Experimental Analysis of Emission Characteristics using Olive Oil Biodiesel in a Diesel Engine

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Abstract: A comprehensive study have been investigated experimentally using different proportions like 20%, 40% and 60% and 80% of olive oil with combination of pure diesel with mechanical loading on single cylinder diesel engine .Performance characteristics of emissions like carbon monoxide, nitrogen oxide and hydro carbon particulates were reported .

Introduction:

S. Ramkumar and V. Kirubakaran [1] presented in their technical paper the reviews of the performance and emission characteristics of biodiesel in C.I engines and the influence of engine modifications, various additives, and various proportions of blends of biodiesel with diesel. The physical and thermal characteristics of biodiesel have a great influence in the performance and emission. It has been made attempt on feasibility of admitting vegetable oil in IC engine through Thermal Cracking process.
I. López et al [2] presented in their technical paper the optimal operating conditions of a diesel engine besides reducing both main exhaust emissions and brake-specific fuel consumption a methodology based on multiple response optimization has been proposed. brake-specific fuel consumption and emissions nitro oxides, sulphur oxides and carbon mono oxides using three different load conditions 50%, 75% and 100% using olive pomace methyl esters/diesel blends have been evaluated. Engine testing was followed by the design of the global desirability function in terms of both engine load and biodiesel blends. Eventually, a direct correlation between emissions and load was found. Finally, to ensure minimum values of brake-specific fuel consumption under three levels of emissions reduction 10%, 20% and 40% optimum engine operating ranges, in terms of load rate and biodiesel blends, are studied

Mohammad Ali Rajaeifar et al [3] presented in their technical paper Comparative lifecycle assessment of OPO biodiesel and petroleum diesel were performed.The well-to-wheel environmental impacts of olive pomace oil biodiesel (B20 and B100) and conventional petroleum diesel were compared using life cycle assessment. Moreover, energy and economic analyses of olive pomace oil biodiesel production was conducted throughout its life cycle. Human Health, Ecosystem Quality, Climate Change and Resources were the selected end-point impact categories. Comparing biodiesel with petroleum diesel, significant environmental tradeoffs exist between the Climate Change and Resources damage categories. Having pursued the suggestions of this study, for the B100, the minimum reduction rates of 30–32% and 24–26% in the Human Health and Ecosystem Quality damage categories could be expected, respectively. While for the B20, these reduction rates would be at least 19–22% and 14–16%, respectively. On the other hand, lifecycle energy assessment revealed promising energy indices for example fossil energy ratio of 1.22–1.33. Economic analysis showed a benefit-to-cost ratio of 1.45 revealing the economic viability of olive pomace oil biodiesel production.Lavecchia, R. and Zuorro, A.[4] presented in their technical paper a reduced polynomial model was developed by the stepwise regression method which provided an accurate description of the extraction process. Maximization of the response variable gave: y_{max} = 90.5% at T = 69.9 °C, E = 212 min, R = 36.7 mL/g and C = 43.7%.

I. López et al [5] presented in their technical paper olive–pomace oil biodiesel constitute a new second-generation biofuel. Exergy efficiency and performance of olive–pomace oil biodiesel, straight and blended with diesel fuel was evaluated. olive–pomace oil biodiesel, straight and blended, provided similar exergy efficiency compared to diesel fuel and no exergy cost increment compared to diesel fuel using olive–pomace oil blends.

Titipong Issariyakul and Ajay K. Dalai [6] presented in their technical paper a comprehensive review was on feedstock, production technologies, and characteristics of biodiesel. It also covers a wide range in biodiesel area, it serves as a general public education medium as well as a research reference for biodiesel production from vegetable oils.

M.D. Redel-Macías et al [7] presented in their technical paper Olive pomace oil derives from the oil left in the olive fruit pulp than remains after pressing extra virgin olive oil. To extract olive pomace oil, the pulp was treated with solvents. The resultant oil contains impurities and may undergo several heating and filtering processes to refine it to an acceptable standard. To make it satisfactory to consumers, it must be blended with virgin olive oil before use. Therefore, another uses for this oil could be soap production or its recycling to produce biodiesel. Exhaust emissions, noise and sound quality of a direct injection diesel engine fueled with olive pomace oil methyl ester (OPME) blends were studied at several steady-state engine operating conditions.

M.D. Redel-Macías et al [8] presented in their technical paper the use of different approaches for sound prediction of a diesel engine, based on artificial neural network (such as Evolutionary Product Unit Neural Networks (PUNNs) and Radial Basic Function Neural Networks (RBFNNs)) and response surface models. Their accuracies are compared in terms of Mean Square Error (MSE) and Standard Error of Prediction (SEP). It can be concluded that the use of PUNN improves the accuracy achieving acceptable values for both MSE and SEP by means of a simpler model than the combined PU and RBF NN proposed model. Moreover, it was found that the variable power does not explain the noise value prediction, the noise emitted by the engine is inversely related to the 1/3rd octave band of the frequency value and diesel fuel noise plays the most important role and influence in the PUNN model. Response surface models are rejected, due to their unacceptable accuracy in terms of noise prediction.
Franklin Che et al [9] presented in their technical paper the experimental procedures carried out to optimize experimentally the pretreatment process for this feedstock in order to convert free fatty acids (FFA) to their respective methyl esters. Thus, an acid esterification process with sulfuric acid as catalyst was employed and evaluated for different acid-to-oil and methanol-to-oil ratios over the process time. The initial results are showing that olive kernel oil can be efficiently processed in order to decrease the free fatty acid concentration and improve the biodiesel potential of this feedstock.

Uğur Özveren and Z. Sibel Özdoğan [10] presented in their technical paper slow pyrolysis characteristics of olive oil pomace were investigated by using thermo gravimetric analysis coupled with mass spectrometry. The major pyrolysis products identified are H_2, CH_4, CO, CO_2. Their evolution profiles with respect to temperature enable a realistic evaluation of weight loss results. The chemical structure of the olive oil pomace was analyzed using FTIR. Thermogravimetric analysis results have been utilized to determine kinetic parameters by using model fitting (Coats Redfern method), model free (ASTM E698, Flynn–Wall–Ozawa, Friedman methods) and nonlinear regression analysis approaches. Comparative evaluation of the kinetic results indicate that the multivariate regression analysis is an appropriate method to derive kinetic models which give reliable results for the whole temperature range especially in multi-step reactions.

Fig 1 Experimental setup

IC engines are widely used in automobile, domestic and industrial sector. They are classified according to cycle, number of cylinders, arrangement of cylinders, fuel used, type of ignition, valve arrangement, cooling system. Test rigs are used to find out the performance of an IC engine. It consists of an IC Engine, barke mechanism, fuel measuring, air intake measuring and various other arrangements.

EXPERIMENTAL INVESTIGATION

Test Procedure

The engine performance test was conducted on single cylinder, four-stroke, naturally aspired, direct injection, water cooled, 3.7kW output power with computerized diesel test rig.The engine was directly coupled to a rope brake mechanism as shown in the Fig and the engine characteristics are cited in specifications of engine. A four stroke , single cylinder, water cooled, indirect injection diesel engine is used for the performance test . Experiments were carried out initially using pure diesel fuel to generate the observations. After recording the pure diesel observations, tests were carried out using 20% olive oil&80% of diesel ,40% Olive oil &60% of diesel and 60% Olive oil &40% of diesel as blends. Engine tests is conducted at various loads starting from no load to full load and the parameters related to performance were recorded and calculated. The experiment is repeated for different loads by changing the voltage. All The above values are noted for different blends.

RESULTS AND DISCUSSIONS:

Compression Ignition engine is a naturally aspirated engine. The air is compressed and fuel is injected just before the desired start of combustion. The quantity and quality of fuel injection plays a vital role in the power output of the engine. The performance and emission parameters are based on the correlation of the combustion parameters like cylinder pressure, rate of pressure rise, ignition delay, combustion duriation etc. Hence a series of engine tests were carried out using diesel and biodiesel to find out the effect of various blends on the performance and emission characteristics of the engine. Investigations are carried out on the engine mainly to study the effect of specific fuel consumption, brake thermal efficiency, exhaust gas temperature and emissions such as NO_X, CO, CO_2, and HC
The optimal blend for the oil tested was found by ranking the critical parameters viz specific fuel consumption, brake thermal efficiency, and NO_X emissions. It was found that exhaust gas temperature and NO_X increases with increase in B.P(kw) for all cases. The performance and emission trends and the variations in the fuel properties such as viscosity and density for various blends of olive oil are in accordance with the findings of many researchers. A detailed discussion on the optimal blends and the

emissions such as NO_X, CO_2 were also presented here under to understand the behaviour of the engine running on biodiesel. The optimum blend ratio is determained on the basis of specific fuel consumption, brake thermal efficiency, CO,CO_2, and oxides of nitrogen. For optimization, experiments were conducted using diesel and the various ester blends. The blend ratios were in steps of 20 percent up to maximum of 60 percent.

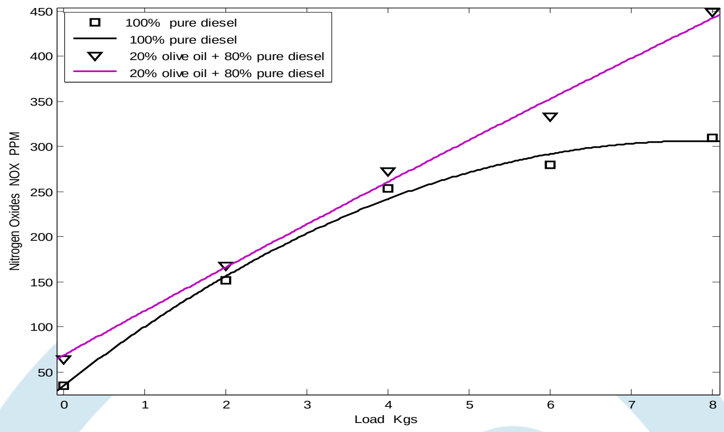

Fig 2 Plot Load VS NOx for 20% olive oil + 80% pure diesel

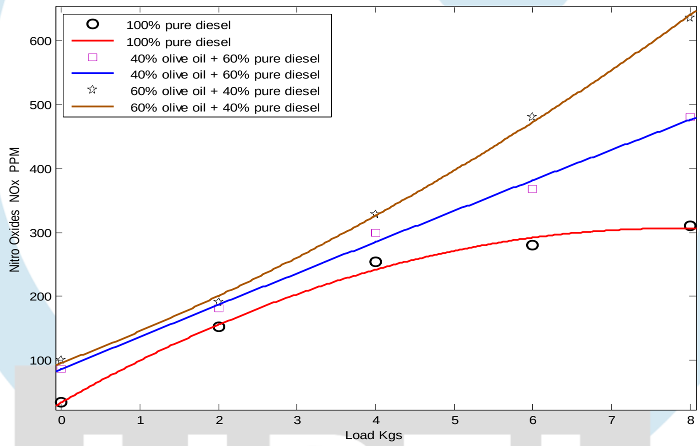

Fig 3 Plot Load VS NOx for 40% olive oil + 60% pure diesel & 60% olive oil + 40% pure diesel

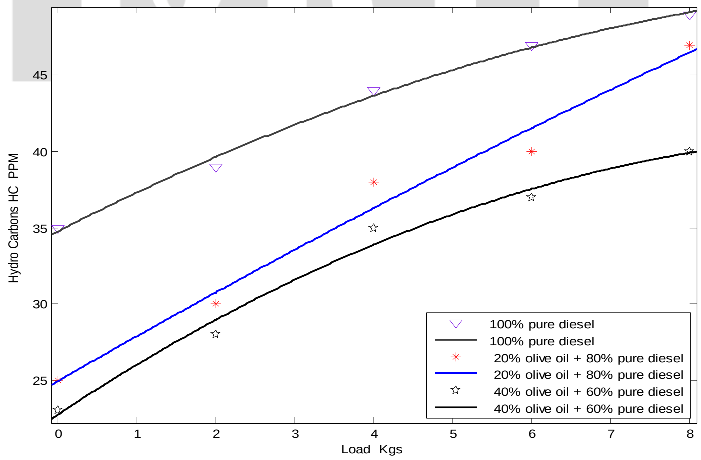

Fig 4 Plot Load VS HC for 20% olive oil + 80% pure diesel & 40% olive oil + 60% pure diesel

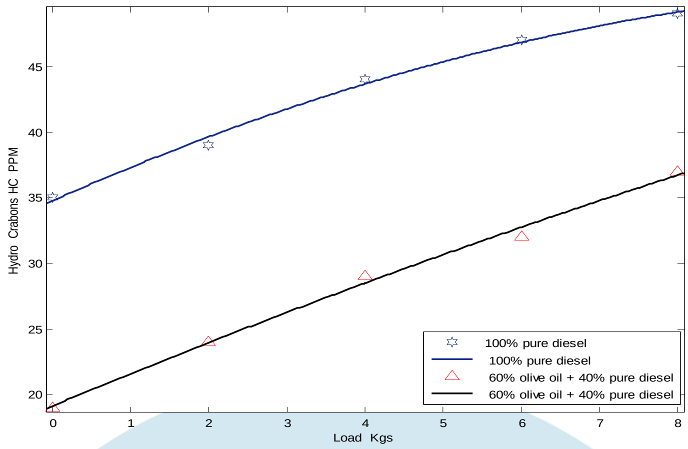

Fig 5 Plot Load VS HC for 60% olive oil + 40% pure diesel

From the above fig 2 & fig3, we plotted between load and nitrogen oxides and compared with 100% pure diesel data. It can be inferred from the graphs that when load is increased, the emission NOx also increase.
From the above fig 4 & fig5 , we plotted between load and hydro carbons and compared with 100% pure diesel data . It can be inferred from the graphs that when load increase, the hydro carbon particulates decreases.

CONCLUSION:

The following are the major conclusions that were drawn from the result of the study on performance and emission characteristics of diesel engine using biodiesel.

1.Based on the performance and emission parameters B20 has good BTE and CO_2 Emission, NO_X & HC Emissions which is at acceptable range.
2.The Brake thermal efficiency value at maximum brake power for this optimum blend is 30.2% compared to 31.3% for base diesel.
3.For the optimum blend mass of fuel consumption is 0.3Kg/KW-h higher compared to diesel due to low calorific value.
4.The CO emissions are decreased with increasing in the blending ratio of olive oilbiodiesel with diesel this is due to oxygen content present in the fuel.
5.The CO_2 emissions increased with increased blending ratio of olive oil biodiesel to diesel because of complete combustion quality in olive oil biodiesel.
6.UHC is decreased with increasing the load for all blends, olive oil is an oxygenated fuel which gives good combustion efficiency. So, less amount of unburned fuel in exhaust.
7.NO_X Emission is increased with increasing the load this is due to the excess amount of oxygen supplied causes the higher NO_X Formation

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