An Experimental Investigation On Diesel Engine With Palmstearin-Diesel Blends At Different Injection Pressures

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ABSTRACT

Present work describes the experimental investigations carried on a four stroke single cylinder water cooled Kirloskar diesel engine with vegetable oil-diesel blends. Palm stearin oil is blended with diesel in varying proportions like (B10, B15, 20) 10%, 15% and 20% and experiments were carried out by varying the injection pressures from 165 bars to 210 bar. The performance characteristics like brake thermal efficiency, brake specific fuel consumption and exhaust gas temperatures were 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 45% with 20% blend at an injection pressure of 195bar and lower specific fuel consumption observed is 0.25 kg/kw-hr with 20% blend at an injection pressure of 180bar. **Keywords:** injection pressure, palmstearin, brake power, specific fuel consumption, compression ignition.

Notation: BTE: brake thermal efficiency Texg: exhaust gas temperature BSFC: brake specific fuel consumption.

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.

Sukumar Puhan et.al [1] investigated high linolenic linseed oil methyl ester 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. They found the optimum fuel injection pressure as 240 bars with linseed methyl ester. At this optimized pressure the thermal efficiency was close to diesel and a reduction in carbon monoxide, unburned hydrocarbon and smoke emissions with an increase in the oxides of nitrogen was noticed compared to diesel. The combustion analysis showed the lower ignition delay at higher injection pressures compared to diesel. They concluded that linseed methyl ester at 240 bar injection pressure was more efficient than 200 and 220 bar, except for nitrogen oxides emission. Rosli Abu Bakar et.al [2] studied effect of injection pressure on performance of diesel engine with four-cylinder, two-stroke, direct injection by changing the fuel injection pressure from 180 to 220 bar. According to the results, the best performance of the pressure injection has been obtained at 220 bars, specific fuel consumption has been obtained at 200 bars for fixed load – variation speeds and at 180 bar for variation loads – fixed speed.

Can Cinar [3] et.al in their study, used carbon dioxide (CO_2) as a 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 CO_2 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 test results demonstrated that NOx was reduced by the introduction of CO_2 in the inlet charge. The performance of a diesel engine using biodiesel from refined palm oil stearin [4] obtained the following results. 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[5].The effects of injection pressure on engine performance and exhaust emissions on a turbocharged diesel engine with 4-cylinder, 4-stroke, indirect injection were investigated[6]. 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. They concluded that maximum performance was obtained at 150 bar and high injection pressure for O_2, SO_2, and CO_2, low injection pressure for NOx, and smoke level could be preferred for decreasing emissions.

EXPERIMENTAL

The engine used was a four stroke, single cylinder, water cooled Kirlosker diesel engine. It was 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 in Table1.

Table 1. Specifications of test engine

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

Engine was loaded mechanically with rope brake dynamometer and speed was kept constant at 1500 rpm. By varying the injection pressure from 165 bar to 210 bar tests were 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%. The properties of test fuels are shown in Table2.

Table 2. Properties of test fuels

Property	Density	Kinematic Viscosity	Flash point(°C)	Fire point(°C)
Diesel	0.83	3.15	60	62
B10	0.835	6.243	58	68
B15	0.836	6.547	62	70
B20	0.838	6.898	64	72

RESULTS AND DISCUSSION

The results obtained from the tests conducted on four stroke single cylinder water cooled diesel engine with palmstearin-diesel blends were 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.

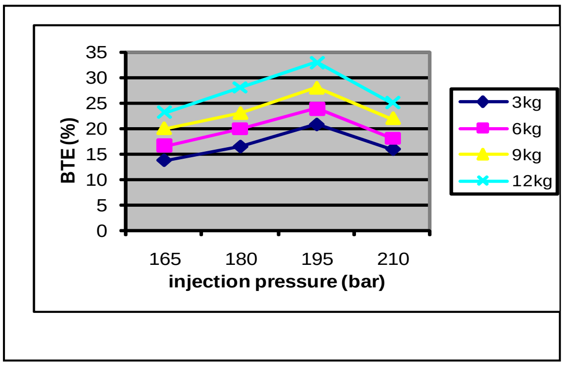

Fig1. Variation of BTE with Injection Pressure (pure diesel)

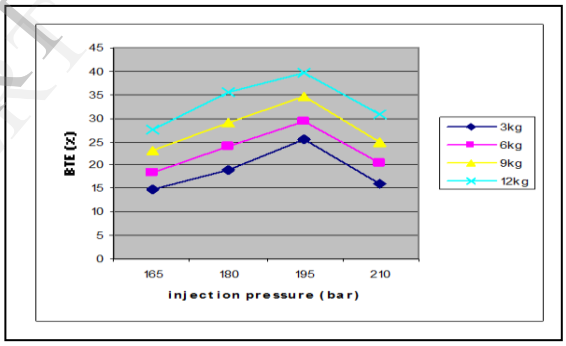

Fig2. Variation of BTE with Injection pressure (B10)

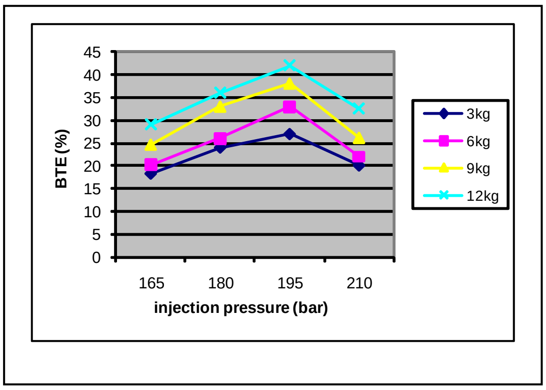

Fig3. Variation of BTE with Injection Pressure (B15)

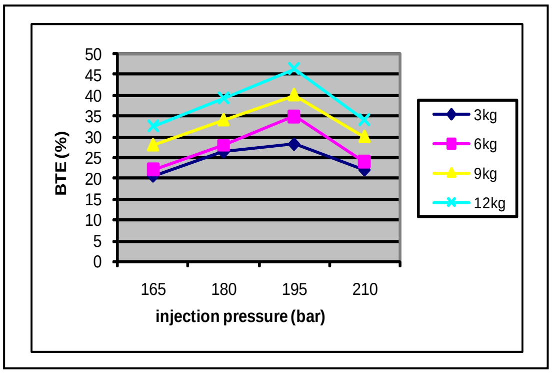

Fig4. Variation of BTE with Injection Pressure (B20)

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 was observed to be better.

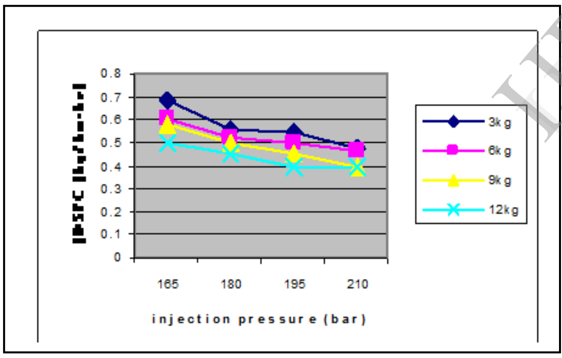

Fig5. Variation of BSFC with Injection Pressure (pure diesel)

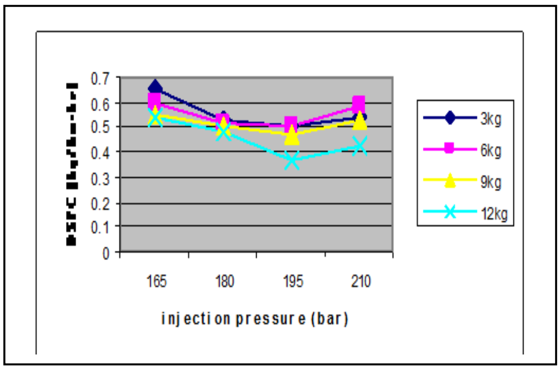

Fig6. Variation of BSFC with Injection Pressure (B10)

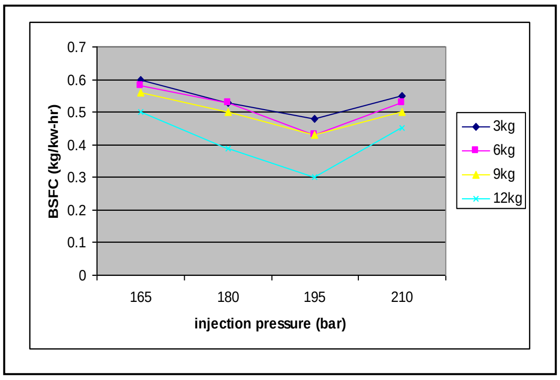

Fig7. Variation of BSFC with Injection Pressure (B15)

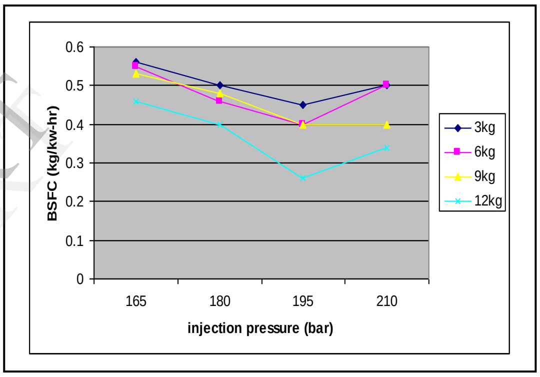

Fig8. Variation of BSFC with Injection Pressure (B20)

Figures 9-12 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 attributed to be 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.

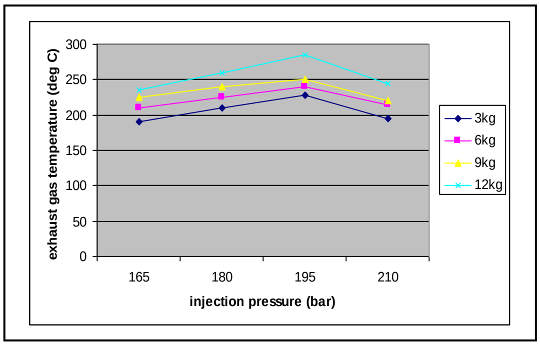

Fig9. Variation of T exg with Injection pressure (pure diesel)

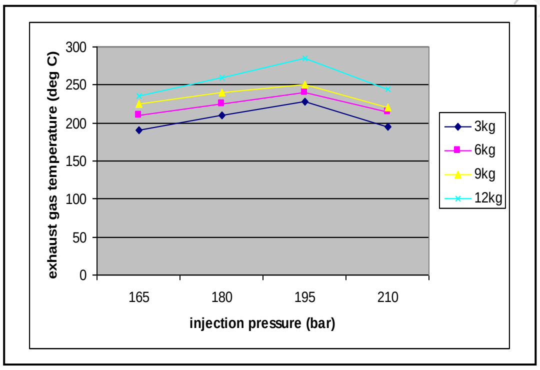

Fig10. Variation of Texg with Injection Pressure (B10)

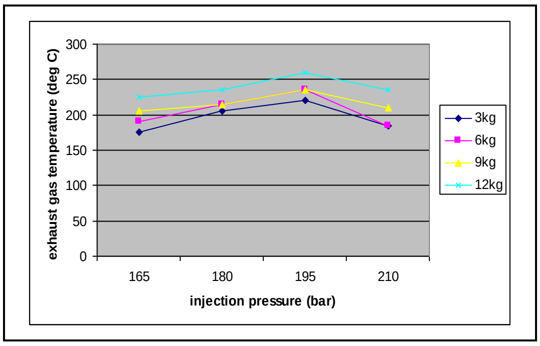

Fig11. Variation of T exg with Injection Pressure (B15)

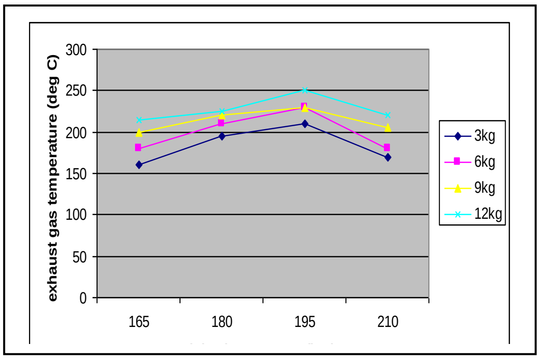

Fig12. Variation of T exg with Injection Pressure (B20)

CONCLUSIONS

The principal conclusions drawn from present investigations on 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 are as follows

At 195 bar fuel injection pressure, the performance characteristics are observed to be better. Maximum brake thermal efficiency observed was 45% with 20% blend at an injection pressure of 195bar. Lower specific fuel consumption (0.25 kg/kw-hr) was observed with 20% blend at an injection pressure of 180bar. Palmstearin can be substituted for diesel blending in small proportions with diesel without any modifications.

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