Review on Effect of Varying Injection Pressure and Injection Timing on Performance and Emissions of Diesel Engine operating on Diesel/Biodiesel

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Abstract: - **Pollutant emissions and fossil fuel depletion from diesel engine has made research for alternative fuel much rigorous. Research on alternatives like alcohols, vegetable oils and biodiesel (used in original forms or blended with diesel) has been done at much depth. Along with alternate fuel, engine performance and emissions are also affected by various engine operating parameters. The present paper presents a review on effects of varying injection pressure and injection timing. Results on three alternative fuels have been presented with a view to compare the effects. Effects on brake thermal efficiency, peak cylinder pressure and NO emissions have been studied and presented. Increasing injection pressure and injection advance increases brake thermal efficiency, peak cylinder pressure as well as NO emissions. The optimum conditions for engine operating on diesel is 500bar/15^{0}BTDC and biodiesel is 280 bar/25.5^{0}BTDC. Further increase in injection pressure and timings decreases brake thermal efficiency and cylinder peak pressure.**

Index Terms: Injection Pressure, Injection Advance, Brake Thermal Efficiency, Peak Pressure, NO emissions

I. INTRODUCTION

Use of compression ignition engines has become much popular for automotive applications owing to excellent fuel efficiency and durability. However emissions from diesel engines have faced stringent emission policies due to adverse effect on human health. In recent years, search for alternate diesel engine fuel has been much more focused owing to pollutant emissions, depletion of fossil fuel and environmental degradation. Many alternative solutions viz. use of alcohols, vegetable oils, blend of diesel and alcohols, biodiesel have been studied in detail. Of all the alternatives, biodiesel has been proved to be most promising due to its advantages like low emissions, biodegradable and non-toxic. Additionally, its cetane number matches most closely with diesel.

Combustion, performance and emissions from engine depend on number of engine operating parameters like compression ratio, injection rate, injection swirl, injection pressure and injection timing. Ignition delay and combustion characteristics of engine and hence overall efficiency are significantly affected by injection pressure and injection timings. The present paper presents effect of these parameters on following alternatives:

(a) 100% diesel

(b) 100% biodiesel [biodiesel from waste cooking oil]

The paper aims to provide base for comparison of effects of change in injection pressure and timing on the above three alternatives. Effect on brake thermal efficiency, cylinder peak pressure and NO emissions are studied and discussed.

1. Test Conditions

	Sample 1 (100% diesel) [1]	Sample 2 (100% biodiesel) [3]
Cylinder bore/stroke	85mm/90mm	87.5mm/110mm
Compression ratio	17.5	17.5
Speed	4200 rpm	1500 rpm
Injection pressure range	500 bar and 1000 bar	220 bar to 300 bar (in steps on 20 bar)
Injection timing range	15^0 BTDC to 9.375^0 BTDC for 500 bar pressure 9.375^0 BTDC to 4.875^{0}BTDC for 1000 bar	23^0, 25.5^0 and 28^0 BTDC

Table 1. Test Conditions.

II. EFFECT ON BRAKE THERMAL EFFICIENCY

The results of effect on brake thermal efficiency are presented in following graphs (Figure 1& 2).For 100% diesel, brake thermal efficiency was observed to be increasing with increase in injection advance timing. However as injection pressure increased, BTE was observed to decrease. For advanced injection timings, more amount of evaporated fuel accumulates during

ignition delay and burns quickly resulting in rapid heat release rate. Reduction in efficiency due to increase in injection pressure is due to small droplet size and higher jet penetration resulting in enhanced mixing and reduced ignition delay. In case of 100% biodiesel, the efficiency was maximum at 280 bar, 25.5^0BTDC. Further advancement of injection timings lead to fuel injection at low temperature which lead to poor combustion.

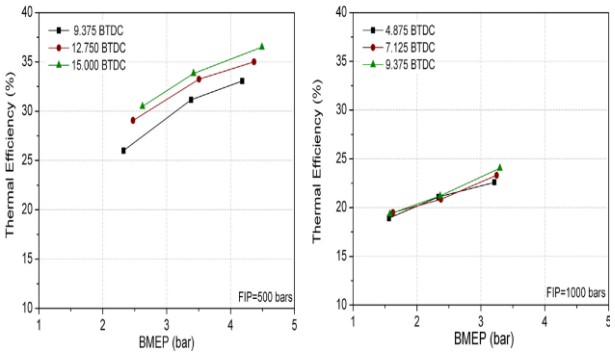

Fig 1: Effect on brake thermal efficiency for sample 1 [1]

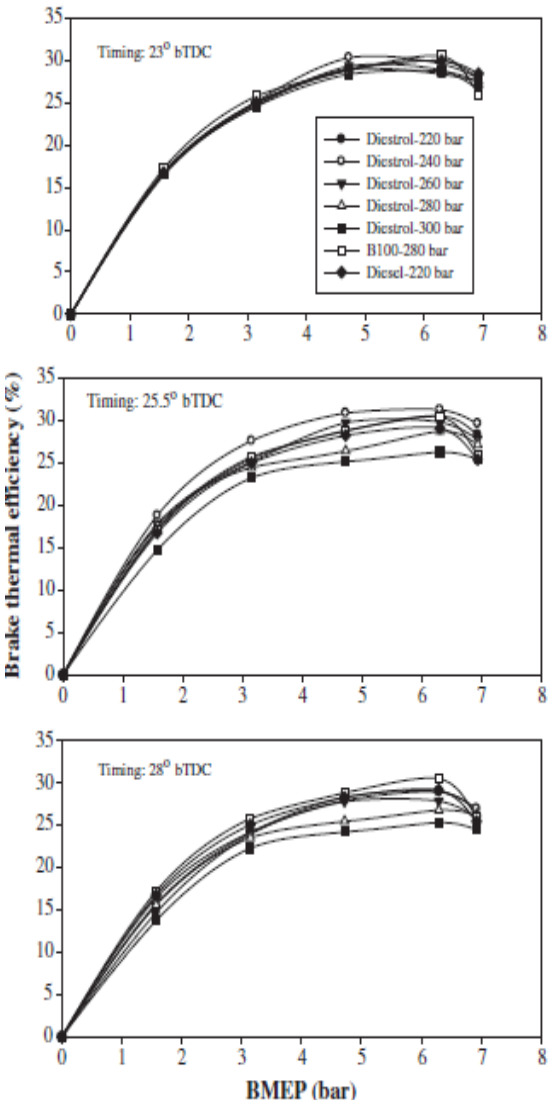

Fig: 2-Effect on brake thermal efficiency for sample 2 [3]

III. EFFECT ON PEAK CYLINDER PRESSURE

Figure 3 and figure 4 represent the effect on peak cylinder pressure. It can be observed from graphs that for diesel peak pressure increased with increase in injection timing. Advancing the timing leads to longer ignition delay and hence better combustion and maximum pressure. However increase in injection pressure produced knocking conditions with increase in injection timing. The reason for the same is smaller droplet size and more accumulation of unburnt droplets. Too high injection pressure and timing has no considerable improvement due to delayed injection and hence increase in ignition delay. For 100% biodiesel, optimum conditions were 280 bar, 25.5^0BTDC

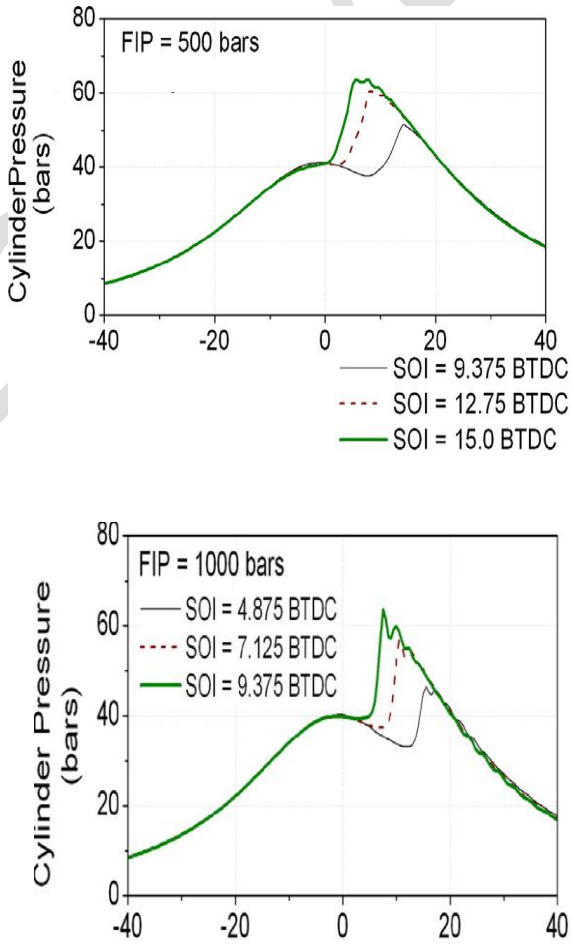

Fig 3 - Effect on peak cylinder pressure for sample 1 [1]

IV. EFFECT ON NO EMISSIONS

Figure 5 and figure 6 represent the effect on NO emissions. NO emissions depend on in-cylinder temperature, oxygen concentration and residence time for reaction to occur. The emissions were observed to increase with increase in fuel injection pressure and injection timing in all three samples. The reason attributed for the same is faster combustion and higher peak pressure and temperature.

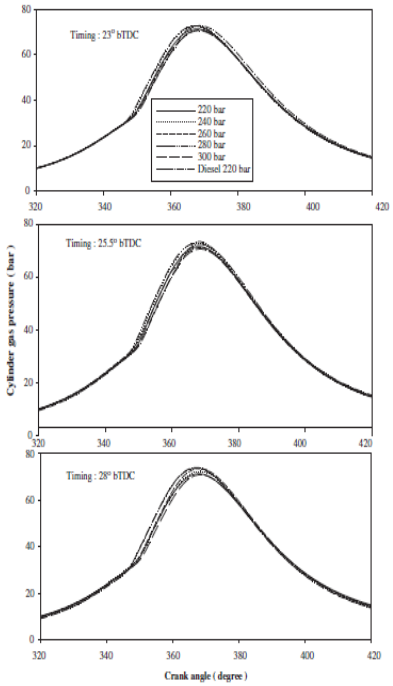

Fig 4 - Effect on peak pressure for sample 2 [3]

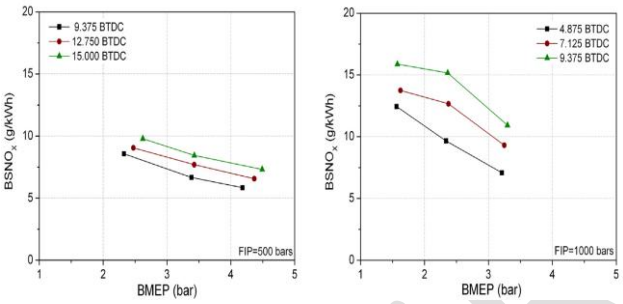

Fig 5 - Effect on NO emissions for sample 1 [1]

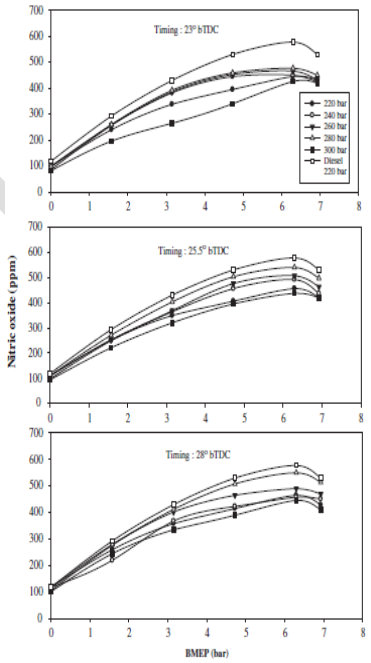

Fig 6 - Effect on NO emissions for sample 2 [3]

CONCLUSIONS

Increasing injection advance, until an optimum value increases brake thermal efficiency, due to higher accumulation of evaporated fuel in cylinder. Further increasing advance decreases efficiency due to unfavorable conditions for combustion. Similarly increasing injection pressure until an optimum value improves brake thermal efficiency. Further increase reduces efficiency due to less droplet size and enhanced mixing.

Cylinder peak pressure increases with increase in injection advance and injection pressure until an optimum value due to longer ignition delay and proper mixing. Further increase in both values is not favorable due to much longer ignition delay.

NO emissions increase with increase in injection advance and injection pressure due to higher pressure and temperature and more reaction time available.

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