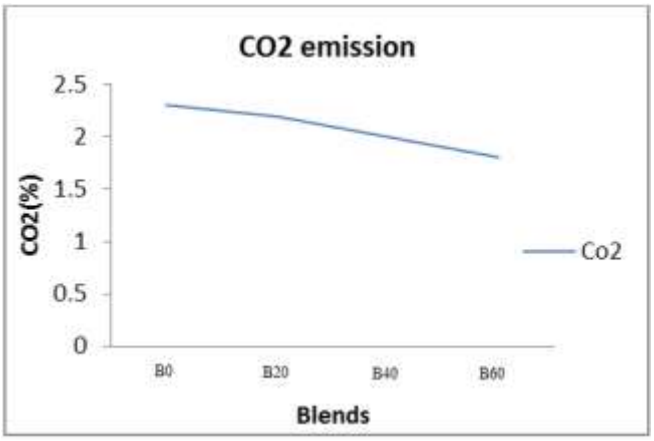

Fig. 8: From the above graph CO2 emission it is observed that CO2 emission decreases in compare with pure diesel (B0) as percentage of blends diesel with Undi oil increases from B20 to B60 respectively.

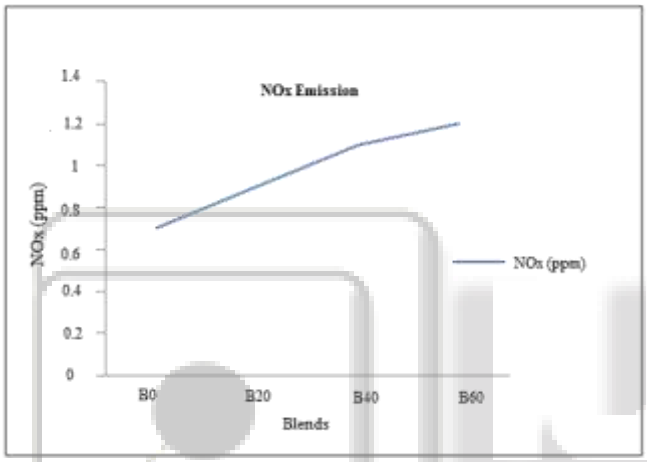

Fig. 9 From the above graph NOx emission it is observed that NOx emission increases in compare with pure diesel (B0) as percentage of blends diesel with Undi oil increases from B20 to B60 respectively.

VI. CONCLUSION

- The result was discussed as above on basis of experiment work come out. It is observed that viscosity of blend is very close to diesel. Experimental investigation of performance & emission analysis of Undi oil in diesel engine is the main objective.
- The viscosity of Undi oil higher than that of the diesel so viscosity is reduced by blending these biodiesel with the diesel
- From the result it is conclude that engine performance when fuelled with the biodiesel (Undi oil) are compare to that when fuelled with diesel.
- Since a little more biodiesel (Undi oil) must be supplied to the engine to produce an equivalent amount of work, as evidence by the lower calorific value stated earlier. The fuel consumption when engine fuelled with the biodiesel (Undi oil) are near about same when that fuelled with pure diesel
- The Undi oil biodiesel are nearly close brake specific fuel consumption (BSFC) with diesel.
- The Undi oil has good lubricity & content of oxygen in it due to the blends (40% & 60%) are improve brake thermal efficiency & volumetric efficiency.
- Specific fuel consumption is slightly close to diesel with biodiesel.
- CO emission decreases from pure diesel to 60% blend at 17.5 compression ratio and full load.
- HC, CO2 emissions are decreases when increases in percentage of biodiesel with diesel.
- With increasing percentage of blend NOx emission increases.

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