Study on Performance and Emission Characteristics of Single Cylinder CI Engine using Diesel-Simarouba blends

M.S.Channe Gowda[1], J Venkatesh[2]

Associate Professor, Department of Automobile Engineering, PES College of Engineering, Mandya – 571401, Karnataka, India

Professor, Department of Automobile Engineering, PES College of Engineering, Mandya – 571401, Karnataka, India

ABSTRACT

In recent years, much research is being carried out to find suitable alternative fuel to petroleum products in response to the ever increasing demand on the fossil fuels. In the present investigation, to learn the suitability of the simarouba biofuel in CI engines, experimental work has been carried out to analyze the performance and emissions characteristics of a single cylinder compression ignition engine fuelled with the blends of diesel and simarouba biodiesel at the different loading conditions. The performance parameters evaluated were brake thermal efficiency, brake mechanical efficiency, break specific fuel consumption and the emissions were measured using smoke meter. The results of experimental investigation with diesel-biodiesel blends are compared with that of diesel. The results indicated that the 20% simarouba with 80% diesel gives maximum mechanical efficiency. Whereas for other blends, the result is very much comparable to that of pure diesel. The brake thermal efficiency of the engine reduced slightly for all blends in comparison with diesel, which could be improved by proper setting of the injection timing for respective fuel blends. The break specific fuel consumption was slightly more than that of diesel as the calorific value of simarouba biofuel is less than that of diesel.

Keywords - biodiesel; diesel engine; simarouba; performance; efficiency; exhaust emissions

I. INTRODUCTION

In recent times, the world is confronted with the twin crisis of fossil fuel depletion and environmental degradations. The situations have led to the search for an alternative fuel which should be not only sustainable but also environment friendly without sacrificing the performance[1]. Biodiesel is a renewable fuel which is produced from vegetable oil or animal fat through a chemical process and can be used as either direct substitute, extender or as an additive to fossil diesel fuel in compression ignition engines. The most promising feature of biodiesel is that it can be utilized in existing design of diesel engine with no or very little modifications. It has a proven performance for air pollution reduction. Biodiesel is typically produced through the reaction of vegetable oils or animal fat with methanol or ethanol in the presence of catalyst to yield glycerol as major by product[1] (biodiesel chemically called methyl or ethyl ester). However, the price of biodiesel is presently more as compared to petrol and diesel [2]. Higher cost of biodiesel is primarily due to the raw material cost [3].One non edible biodiesel feedstock is simarouba glauca [3]

Biodiesel is produced by the transesterification of vegetable oils with alcohols to produce esters. [6]. Bio-diesel has become more attractive recently because of its environmental benefits and the fact that it is made from renewable resources [7]. Biodiesel has demonstrated a number of promising characteristics, including reduction of exhaust emissions [8].

Evaluation of Simarouba esters indicates its superiority over many other vegetable oils in terms of engine performance, emissions, ease of use and availability. Simarouba glauca belongs to family simarubaceae, commonly known as "The Paradise Tree" or "King Oil Seed Tree", is a versatile multipurpose evergreen tree having a height of 7-15 m with tap root system.

In India, it is mainly observed in Andhra Pradesh, Karnataka and Tamil Nadu etc. It can adapt a wide range of temperature, has the potentiality to produce 2000-2500 kg seed/ha/year; can grow well in marginal lands/wastelands with degraded soils and therefore considered as a major forest tree. All parts of Simarouba are useful in some way or the other. The plant is also known for its medicinal properties.

To avoid the recycling of carbon from the earth crust more focus is given to find the alternate fuel from the natural resources available on the earth surface. There by reducing the cost of

fuel production and its ill effect on the atmosphere.

In this paper attempt has been made to test for the adaptability of simarouba bio diesel in the conventional CI engine. Citing to the lower CV and higher kinematic viscosity of the simarouba bio fuel its energy released is comparatively lower compared to that of the conventional diesel and this may be an obstacle to optimal performance.

Due to higher viscosity, the particulate emission is expected to be higher than that of the conventional diesel as the poor atomization leads to leads to pyrolysis thus promoting soot formation. In this study various test are conducted on varying loads to exactly determine the mechanical efficiency, thermal efficiency and the emission levels on different ratios of diesel – simarouba mixtures. For this purpose various reading were noted in regular intervals and based on these readings the best ratio of fuel mixture was decided comparing all the parameters. Detailed study was conducted to determine the reason for decreased performance and increased emission in certain conditions.

Results showed increase in smoke meter reading indicating the necessity to alter the engine components to facilitate better atomization of fuel atoms thereby reducing emission and the same time improving the efficiency of the operation using simarouba as bio-fuel. Thus projecting a promising future and the possibility of using simarouba bio-fuel to run the future CI engines.

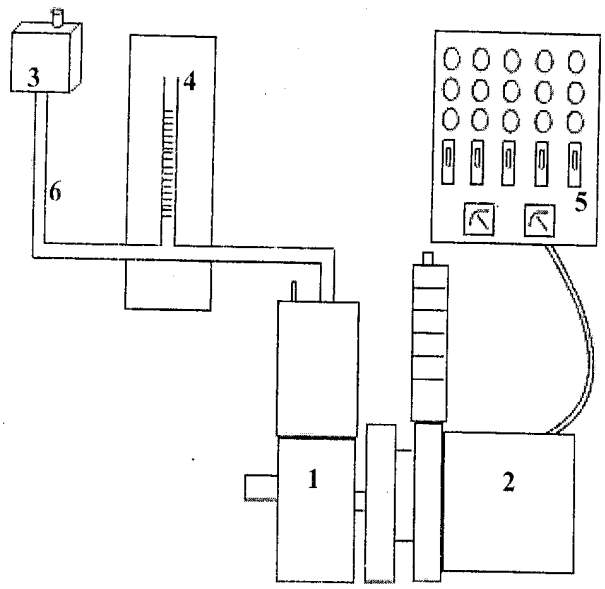
II. Experimental setup and experiments

The experimental set up to conduct the experiments is as shown in fig 1. A four stroke one cylinder parry CI engine with 6.5 H.P. capacity was used for this purpose and it was coupled to the 3kw capacity generator. The engine was lamp loaded with the help of this electrical generator, number of 100W bulbs were used for this purpose. No changes were made in the engine auxiliary systems. Ammeter and voltmeter were used to monitor the change in the voltage and current consumption depending on the loads. Monometer setups were used to actively measure the quantity of fuel consumed by the engine for 10sec of running at various loads. Tachometer was used keep the track of engine speed with varying conditions. Cooling water and lubricating oil temperatures were noted in the beginning and

at the end of the trail. Exhaust gas temperature and smoke meter reading were also noted during every trail.

Initially the test was done on 100% diesel and the readings were noted. Then the trails on different ratios of simarouba – diesel mixtures were carried out, comparing the values with the pure diesel values. In every ratios of fuel mixture different trails were carried out starting from no load condition or zero load to 1700watt load on the engine with gradual increase in load for every trail. The experiment was carried out on a nearly constant engine speed of 1500 rpm keeping all other parameters constant.

The values obtained from the above procedures were used to plot graphs which later were used as a base to compare the performance and the emission levels for different fuel ratios at different loading conditions.



I. TEST ENGINE
2. GENERATOR
3. FUEL TANK
4. MANOMETER
5. LOADING MECHANISM
6. FUEL LINE

Fig1. Experimental Set Up

III. RESULTS AND DISCUSSION

Comparison of thermal efficiency, mechanical efficiency, bsfc and smoke meter reading are done using suitable graphs. As per the readings the fuel consumption is more in case simarouba fuel, this due to lower calorific value when compared to the diesel. Kinematic viscosity of the fuel also plays a major role in the performance and emission characteristics. The graphs shows the reading for different parameters

The fig 2 shows variation of BSFC of diesel with different blends of simarouba and diesel has been done. It can be seen that maximum brake specific fuel consumption takes place when 100% simarouba bio-fuel is used. The minimum brake specific fuel consumption takes place when a blend of 80% simarouba with diesel is used and brake fuel consumption of 100% diesel takes place between 100% simarouba bio-diesel and a blend of 10% simarouba bio-diesel with diesel.

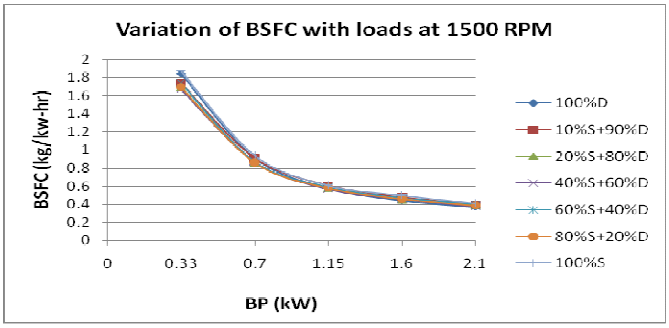


Fig 2. Variation of BSFC with BP

The Fig 3 was plotted for brake thermal efficiency verses BP for 100% diesel and different simarouba blends for brake thermal efficiency. The maximum brake thermal efficiency was observed for 100% diesel. The minimum brake thermal efficiency was observed when 10% simarouba with 90% diesel blend was used. So according the graph 100% diesel has more brake thermal efficiency compared to any of the simarouba blends.

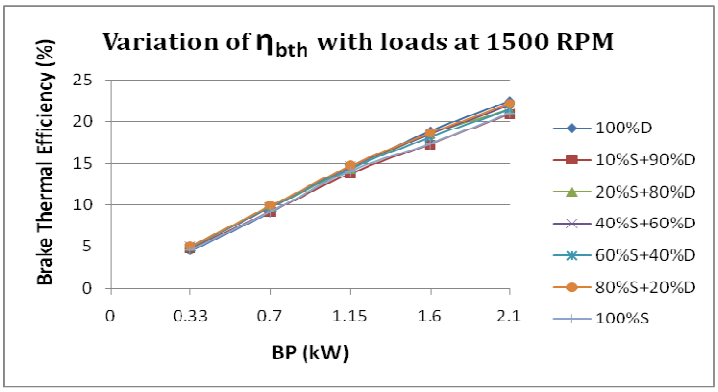


Fig 3. Variation of Brake thermal efficiency with BP

The Fig 4 was plotted for comparison of 100% diesel with different simarouba biofuel blends with diesel for mechanical efficiency. The maximum mechanical efficiency was observed when 20% simarouba blend with diesel was used. The minimum mechanical efficiency was observed when 80% simarouba blend with diesel was used and the mechanical efficiency of 100% diesel fuel was found to be slightly above thermal efficiency of 100% simarouba bio-fuel and slightly below 20% simarouba blend with diesel.

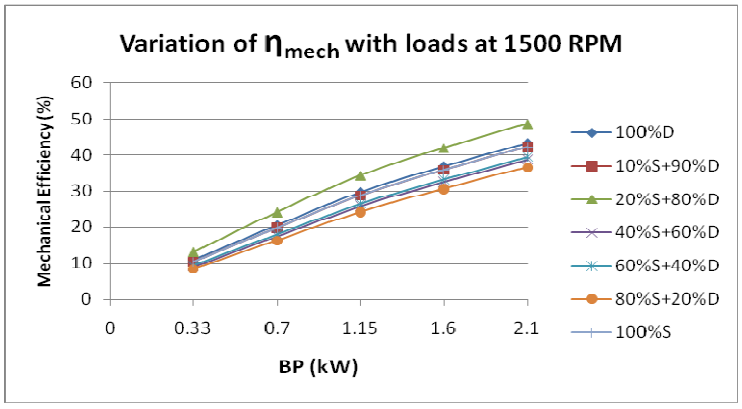


Fig 4. Variation of Mechanical Efficiency with BP

The fig 5 shows the comparison of smoke emission between 100% diesel with different simarouba bio-fuel blends with diesel is shown in graph no.4. We can notice that initially in the no load condition the emission of 10% simarouba blend with diesel has lowest emission and the 100% diesel lies slightly above this value and the 100% simarouba bio-

diesel has the highest level of emission. As the load goes on increasing the emission of all the blends of simarouba gives higher emission compared to 100% diesel. At full load condition 60% simarouba blend with diesel is seen to give out maximum emission according to the reading acquired from opacity meter.

It was seen that in all the cases the performance of the simarouba bio fuel was comparable with that of the diesel. With proper research and modification to the engine design and in auxiliary system settings the performance is believed to further improve, making it suitable alternate fuel that is sustainable and easily available.

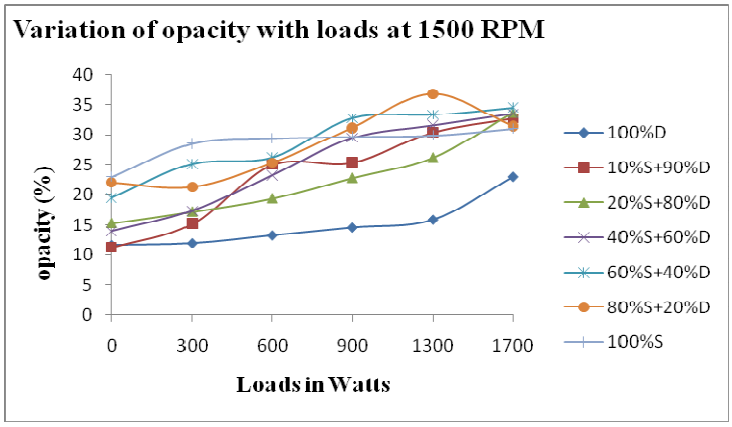


Fig 5. Variation of Smoke Emission with loads

IV. CONCLUSION

•By calculation we found that the frictional power is least for a blend of 20% simarouba bio-fuel with diesel and the maximum frictional power was found when 80% bio-fuel with diesel is used. The frictional power for diesel found to be lie between 100% simarouba bio-fuel and 60% simarouba bio-diesel blend.

•The mechanical efficiency was found to decrease with the increase in simarouba bio-fuel ratio with diesel. But in initial blends diesel has the better mechanical efficiency.

•As we found that the simarouba bio-fuel blends with diesel have more emission levels than pure diesel.

•The thermal efficiencies of the all the simarouba blends are found to be comparable to

diesel and found to exist in a narrow range

REFERENCES

1. Meher, D. Vidya Sagar, S.N.Naik, "Technical aspects of biodiesel production by transesterification—a review", Journal: Bio resource Technology - BIORESOURCE TECHNOL , vol. 102, no. **1**, pp. 57-70, 2011.
2. Amrita. E, Dr. R. Suresh, Yathish K V, "Production Of Simarouba Bio-Diesel Using Mixed Base Catalyst, And Its Performance Study On CI Engine". International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 5, May - 2013 ISSN: 2278-0181
3. Mishra S.R.et.al**, "**Production of Bio-diesel (Methyl Ester) from Simarouba Glauca Oil", *Research Journal of Chemical Sciences,* ISSN 2231-606X Vol. 2(5), 66-71, May (2012)
4. Prakash C. Jena et.al, "Biodiesel production from mixture of mahua and simarouba oils with high free fatty acids", International Journal of Biomass and Bio energy, Volume 34, Issue 8, August 2010, Pages 1108–1116
5. Taylor & Francis, "Process Optimization for Biodiesel Production from Simarouba, Mahua, and Waste Cooking Oils", International Journal of Green Energy, Volume 12, Issue 4, 2015
6. Raheman et al. "Performance of a diesel engine with blends of biodiesel (from a mixture of oils) and high-speed diesel", International Journal of Energy and Environmental Engineering 2013.
7. Mishra S. R. et.al, "Biodiesel Production from Simarouba glauca Oil using CaO and KOH Catalysts: A Comparative Study", International Journal of Scientific & Engineering Research, Volume 4, Issue 12, December-2013 147 ISSN 2229-5518
8. T.Tamilarasan, K.Vinod, R.Saravanan "Review of Biodiesel Production, Emissions and Performance characteristics of Mahua oil" International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-5, August 2015, ISSN: 2395-3470,