International Journal of Engineering Research and Technology.
ISSN 0974-3154 Volume 7, Number 1 (2014), pp. 55-68

http://www.irphouse.com

Experimental Investigation on Four Stroke Diesel Engine using Diesel –orange Oil Blends

K. Harshavardhan Reddy[1], Dr. M. Yohan[2] and N. BalajiGanesh3

[1]Assistant Professor, SVIST Engineering College, Madanapalli, Andhra Pradesh
[2]Associate Professor, Hod of Mechanical Engineering,
JNTUA Ananatapur, Andhra Pradesh.
[3]Assistant professor, Adithya Engineering College, Madanapalli, Andhra Pradesh.

Abstract

Modernization and increase in the number of automobiles worldwide, the consumption of diesel and gasoline has enormously increased. As petroleum is non renewable source of energy and the petroleum reserves are scarce nowadays, there is a need to search for alternative fuels for automobiles. The intensive search for alternative fuels for compression ignition engines has been focused attention on fuels which can be derived from bio mass in this regard orange oil is found to be a potential fuel for C.I Engines .Orange oil is one of the source for alternative fuel. Oranges are available in large quantities around the world .orange skin is a biomass and oil is extract from the orange skin. The objective of this work is to use orange oil and its diesel blends in C.I Engine. The properties of orange oil are to be determined by using standard methods. The experiment is to be conduct when the engine fuelled with orange oil and its blends in various proportions like 10%, 20%, 30%, 40% and 50% by volume and then investigate the performance and emission characteristics of C.I Engine at different load conditions

Keywords: Diesel engine, Orange oil Blends.

1. Introduction

In recent years, a lot of effort has been taken all over the world to reduce the dependency on petroleum products for power generation and transportation. Vegetable oils and biomass-derived fuels have received much attention in the last few decades. These fuels have been found to be potential fuels for an agriculture-based country like India. Biomass is a source of fuel, which is renewable, eco-friendly and largely

available. Ethanol as a bio-fuel, derived from sugarcane, has been used in gasoline engines for many years. However, bio-fuels are, in general, 3–5 times more expensive than fossil fuel.

Vegetable oils have been found to be a potential alternative to diesel. They have properties comparable to diesel and can be used to run a compression ignition engine with minor modifications. The use of vegetable oils will also reduce the net CO2 emissions. Altin Recep et al. studied the effect of vegetable oil fuels and their methyl esters injected in a diesel engine. They observed that vegetable oils lead to problems such as gum formation, flow, atomization and high smoke and particulate emissions. Due to its complex structure and composition, gas phase emissions are higher. In order to use these fuels in diesel engines, high compression ratio and ignition assistance devices are required.

India has a huge potential of producing orange peel oil of 27,600 ton (based on 0.6% recovery of oil from 46 lakhs ton fruits by cold press process) from the orange fruits. Presently, 2–3 tons of orange oil is produced for food and cosmetic industries. There is no other demand for orange oil. As the demand increases for large quantity of orange oil for fuelling in internal combustion engines, the requirement for orange peel collection may be higher. Orange oil is a biomass-derived fuel obtained from orange skin, which has 90% D-limonene and can be used for many applications. It may be used as an agent or a source in surface cleaners, hand cleaners, furniture polish, soaps and shampoo production. In addition, orange oil can also be used as an alternative to gasoline either partially in the form of a blend or as a total replacement.

Orange oil has been used as a fuel for spark ignition engines, since most of its properties are closer to gasoline. The high-octane value of these fuels can enhance the octane value of the blend when it is blended with low-octane gasoline. As a result, the knock limited compression ratio (CR) can be increased further. Results indicate that gasoline–orange oil blend with catalytic coating performs better when compared to the normal lean burn engine

The fumigation technique offers the advantage of easy conversion of the diesel engine to work in the dual fuel mode with volatile fuels and vegetable oils. The dual fuel engine with appropriate conversion has superior characteristics than those of straight fuel operation. Orange oils are fumigated up to 35% and high cetane number fuel was injected as pilot fuel for ignition. The flame propagation through the orange oil air mixture leads to rapid heat release rates. Significant reduction in smoke emissions was noticed with orange oil admission. With orange oil carburetion there was an increase in hydrocarbon and carbon monoxide emissions for all the pilot fuel injection. Ignition delay increased with orange oil induction because of the reduction in the intake mixture temperature due to the vaporization of orange oil.

In the present work, experiments were conducted to study the performance and emission characteristics of orange oil blended with diesel as an alternate fuel in a diesel engine.

2. Experimental Investigation

The experiments were conducted by considering various parameters. The tests were conducted for orange oil and its blends at different proportions (10%, 20%, 30%, 40% and 50%) for conventional engine. The tests were conducted from no load to maximum load conditions. The readings such as time taken to consume 20cc of fuel consumption, speed of the engine, temperatures, etc, were noted. The observations were recorded in tabular column and calculations are made using appropriate equations.

The experiments were conducted on a single cylinder Alamgir four stroke diesel engine. The general specifications of the engine are given in Table-1. By taking the engine performance and plot the graphs

"Alamgir" engines for generating sets are fuel efficient, with the lube oil consumption less than 1% of S.C.F. lowest among the comparable brands. They are equipped with heavy flywheels incorporating 4% governing on the fuel injection equipment. This complete avoids voltage functions. In case of emergency, the unique overload stop feature safeguards equipments by shutting down the engine automatically

Table 1: Engine specifications.

Item	**Specifications**
Engine power	6.6 kW
Cylinder bore	102 mm
Stroke length	110 mm
Connecting Rod Length	234 mm
Engine speed	1500 rpm
Compression ratio	17.5

Table 2: Properties of Diesel and Fishoil

Properties	**Diesel**	**Orange Oil**
Calorific value (kJ/kg)	42000	34650
Density at 30 ^{0}C (kg/l)	0.85	0.8169
Viscosity at 40 ^{0}C, cSt	2.7	3.52
Flash point	52	74
Fire point	65	82
Cetane number	50	47
Oxygen by difference (%)	3.05	21.6

Fig. 1: Alamgir engine

Fig. 2: Load indicator

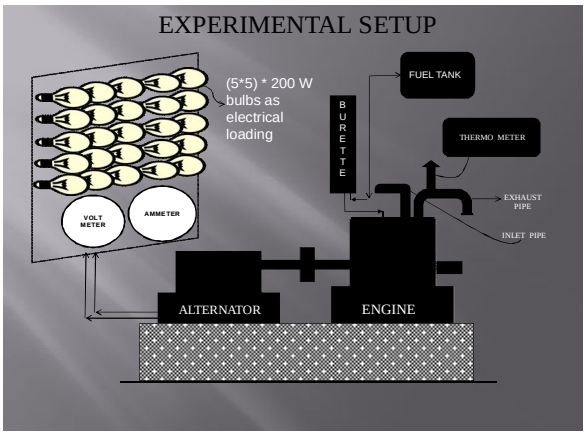
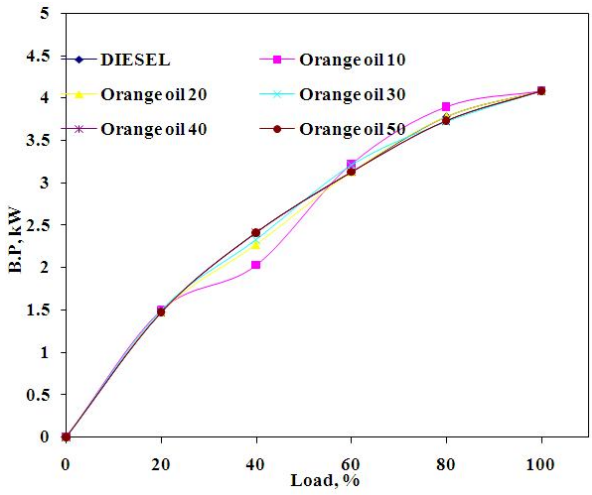


Fig. 3: Experimental setup of engine

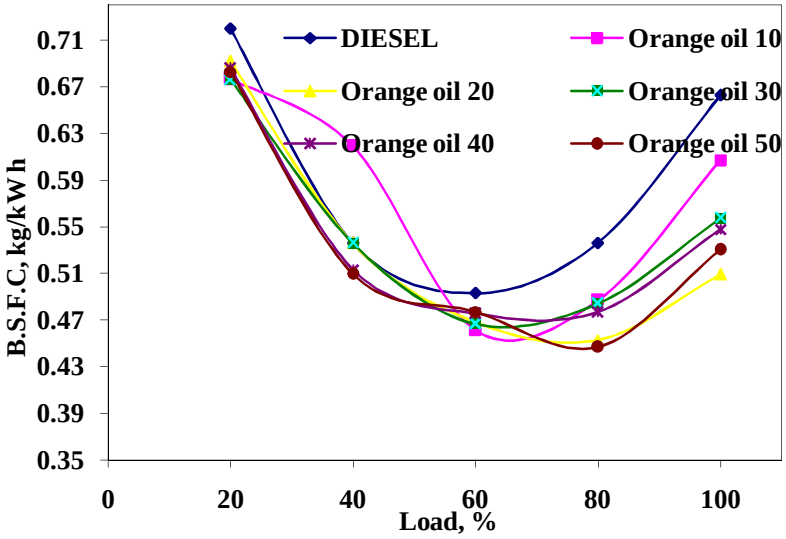
3. Results and Discussions



Graph 1: Load against Brake Power

4. Analysis for Brake Power

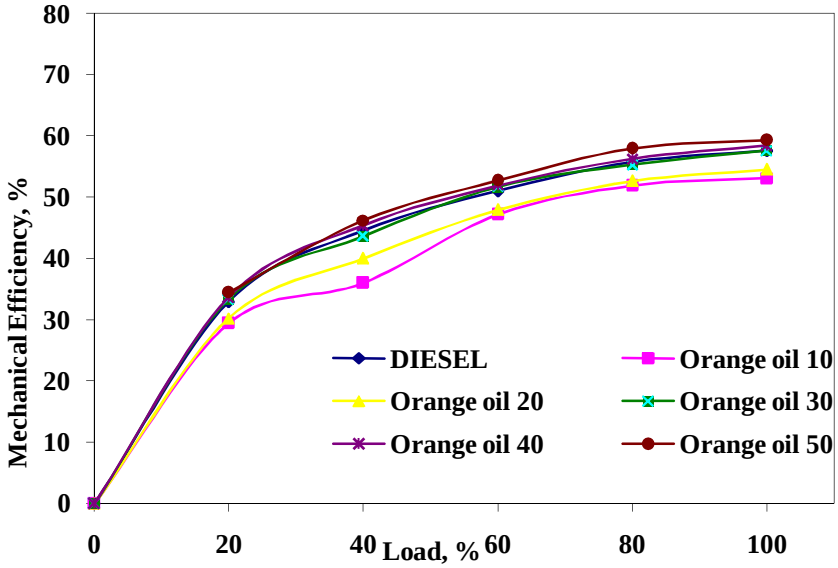
The Graph 1 shows the Variation of Brake Power with load for the fuels tested. It can be observed from the figure that the brake power is 4.08kw at full load for DF. It can be observed that the engine fuelled. Orange oil blends also have the same B.P at full load



Graph 2: Load against B.S.F.C

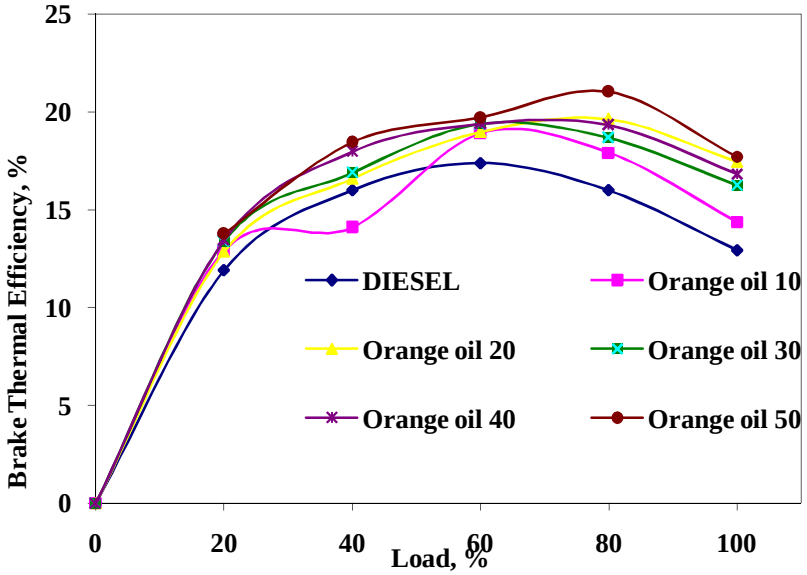
5. Analysis for Brake Specific Fuel Consumption

The variation of brake specific fuel consumption with brake power is shown in graph 2. The blend Orange oil 50 shows specific fuel consumption0.53 kg/kWh, which is higher compared to DF with 0.66kg/kWh.



Graph 3: Load against Mechanical efficiency.

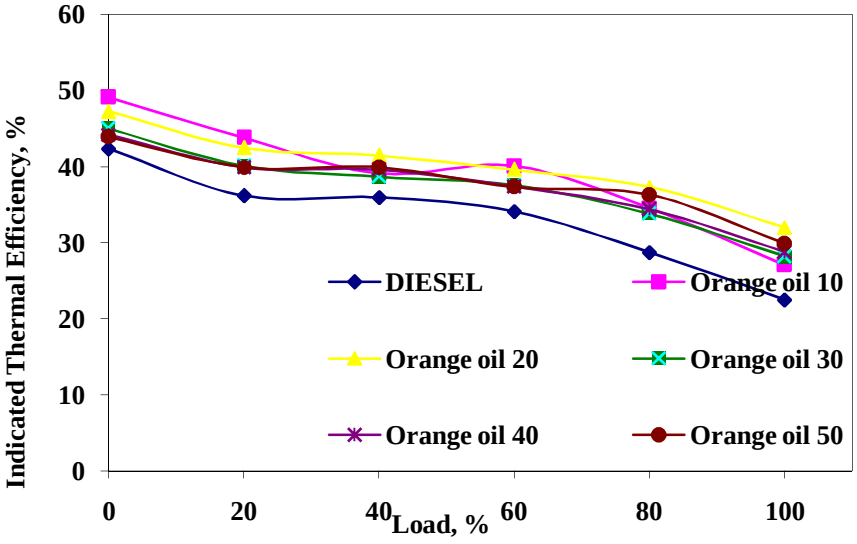
From the Graph 3, the variation of brake specific fuel consumption with brake power can be observed. The values of mechanical efficiency are higher compared to DF with 57.63%. As the engine produces power output the frictional losses are reduced and hence increase in the mechanical efficiency.



Graph 4: Load against Brake Thermal Efficiency

6. Analysis for Brake Thermal Efficiency

The variation of brake thermal efficiency with load for orange oil blends is shown in Graph 4.

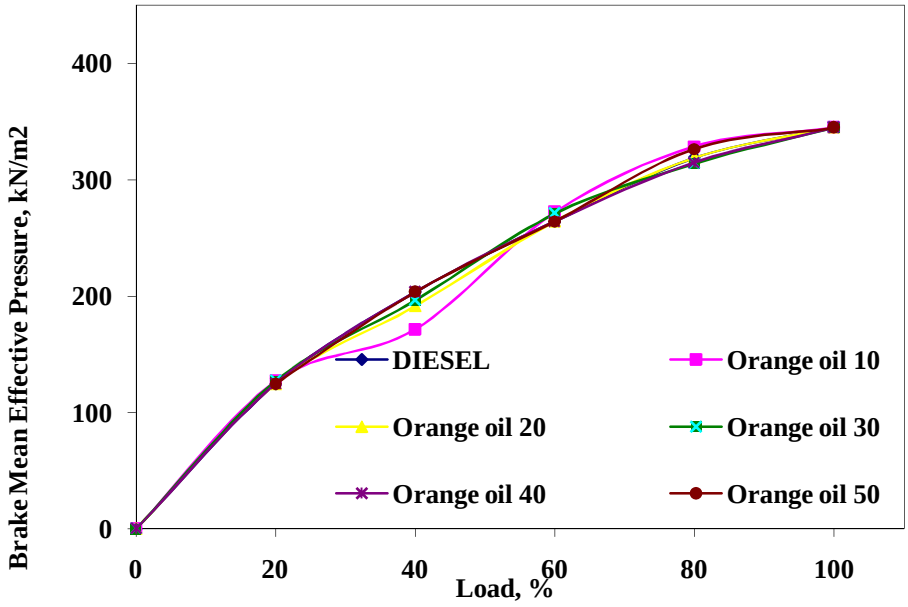


Graph 5: Load against Indicated Thermal Efficiency.

It can be observed that the thermal efficiency is 12.93% at full load for diesel. Because of the changes in composition, viscosity, density and calorific value of Orange oil-DF blends the brake thermal efficiencies of Orange oil blends are high at full load .B-70 blends at all loads. This may be due to the oxygen content of the methyl fish oil, which improves combustion and thus may increase the exhaust gas temperature. But the exhaust gas temperatures of B-10 blend and B-30 are very close to the exhaust temperature of diesel.

7. Analysis for Indicated Thermal Efficiency

The variation of Indicated thermal efficiency with load for Orange oil -DF blends is shown in Graph 5. It can be observed that the thermal efficiency is 22.44% at full load for diesel. Because of the increase in indicated power, the Indicated thermal efficiencies of Orange oil -DF blends are low particularly at full load.

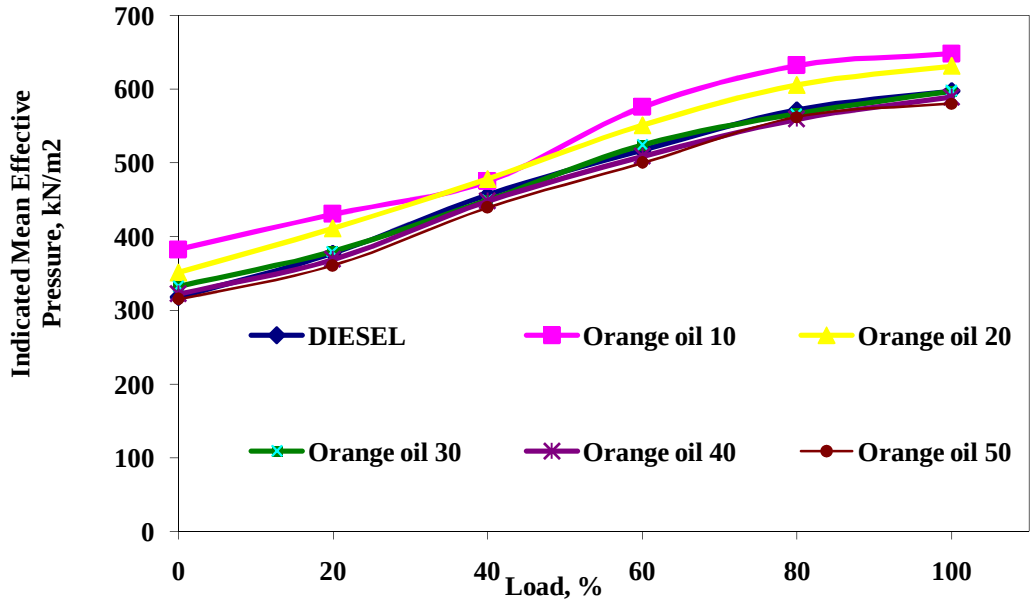


Graph 6: Load against Brake Mean effective pressure.

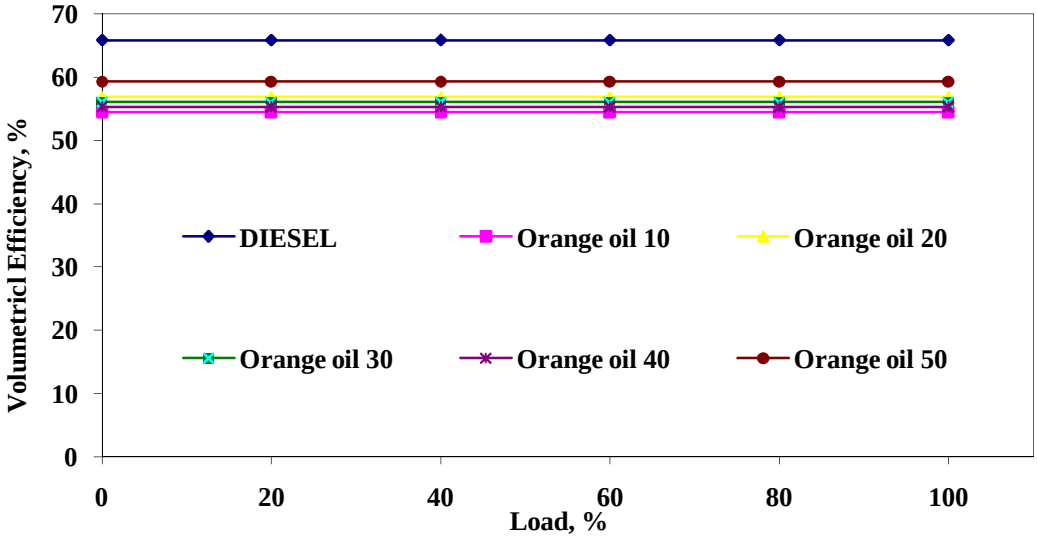
8. Analysis for Brake Mean Effective Pressure

Brake mean effective pressure with respect to load exists for all kinds of fuel can be observed from the figure 6.6. Brake mean effective pressure for the diesel is 344.43 kN/m^2. Linear variations of brake mean effective pressure can be observed and there is no significant deviation in brake mean effective pressure for the orange oil blends from that of pure diesel.

Linear variations of indicated effective pressure with respect to load exist for all kinds of fuel can be observed from the Graph 7.Brake mean effective pressure for the diesel is 597.78 kN/m2. Linear variations of brake mean effective pressure can be observed and there is no significant deviation in brake mean effective pressure for the Orange oil blends from that of pure diesel.



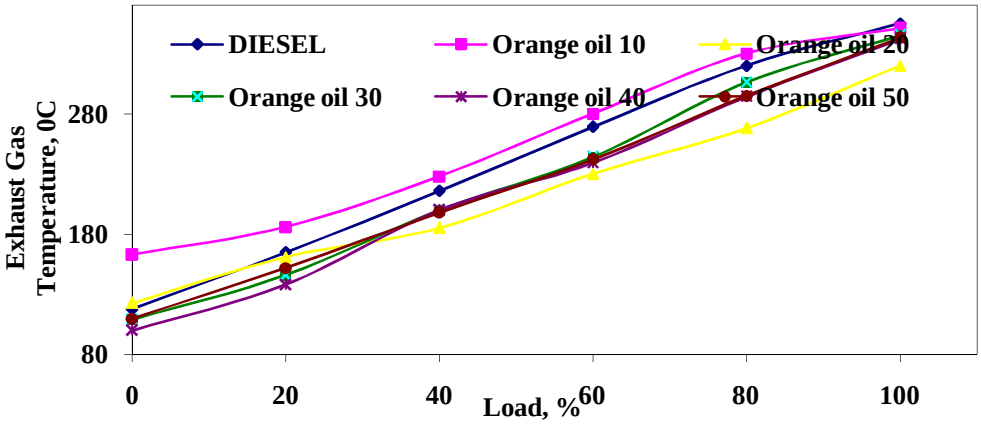
Graph 7: Load against Indicated Mean effective pressure.



Graph 8: Load against Volumetric Efficiency.

9. Analysis for Volumetric Efficiency

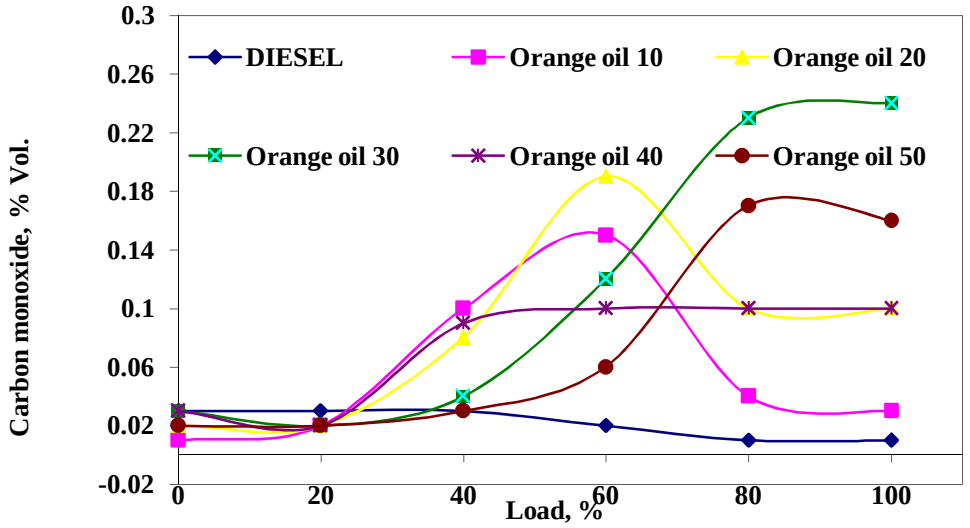
Volumetric efficiency variation for Orange oil -DF blends with load is shown in the Graph 8. Volumetric efficiency of Orange oil is lower than that of pure diesel. This is constant at all loads. Volumetric efficiency is slightly decreased for all the Orange oil - DF blends. It may be reduced due to higher temperature of retained gases, which heats the incoming fresh air.



Graph 9: Load against Exhaust Gas Temperature.

10. Analysis for Exhaust Gas Temperature

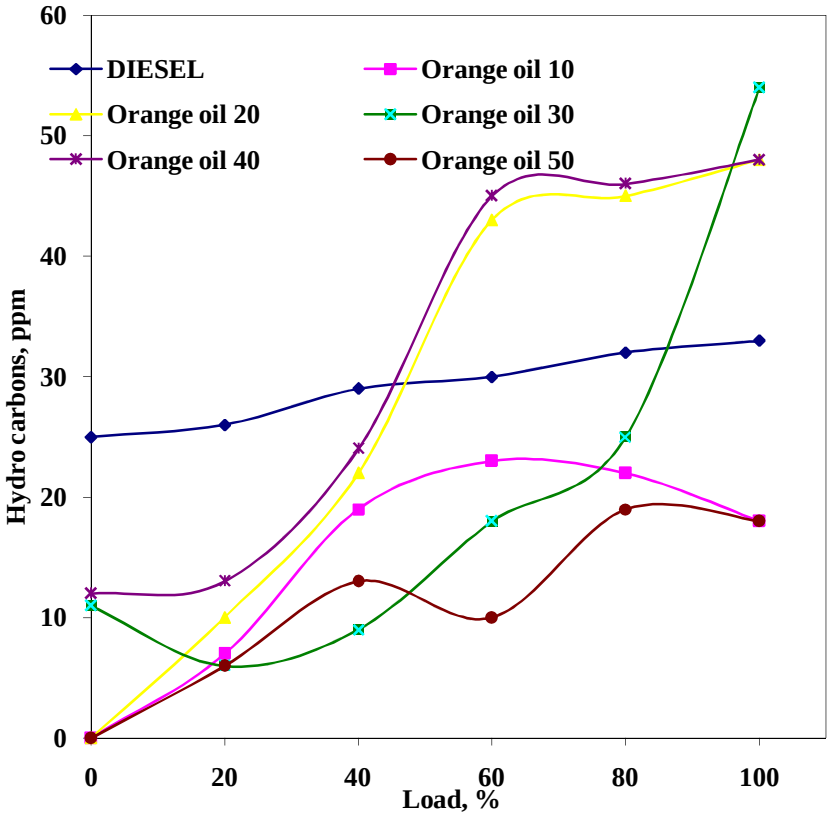
The variation of exhaust gas temperature with load at various load conditions is depicted in Graph 9.It is observed that the exhaust gas temperature increases with load because more fuel is burnt to meet the power requirement. It can be seen that in the case of diesel fuel operation exhaust gas temperature ranges from 85 ^{0}C at low load to 275 ^{0}C at full load. For Orange oil 10 and Orange oil 20, at full load the exhaust gas temperature marginally increases to 322 ^{0}C and 315 ^{0}C respectively. The exhaust gas temperature for Orange oil 40 varies from 141 ^{0}C at low load to 353 ^{0}C at full load. In the case of Orange oil 50, the exhaust gas temperature varies from 137 ^{0}C at low load to 351 ^{0}C at full load. Higher exhaust gas temperature in the case of Orange oil blends compared to DF is due to higher heat release rate. It may also be due to the oxygen content of the Orange oil, which improves combustion. In the case of Orange oil, the fuel spray becomes finer and effective combustion takes place.



Graph 10: Load against Carbon monoxide.

11.Analysis for Carbon Monoxide

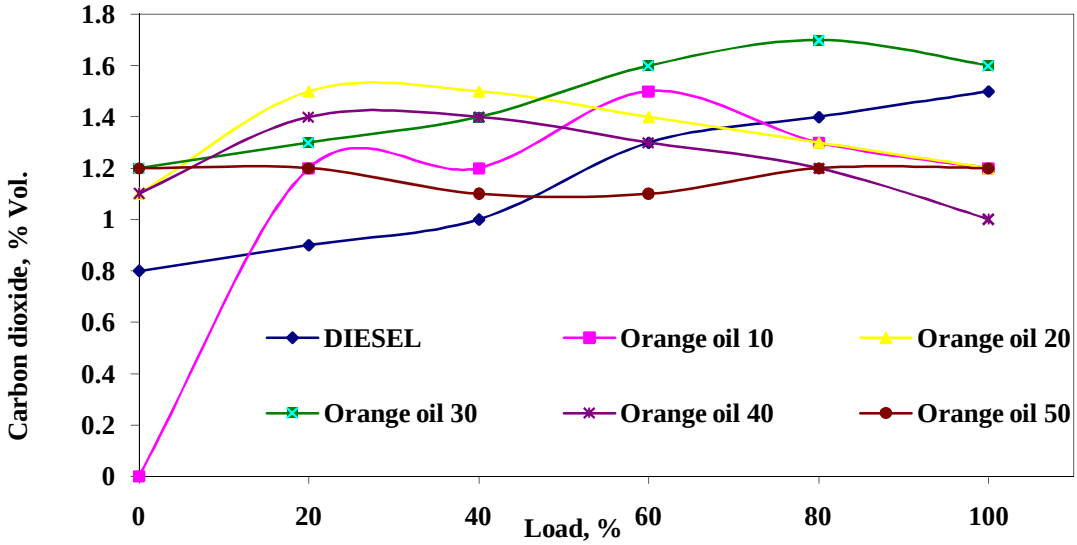
From Graph 10, the variation of carbon monoxide with load can be observed for all the Orange oil-DF blends. The results show that CO emission of Orange oil-DF blends is lower than DF. With increase in power output, the CO emission gradually reduces for Orange oil -DF blends and the difference in the values for CO emission with DF reduces significantly.



Graph 11: Load against Hydrocarbons

12.Analysis for Hydro Carbons

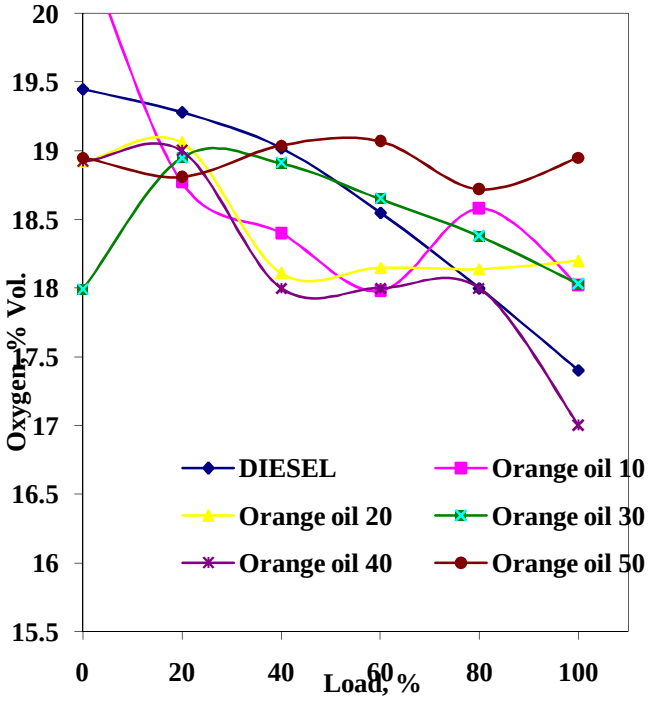
The variation of hydrocarbons with load for tested fuels is depicted in Graph 11. From the results, it can be noticed that the concentration of hydrocarbon of Orange oil -DF blends is less than DF. With increase in power output, the HC emission gradually increases for Orange oil -DF blends.



Graph 12: Load against Carbon dioxide.

13. Analysis for Carbon Dioxide

As shown in Graph 12, it can be observed that the variation of carbon dioxide emission with load for DF and Orange oil -DF operation. From the results, it is observed that the amount of CO_2 produced while using Orange oil -DF blends is lower than DF at all loads except full load. This may be due to late burning of fuel leading to incomplete oxidation of CO.



Graph 13: Load against Oxygen

14. Analysis for Oxygen

The variation of brake thermal efficiency with load for Orange oil-DF blends is shown in Graph 12. It is clear that oxygen present in the exhaust gas is decreases as the load increases. It is Obvious that due to improved combustion, the temperature in the combustion chamber can be expected to be higher and higher amount of oxygen is also present, leading to formation of higher quantity of NOx, in Orange oil-DF blends.

15. Conclusions

A Single Cylinder Four Stroke Compressed Ignition Engine was operated successfully using the orange oil and diesel blends as fuel. The following conclusions are made based on the experimental results.

a. The blends of orange oil show lowest specific fuel consumption than the diesel at part loads. The blends Orange oil 30 shows lesser specific fuel consumption than the diesel at full load condition.
b. Increase in Brake power is observed at all loads for all the blends. Since the waste plastic oil having the viscosity close to the diesel it results in the good spray pattern and better atomization of the fuel.
c. Thermal efficiency of the tested diesel engine is improved when it is fuelled Orange oil. On an average the thermal efficiency is increased with Orange oil 50, even it is lower than the diesel for the blend Orange oil 10.
d. Actual Breathing capacity of the engine also slightly decreased which leads to increase of volumetric efficiency.
e. Exhaust gas temperature of blends Orange oil 30 is less than that of the diesel, which indicates the effectiveness of input energy.
f. Carbon monoxide emission from the exhaust gas is reduced as the output power increases but this concentration is increased as the orange oil blend increase with the diesel fuel.
g. Hydro carbon emission is found that lesser in concentration than the diesel at all load conditions. For the blend Orange oil 20 and Orange oil 40 hydrocarbon emission is slightly higher than the diesel.
h. Carbon dioxide emission is increased as the load variation increased but the concentration is less when compared to the diesel fuel operation.
i. Oxygen content is reduced from the exhaust gas as the load is increased. If the high content of oxygen is present in the exhaust it leads to the formation of oxygen.

So, it is preferred to use the 50% Orange oil blend, as a best blend to the diesel due to the following reasons:

1. Lowest specific fuel consumption reduces the expenditure on fuel.
2. The power utilized is more from the developed power than other blends.
3. Low exhaust gas temperature results in decreasing the environmental pollution.
4. As the volumetric efficiency is good sufficient amount of air is available to the fuel, so the emission is due to incomplete combustion is lowered.

References

[1] A.K. Agarwal, L.M. Das, "Biodiesel development and characterization for use as a fuel in C.I Engine", Journal of Engineering, Gas turbine and power (ASME), Vol.123, 2000, 440-447.

[2] A.S.Ramadhas, S.Jayaraj, C.Muraleedharan, "Use of vegetable oils as I.C engine fuels: A Review", Renewable Energy, Vol.29, 2004, 727-742.

[3] A.Srivastava, R.Prasad, "Triglycerides- based diesel fuels" Renewable Energy Reviews, Vol.24, 2004, 111-133.

[4] B.K.Barnwal, M.P. Sharma, "Prospects of bio-diesel production from vegetable oils in India" Renewable and sustainable energy reviews, Vol. 9, 2005, 363-378.

[5] F. Karaoamanoplu, "Vegetable oil fuels: A review", Energy sources, Vol.70, 1999, 221-231.

[6] M.A. Fangrui, M.A.Hanna, "Biodiesel production: A review", Bio source Technology, Vol.7 1999,1-15.

[7] B.S. Chiou, H.M. El-mashad, R.J. Avena-Bustillos, R.O. Dunn, P.J. Bechtel, " Biodiesel from waste salmon oil" American society of Agricultural and Biological Engineers, Vol. 51(3), 2008,797-802

[8] Cherng Yuan Lin, Rong Ji Li, "Fuel properties of biodiesel produced from the crude fish oil from the soap stock of marine fish", Science direct, Fuel processing technology 90 (2009) 130-136.

[9] El-mashad, H.M., R. Zhang, and R.J.Avena-Bustillos, "A two-step process for biodiesel production from salmon oil" Biosystems Eng. Vol.99 (2), 2008 220-227.

[10] Otto Andersen, Jan-Erik Weinbach, Residual animal fat and fish for biodiesel production. Potentials in Norway, Biomass and Bioenergy 34 (2010) 1183–1188.

[11] F. Preto, F. Zhang, J. Wang, A study on using fish oil as an alternative fuel for conventional combustors, Fuel 87 (2008) 2258–2268.

[12] C.Y. Lin, R.J. Li, Fuel properties of biodiesel produced from the crude fish oil from the soapstock of marine fish, Fuel Processing Technology 90 (2009) 130–136.

[13] C.Y. Lin, R.J. Li, Engine performance and emission characteristics of marine fish-oil biodiesel produced from the discarded parts of marine fish, Fuel Processing Technology 90 (2009) 883–888.