# Effect of Injection Pressure Variation on The Performance And Emission Characteristics of Single Cylinder Diesel Engine Using Simarouba Seed Biodiesel Blended With Diesel As Fuel

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***Abstract***- *Diesel engine plays a significant role in the field of commercial transportation. Biodiesel is one of the alternate fuels to reduce harmful effects on the environment. Present research work deals with the extraction of Simarouba oil from the seeds available in market and reducing its viscosity by transesterification which is one of simple method using in the present time. The fuel properties of biodiesel produced are tested in Bangalore test house and which are compared with that of diesel. The properties of biodiesel from Simarouba oil are found that they are closer to the diesel.*

*In this experimental investigation biodiesel from Simarouba oil, a non-ediable oil and its blends are selected for the test on a single cylinder diesel engine and its suitability as an alternate fuel is examined. Initially biodiesel blended with diesel by adding 20% biodiesel by volume i.e. B20. The performance and emission characteristics of blend prepared are evaluated by varying injection pressure at constant speed of 1500 rpm and results are compared among them and optimized the injector pressure.*

*The various performance and emission parameters like brake power (BP), brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), and emissions such as CO, HC and NOx were evaluated at different loads. Out of various injectors pressure used for testing the results showed that maximum increase in brake thermal efficiency was found to be at 210 bar. Results showed decreased specific fuel consumption at full load conditions reduces The optimized injection pressure of 210 bar improves the emissions of hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) at full load conditions.*

***Keywords***- Extraction of Oil , Transesterification ,Preparation of Blends and Study of Performance, Emission Test and effect of variation of injection pressure on CI Engine.

## I. INTRODUCTION

The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high temperature and high pressure gases produced by combustion apply direct force to some component of the engine. This force is transferred to crankshaft through connecting rod, transforming chemical energy into useful mechanical energy.

Sir Rudolf Diesel

In the year 1892, compression ignition engine was introduced by RUDOLF DIESEL (1858-1913) a German engineer born in Paris. Here, compression of air alone to sufficiently high temperature ignited the fuel without the help of ignition systems. Today CI engine is a very important prime mover, being used in buses, trucks, locomotives, tractors, pumping sets and other stationary industrial applications, small and medium electric generation and marine propulsion.

The importance of CI engine is due to:-

I. Its higher thermal efficiency than SI engines
II. CI engines fuels (diesel oils) being less expensive than SI engine fuels (petrol). Furthermore, since CI engines fuels have a higher specific gravity than petrol, and since fuel is sold on volume basis (litres) and not on mass basis (kg), more kg of fuel per litre are obtained in purchasing CI engine fuels.

These factors make the running of the CI engines much less than SI engine and hence make them attractive for all industrial, transport and other applications. However, in passenger cars it has not found much favour because of the main drawbacks of a CI engine in relation to SI engine i.e., heavier weight, noise and vibration, smoke and odour. Because of the utilization of higher compression ratios (12:1 to 22:1 compared to 6:1 to 11:1 of SI engine) the forces coming on the various parts of the engines are greater and therefore heavier parts are necessary. Also because of heterogeneous mixture, lean mixture (large air-fuel ratio) is used. Both result in a heavier engine

Performance tests are necessary to carry out for an engine to assess the fuel and thermal efficiencies. Further, it is also required to study the effect of different parameter on the engine performance, i.e. incomplete combustion of heterogeneous mixture, and droplet combustion. Compression ignition engines, because of their varied applications, are manufactured in a large range of sizes, speed and power inputs. The piston diameters vary from about 50mm to 900mm, speed range from 100 to 4400rpm and power output range from 2 to 40000 bhp.

Performance tests of internal combustion engines are conducted since the beginning of this century and their actual design is a result of this extensive accumulation of practical knowledge. However, the understanding of the physical phenomena and the precise identification of the processes taking place inside the engine always lagged behind experimental information. Various reasons exist for this lag between theory and practice, but the main problems are due to fact that the processes are not in steady state and occur at high temperatures, the working fluid consumption changes by chemical reaction and the complexity of all geometries.

In this project we have conducted experiment in parry engine with diesel and diesel chicken fat biodiesel blends. The different proposition for ethanol blends of B0% B20%, B40%, B60, B80 and 100% chicken fat biodiesel were used to run the engine at nearly constant speed of 1500 rpm at different loads from 5 to 20 Nm, the load were increased gradually with the help of eddy current dynamometer, in which the engine load were increased by increasing the power supply with the help of knob, time taken for 10 cc of fuel consumption in different load are noted. The smoke meter was maintained at temperatures between $70^0$C to $75^0$C to measure the opacity of smoke from the exhaust of the engine at different loads. Further the readings were used to prepare the table and plot the graph for different proposition of ethanol blends.

## II. LITERATURE SURVEY

The oil crisis in 1973 triggered numerous studies on natural oils and fats all over the world, but we really entered the field only on 2 August 1990, the day the Gulf crisis began. Today, 19 years later approximately more than 100,000 cars running on biodiesel mainly in Germany, but also Sweden and the Netherlands and some other countries, representing possibly over 90% of today's cars powered by neat biodiesel. The concept of using vegetable oil as fuel for diesel engines is nothing new. Dr.Rudolph Diesel first developed the diesel engine in 1895 with an intention of running it on a variety of fuels, including vegetable oil. Diesel demonstrated his engine at the Paris Exposition of 1911 using peanut oil fuel. In 1911, he stated, "The diesel engine canbe fed with vegetable oils and will help considerably in the development of agriculture of the countries which use it". In 1912, Diesel said, "The use of vegetable oils for engine fuels may seem to be insignificant today. Such oils may become in course of time as important as petroleum and the coal tar products of the present time". The interest in using vegetable oils as alternative fuels originated within the agricultural community as afuel for agricultural tractors and equipments.

**Mishra S. R. et al, [1]**conducted experiments on production of biodiesel (methyl ester)

From simaroubaglauca oil. This paper dealswith the transesterification of simaroubaglauca oil by means of methanol in presence of potassium hydroxidecatalyst at less than 65˚C. The important properties of simarouba biodiesel such as viscosity, density, flash point, cloud point, pour point, carbon residue and ash content are found out and are compared with that of diesel. The results showed that, for simarouba biodiesel kinematic viscosity at 40˚C was found to be 4.68 cSt, density 865 kg/m³, flash point 165˚C, cloud point 19˚C, pour point 14.2˚C, carbon residue 0.10% w/w, ash content 0.005%w/w.

**VishwanathKasturi et al, [2]**conducted experiments on performance, combustion and emission characteristics of diesel engine using simarouba oil and its blends with the diesel. The air-fuel ratio of pure diesel was higher than the simarouba biodiesel and its blends and air-fuel ratio decreases as the load increases. Brake thermal efficiencies of all blends were lower at almost all load levels. Among the blends S20 is found to have maximum thermal efficiency of 25.01% at a brake power of 3.97kW while for diesel it is 27.84%. Exhaust gas temperature at full load was maximum for all the blends. The CO emission initially decreases at lower loads and sharply increases after 4kW of power for all test fuels. The S20 blend had more CO emission compared to all blends. The emission of HC was decreasing with increase in loads, but the blend S20 exhibits emission of HC similar to diesel and S100blend had least emission of HC compared to other blends.

**Lesh Goshailabhanvi et al, [3]**conducted experiments on performance, emission and combustion characteristics of a single cylinder diesel engine operating on simarouba biodiesel and diesel fuel. Results showed that, as the brake power increases the brake thermal efficiency increases to an extent and then decreases slightly at the end. The brake thermal efficiency of S80 is nearer to the diesel, which shows S80 blend can be a favourable to existing diesel engine. The mechanical efficiency of diesel was slightly higher than the simarouba biodiesel. Mechanical efficiency of both diesel and biodiesel was equal at 20% of blend. Specific fuel consumption decreases at higher brake power. The specific fuel consumption for S80 blend was almost similar to diesel. The exhaust gas temperature increases with increase in loads for all the blends. Volumetric efficiency of diesel was higher than simarouba blends. The NOx emission for biodiesel and its blends was higher than that of diesel except S80 at lower loads. HC emission for all biodiesel blends was less than that of diesel except at full load. Smoke emission of diesel at full load condition was higher than that of the blends of simarouba biodiesel.

**Sharun Mendonca et al, [4]**conducted experiments on influence of injection timing on performance and emission characteristics of diesel engine fuelled with 20% simarouba biodiesel.Results showed that, for retarded injection timing brake specific fuel consumption was more for dieselcompared to S20 blend at 20.5˚bTDC. For retarded injection timing diesel gives maximum brake thermal efficiencythan S20 blend at 20.5˚bTDC. CO emission for diesel was less than S20 blend at 20.5˚bTDC injection timing.Retarding injection timing causes more HC emission. NOx emission of S20 blend was higher than diesel at20.5˚bTDC injection timing.

**Lava K. R et al,[5]**conducted experiments on effect of modified (threaded) piston on performance, combustion and emission characteristics of diesel engine by using simarouba biodiesel. This paper relates the modification of enginecombustion chamber design, for including turbulence to improve the combustibility of combustible mixture.Results showed that, the standard piston produces higher cylinder pressure compared to threaded piston. The mass fraction burned was high with threaded piston than standard piston. The HC emission was decreasing with the increase in turbulence in threaded piston, which results in complete combustion of fuel. The CO emission was high in case of standard piston than the threaded piston. The NOx emissions were slightly increased for S20 blend with threaded piston in comparison with the standard piston.

**Babu et al, [6]** his review aims to study the prospects and opportunities of introducing vegetable oils and their derivatives as fuels in diesel engines. Fuel related properties are reviewed and compared with conventional diesel fuel. The use of neat vegetable oil (edible and/or non edible), biodiesel and its blends in a diesel engine has been discussed. Performance and emission characteristics are highlighted. Current developments on the use of vegetable oils and its blends, biodiesel and its blends in diesel engines are examined.

**Pugazhvadivu et al, [7]** in his experimental investigation, waste frying oil,(WFO) a non edible vegetable oil was used as an alternative fuel for diesel engine. Preheating reduces the high viscosity of the waste frying oil and the effect of temperature on the viscosity of WFO was evaluated. The results reveals that, using preheated WFO, the BSEC and break thermal efficiency were improved. Exhaust emission such as CO and smoke were reducedconsiderably. Maximum reduction in CO and smoke emissions was obtained using WFO (1350 C) compared to WFO (750C).

**Norbert Hemmeriein, et al, [8]** conducted a performance test on a dividedcombustion chamber diesel engine with neat rapeseed oil as fuel. They discussed on energy consumption and engine performance. By order of the Ministry of Research and Technology PORSCHE has investigated six modern Diesel engines, where rapeseed oil was used as fuel. They concluded that, engine performance and energy consumption with rapeseed oil is similar to operation with diesel fuel and diesel engines with divided combustion chambers and big cylinder units are able to operate permanently with neat rapeseed oil.

**Alberto et al, [9]**reviewed the potential of palm oil as an alternative fuel in automotive and industrial diesel engines with respect to its performance and terminological, environmental, economic and social implications. They observed that performance and exhaust gas emissions using palm oil fuel and its blends with conventional diesel fuel in stationary diesel engines are comparable with those of conventional diesel fuel.

**Seppo and Niemi et al, [10]** used preheated palm oil to run a CIengine. Preheating reduced the viscosity of fuel and hence better spray and atomization characteristics were obtained. Torque, break power, specific fuel consumption, exhaust emission and break thermal efficiency were found to be comparable to that of diesel.

## III. OBJECTIVES

1. To study the fuel properties of the biodiesel and preparation of various blends.
2. To carryout the performance and emission test on diesel engine.
3. Conducting performance and emission test of diesel engine by varying injection pressure of optimum blend.
4. Compare the results and study the effect of varying injection pressure.

## IV. PRESENT WORK AND METHODOLOGY

**Result and Discussion**

It is observed that performance of the engine at all injection pressure for B20 fuel blends is almost identical. It can be seen that as the amount of injection pressure increases there is a tendency to power improvement. This trend is observed up to 210 bar, further increase in injection pressure leads to decrease in efficiency. The increase in injection pressure will lead to fuel droplet refinement which in turn improves the fuel spray, atomization, and fuel evaporation and injection characteristics of fuel.

**Engine performance**

**1. Brake specific fuel consumption**

The fig 7.1. Shows variation of BSFC with BP for different injection pressure. It can be seen that BSFC is decreased with increasing brake power due to high percentage of conversion of heat energy into useful work. The fuel consumption of the engine was somewhat higher at all loads and injection pressures for biodiesel blends due to lower gross heat of combustion when injection pressure is increased from 180 to 220 bar. The value of specific fuel consumption decreases as the value of injection pressure increases. The optimum value of 0.404 Kg/kW.h is found for 210 bar injection pressure when engine runs at full load.

**2. Brake specific energy consumption**

The figure-7.2 shows the variation of BSEC with various injection pressures for the biodiesel blend at varying load operations. It is observed that the BSEC has decreased with increase in injection pressure. The lowest BSEC for B20 blend is found to be at 210 bar injection pressure (IP) is 17.354 MJ/kW-hr respectively. This is better than that for BSEC of other i.njection pressures. At higher injection pressure of 210, the reduction in BSEC may be lower due to improved combustion as the atomization has improved

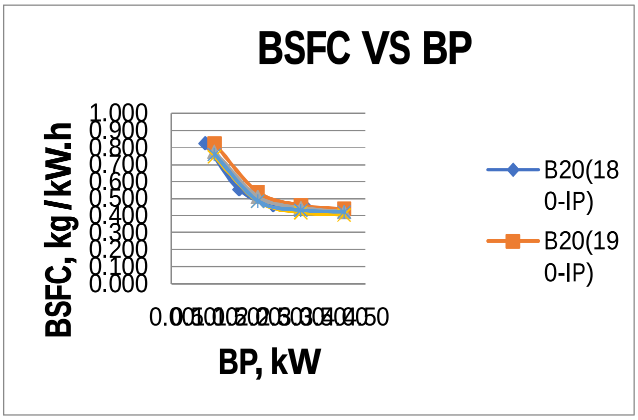


Fig.7.1. BSFC vs BP for various Injection pressure

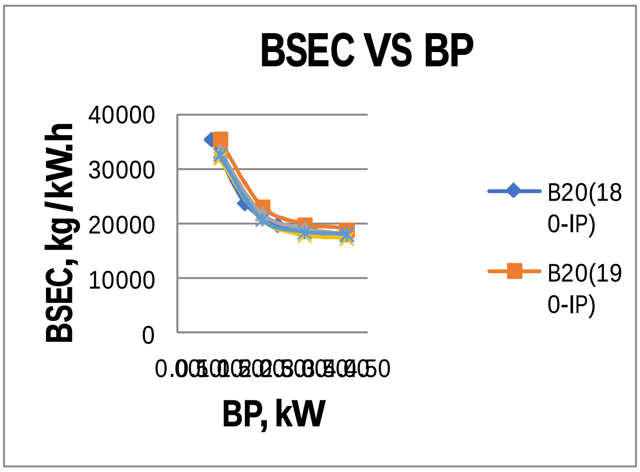


Fig.7.2. BSEC vs BP for various Injection pressure

**3. Brake thermal efficiency**

The fig 7.3. Shows variation of Brake Thermal Efficiency with BP for different load and engine run at various injection pressure. The value of BTE of engine increases as the value of injection pressure increases. The maximum value of BTE is 21.31 % when engine runs at 210 bar at full load. The value of thermal efficiency is maximum when brake specific fuel consumption is minimum.

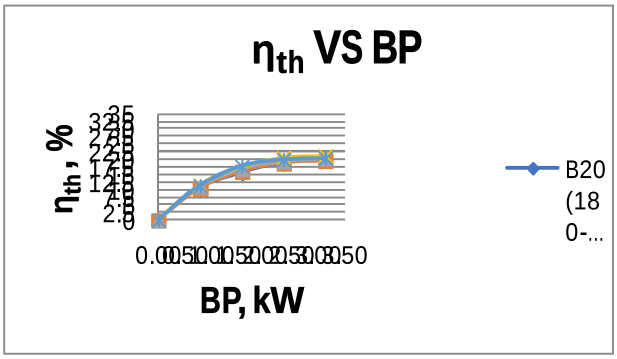


Fig.7.3. BTE vs BP for various Injection pressure

**4. Exhaust GasTemperature**

The variation of Exhaust Gas temperature (EGT) with load for various injection pressure is presented in fig.7.4 for all injection pressure tested, EGT increase with increase in load. It is observed from the figureIP 200 bar, IP 190 bar&IP 220 bar has shown lower EGT corresponding to IP 210 bar at full load. The magnitude of EGT decreaseas the amount Injection pressure

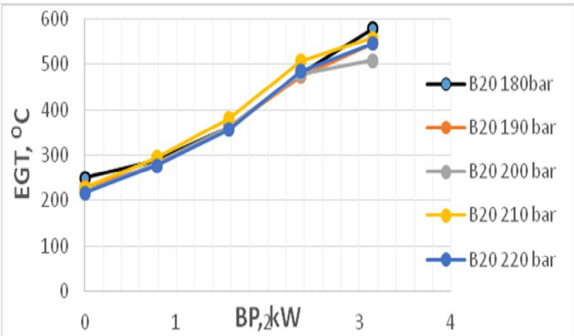


Fig.7.4. EGT vs BP for various Injection pressure

**ENGINE EMISSION**

**1. Carbonmonoxide**

The variation of carbon monoxide with load for various injection pressure is presented in fig.7.5. For all injection pressure tested, CO decreased with increase in load in the initial stage and further increases with load. It is observed from the fig. thatIP 180 bar,IP 200 bar &IP 190 bar has shown lower CO corresponding to IP 210 bar at full load.The amount of decrease in CO is very less at lower loads and increases more at higher loads. The viscosity of blends decreases and other properties reaches nearing diesel this kind of result can be attributed to good atomization and combustion quality.

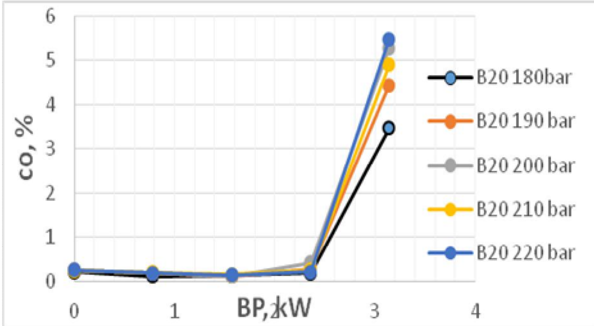


Fig.7.5. CO vs BP for various Injection pressure

**2. Hydrocarbon**

The variation of Hydrocarbon with load for two fuel blends is presented in fig.7.6. For all fuel tested, HC decreased with increase in load and increase due increase in loads. It is observed from the figure thatIP 180 bar,IP 200 bar &IP 190 bar has shown lower HC corresponding to IP bar 210 at full load.

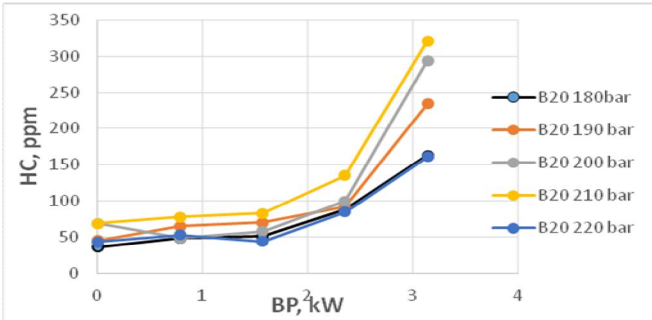


Fig.7.6. HC vs BP for various Injection pressure

**3. Nitrogenoxides**

The variation of Nitrogen oxides with load for two fuel blends is presented in fig.7.7. For all fuel tested, NOxincreases with increase in load. It is observed from the figure thatIP 210 bar,IP 200 bar &IP 220has shown lower NOx corresponding to IP 180 bar at full load. The magnitude of NOx decrease as the value of injection pressure increases

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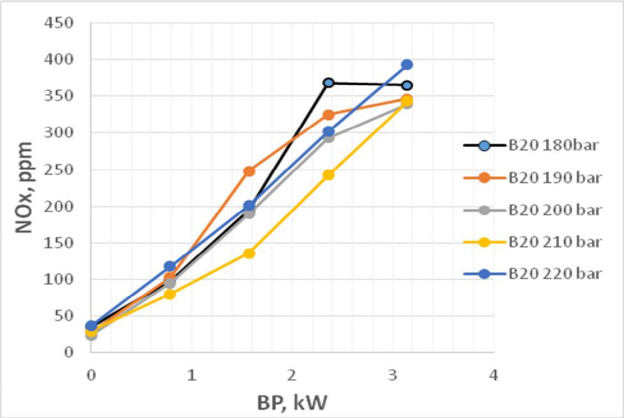


Fig.7.7. NOx vs BP for various Injection pressure

## V. CONCLUSION

The experimental study on the effect of injection pressure on emission characteristics of a diesel engine is conducted by using diesel and its blends with Simarouba biodiesel and the following conclusions are drawn.

- The values of BSFC and BSEC decreases with increase in injection pressure of 210 bar.
- Thermal efficiency of engine increases with increase in injection pressure. The optimum value of BTE is 21.3%
- The CO and HC emissions are well reduced by increasing the injection pressure for fuels tested.
- The NOx emissions are increasing with the increasing in injection pressure for the fuels tested.
- The optimum fuel blend is B20 and the optimum injection pressure is 210 bar with respect to the emission.
- The injection pressure 210 bar was found to be the optimum IP and better results obtained for biodiesel blends at 210 bar IP.
- Lower EGT was observed at higher injection pressures.

## VI. FUTURE SCOPE OF WORK

- The combustion characteristics of the engine can be studied at various injection pressure.
- The performance and emissions can be studied by varying injection timings along with injection pressure.
- This project was carried out on a single cylinder engine for which satisfactory results were obtained. Results with multicylinder engine fueled by biodiesels and its blends with diesel fuel can be carried out and can be compared with that of single cylinder engine performance and emissions.
- .Some additives such as LZ-7005, made by the form Lubrizol can be added in to fuel for testing the engine performance and emission. The presence of the additives reduces the smoke emissions and improves the thermal efficiency of the engine.

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