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A Study on Diesel Engine with Palmstearin-Diesel Blends at Different Injection Pressures

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ABSTRACT
Injection pressure plays an important role in the engine performance and emission control of internal combustion engines. Present work describes the experimental investigations carried on a four stroke single cylinder water cooled Kirloskar diesel engine with vegetable oil-diesel blends. Palmstearin oil is blended with diesel in varying proportions like (B10, B15, B20) 10%, 15% and 20% and experiments were carried out by varying the injection pressures from 165 bar to 210 bar. The performance characteristics like brake thermal efficiency, brake specific fuel consumption and exhaust gas temperatures are investigated. Based on investigations, a comparison is drawn on engine performance with pure diesel operation and with different blends. Experimental results demonstrate that at 195 bar fuel injection pressure, the performance characteristics are observed to be better with blends when compared to the pure diesel operation. Maximum brake thermal efficiency observed is 38% with 20% blend at an injection pressure of 195 bar and lower specific fuel consumption observed is 0.25 kg/kw-hr with 20% blend at an injection pressure of 195bar.
Keywords: injection pressure, palmstearin, brake power, specific fuel consumption, compression ignition.

I. INTRODUCTION

Fuel injection pressure in diesel engine plays an important role in engine performance. A fuel injection system for a diesel engine operating at retarded fuel injection timing includes a fuel cam configured to increase fuel injection pressure and decrease fuel injection duration, thereby improving fuel atomization and combustion in a plurality of engine cylinders and improving indicated efficiency of the engine and reducing exhaust emissions The present engines such as fuel direct injection, the pressures can be increased from 100 bar – 200 bar in fuel pump injection system. When injection pressure increases fuel particle diameter will become small. Since formation of mixing of fuel to air becomes better during ignition period, engine performance will increase. If injection pressure is too high, ignition delay period becomes shorter and as a result combustion efficiency decreases.

A high linolenic linseed oil methyl ester has been investigated [1] in a constant speed, DI diesel engine with varied fuel injection pressures (200, 220 and 240 bar).They investigated the effect of injection pressures on performance, emissions and combustion characteristics of the engine. The test results show that the optimum fuel injection pressure is 240 bar with linseed methyl ester. At this optimized within limited of BIS standard. Operational efficiency of diesel pump set for various blends of bio-diesel were found nearer to the expected efficiency of 20 percent. Bio-diesel can be used as an alternate and non-conventional fuel to run all type of C.I. engine.

The effect of Fuel Injection Pressure on Performance of Direct Injection Diesel Engines [4],shows the fixed load-variation speeds and fixed speed-variation loads have been given that the higher engine speed (rpm) given higher engine power. The increase in injection pressure is inline with increasing power. The fuel consumptions experiment result for fixed load-variation speeds and fixed speed-variation loads have been given that increasing injection pressure gives increased fuel consumption for the diesel engine.

Adding any inert gas as diluent to the inlet air reduces oxides of nitrogen (NOx) emissions [5]. In this study, carbon dioxide (CO2) was used as diluent and introduced to the intake manifold of a diesel engine at a ratio of 2%, 4% and 6% respectively. The investigation was conducted on a four stroke, four-cylinder, indirect injection (IDI), turbocharged diesel engine and was concerned with the effect of using diluting CO2 in the intake manifold and injection pressure on engine torque, power, brake mean effective pressure, specific fuel consumption, carbon monoxide, smoke and NOx emissions. The tests have demonstrated that NOx is reduced by the introduction of CO2 in the inlet charge. The results are given in the graph.

The performance of a diesel engine using biodiesel from refined palm oil stearin[6] obtained the following results. Biodiesel from refined palm oil stearin is a promising alternative for using in diesel engines. It is easier for delivering and storage than diesel oil, because of its higher flash point. The biodiesel from refined palm oil stearin has the lowest operating temperature at 15 °C or it may clog at a pipe. The 10%blended biodiesel from refined palm oil stearin can be used in high-speed diesel engine since the viscosity and pour point are in the standard limit for high-speed diesel.

Performance Evaluation of DI and IDI engines with Jatropha oil based biodiesel [7] concluded that transesterification reduces the viscosity by about 88% and density by 4.34%. BSEC values are little higher with biodiesel compared to diesel fuel operation under NA condition. DI engine operation with biodiesel under supercharged condition brings the performance very close to diesel fuel operation. Gummy deposits on important engine components are reduced with biodiesel operation. 50/50 blend of biodiesel and diesel leads to lower BSFCs when compared to 100% biodiesel operation under NA condition. IDI engine operation with biodiesel not only improves the performance but also tremendously reduces the gummy deposits. DI engine exhibits superior BSFC performance compared to IDI engine. Lower pollution levels are achieved in IDI engine with biodiesel and IDI engine operation with biodiesel can be regarded as eco-friendly performance.

In present diesel engines such as common rail engine injection, the pressures can be increased about 150–200 bar [8]. The effects of injection pressure on engine performance and exhaust emissions have been investigated. Experiments have been performed on a turbocharger diesel engine with 4-cylinder, 4-stroke, indirect injection. Emissions and engine performance values such as torque, power, break main effective pressure, specific fuel consumption, and fuel flow have been measured both full and part loads by changing injection pressure from 100 to 250 bar and for different throttle positions. According to results, maximum performance has been obtained at 150 bar. In addition, high injection pressure for O2, SO2 , and CO2, low injection pressure for NOx, and smoke level must be preferred for decreasing emissions. Results have been given as graphics.

The high viscosity of the jatropha curcas oil which has been considered as a potential alternative fuel for the compression ignition (C.I.) engine was decreased by blending with diesel [9]. The blends of varying proportions of jatropha curcas oil and diesel were prepared, analyzed and compared with diesel fuel. The effect of temperature on the viscosity of biodiesel and jatropha oil was also studied. The performance of the engine using blends and jatropha oil was evaluated in a single cylinder C.I. engine and compared with the performance obtained with diesel. Significant improvement in engine performance was observed compared to vegetable oil alone. The specific fuel consumption and the exhaust gas temperature were reduced due to decrease in viscosity of the vegetable oil. Acceptable thermal efficiencies of the engine were obtained with blends containing up to 50% volume of jatropha oil. From the properties and engine test results it has been established that 40–50% of jatropha oil can be substituted for diesel without any engine modification and preheating of the blends.

II. EXPERIMENTAL WORK

The engine used was a four stroke, single cylinder, water cooled Kirlosker diesel engine. It is provided with accessories for the measurement of load, fuel consumption, exhaust gas temperature and volume of air inducted. The specifications of the engine are given below.

Rated power	:	5 HP
Speed	:	1500 r.p.m
Bore	:	80mm
Stroke	:	110mm
Starting	:	Cranking
Method of ignition:		Compression ignition

Engine is loaded mechanically with rope brake dynamometer and speed is kept constant at 1500 rpm. By varying the injection pressure from 165 bar to 210 bar tests are conducted at 3kg, 6kg, 9kg and 12kg loads to study the effect of injection pressure on various parameters like brake thermal efficiency, brake specific fuel consumption and exhaust gas temperatures at the above operating conditions with pure diesel operation and blending the palmstearin with different proportions like 10%,15% and 20%.

III. RESULTS AND DISCUSSION

The results obtained from the tests conducted on four stroke single cylinder water cooled diesel engine with palmstearin-diesel blends are presented and discussed. Figures 1-4 show the variation of brake thermal efficiency with injection pressure, with increase in injection pressure, brake thermal efficiency increases for 10% and 15% and 20% blends.

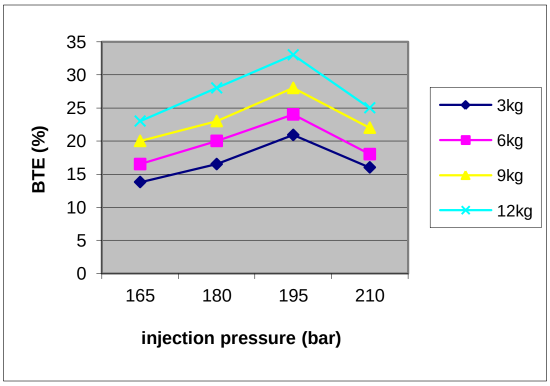

Fig 1. variation of BTE with Injection Pressure (100% diesel)

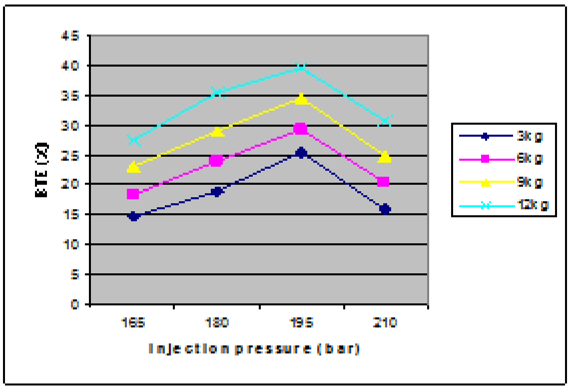

Fig 2. Variation of BTE with Injection pressure (B10)

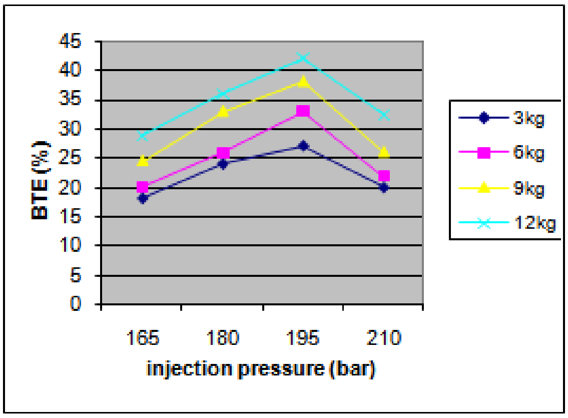

Fig 3. Variation of BTE with Injection Pressure (B15)

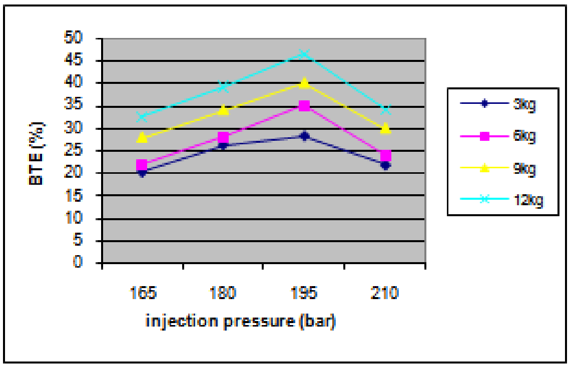

Fig4. Variation of BTE with Injection Pressure (B20)

Figures 5-8 show the variation of specific fuel consumption with injection pressure. 10% and 15% blends show the similar trends as pure diesel but for 20% blend it is observed to be better

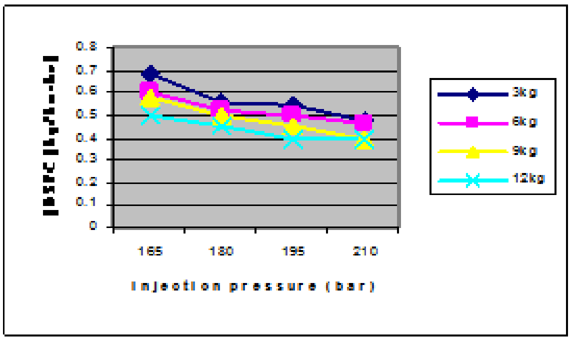

Fig 5. Variation of BSFC with Injection Pressure(pure diesel)

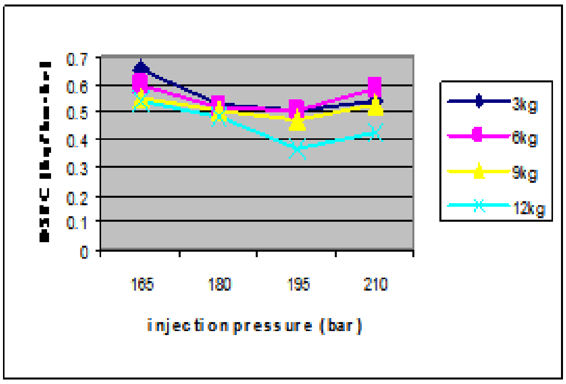

Fig6. Variation of BSFC with Injection Pressure (B10)

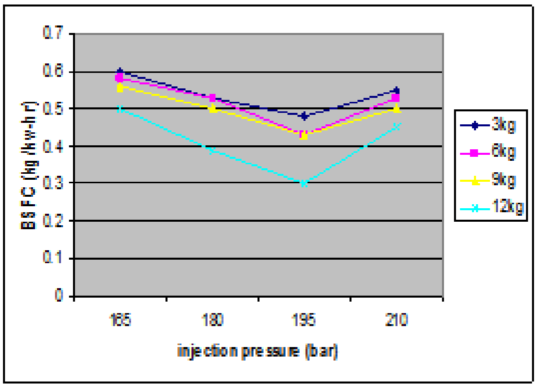

Fig 7. Variation of BSFC with Injection Pressure (B15)

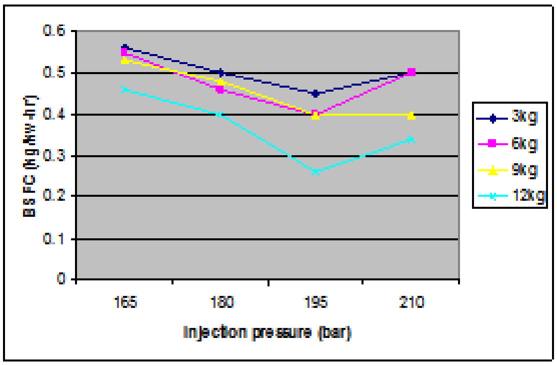

Fig 8. Variation of BSFC with Injection Pressure(B20)

Fig. 9 to Fig. 12 show the variation of exhaust gas temperature with injection pressure, it increases up to 195 bar after that there is a fall in exhaust gas temperature at 210 bar.The reason for the variation in performance is at lower injection pressures the drop let size of the spray is more, but the area exposed is less. Due to higher momentum penetration of droplet is more. But due to less area of the spray the utilization of air is not up to considerable extent. At higher injection pressures droplet size is less and area exposed is more. Due to small size of droplet, penetration is less. Hence, in this case also air utilization is not proper. At optimum injection pressure, the spray utilizes the air to a better extent resulting in higher efficiencies. The exhaust gas temperature graphs indicate that, the temperature is higher at optimum injection pressure in almost all the cases. This may be due to better utilization of air at optimum injection pressure, leading to improvement in combustion efficiency.

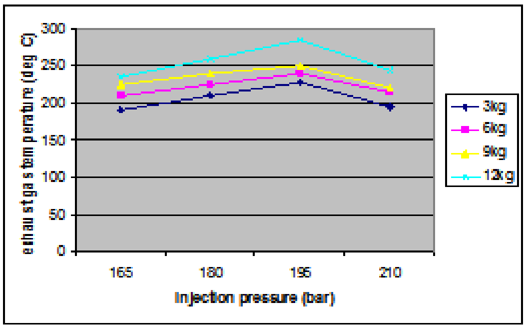

Fig 9. Variation of T_{exg} with Injection pressure(pure diesel)

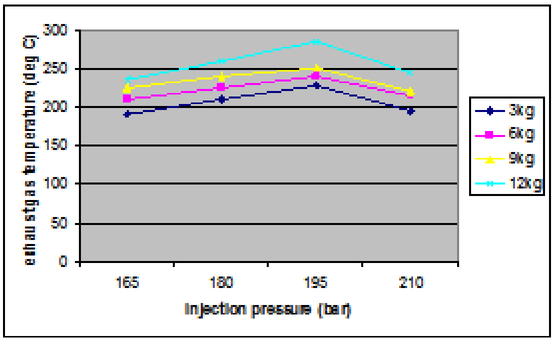

Fig 10. Variation of T_{exg} with Injection Pressure(B10)

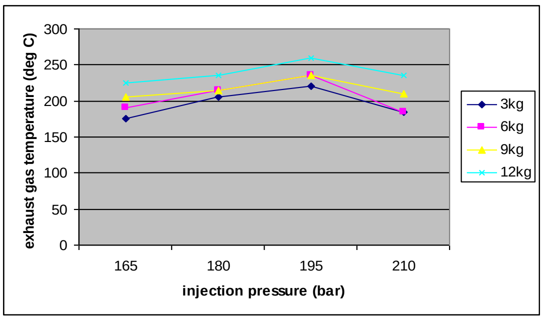

Fig 11. Variation of T_{exg} with Injection Pressure(B15)

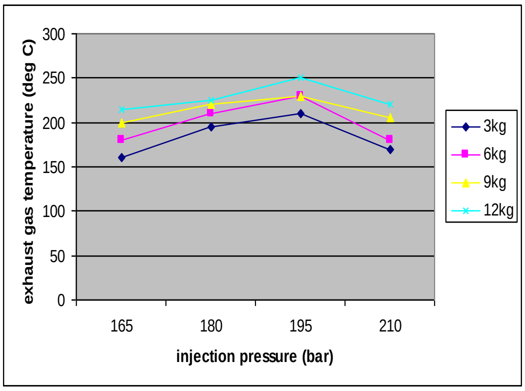

Fig 12. Variation of T_{exg} with Injection Pressure(B20)

IV. CONCLUSIONS

In this present work investigations on a single cylinder four stroke water cooled diesel engine with Palmstearin oil-Diesel blends (B10, B15, and B 20) at different fuel injection pressures 165 bar, 180 bar, 195 bar and 210 bar, the performance characteristics like brake thermal efficiency, brake specific fuel consumption and exhaust gas temperatures are investigated. It is concluded that at 195 bar fuel injection pressure, the performance characteristics are observed to be better. Maximum brake thermal efficiency observed is 47% with 20% blend at an injection pressure of 195bar. Lower specific fuel consumption (0.2 kg/kw-hr) is observed with 20% blend at an injection pressure of 195bar. Palmstearin can be substituted for diesel blending in small proportions with diesel without any modifications.

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