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Analyzing the influence of varied fuel injection pressure on diesel engine fueled with Karanja biodiesel

L. Karikalan *, S. Jacob, S. Baskar, S. Venugopal

Department of Automobile Engineering, Vels Institute of Science, Technology & Advanced Studies (VISTAS), Chennai, India

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ABSTRACT

Performance and pollutants of diesel engines largely rest on factors like fuel injection pressure, number of injections, fuel quantity injected, state of injection, combustion chamber design and nozzle spray patterns. The intention of this effort is to evaluate the diesel engine performance and pollutant features by changing the biodiesel fuel injection pressures. Based on these, the features such as BTE, SEC, CO, HC, NO_X and smoke emissions in exhaust were recorded. The results show that the biodiesel can be utilized as substitute fuel successfully in a CI engine at optimum fuel injection pressure with no major engine alteration.

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1. Introduction

Fuel and energy issues are the concern of humanity and it initiate various sectors to look for alternative fuels. These circumstances encouraged the researchers to seek for substitute renewable/sustainable fuel as an alternative of diesel fuel. The use of biodiesel as substitute fuel for the CI engine started due to the environmental degradation and global warming [1–3]. Biodiesel is chosen as substitute fuel which develops the ecological condition and contributes to gain energy availability. The use of biodiesel blend does not necessitate any alteration in the engine and in fewer cases minor changes are essential for the utilization of pure 100% biodiesel. Tailpipe emission of CI engines working on biodiesel and its blend with diesel have been noticed that reduction in CO, HC, PM emissions and smoke, along with rise in NO_X have been observed in the exhaust [4–6]. Normally high fuel consumption and lesser power output attained with biodiesel due to biodiesel's lesser heating value. The common trends for CO emission are to diminish because of O_2enhancements that come from the biodiesel, assists for total combustion [7].The current study is a tryout to examine experimentally the consequence of changing the fuel injection pressure on a CI engine fueled with Karanja biodiesel for both the engine performance and pollutants.

2. Materials and methods

Biodiesel can be formed by a range of esterification technology. Esterification is the result of an acid with an alcohol in the existence of a catalyst to figure an ester. The karanja oil was transformed to methyl esters by means of transesterification. High fuel injection pressure is utilized to decrease droplet size of the fuel injected and permit the use of inlet air for improved air entrainment leads to perfect combustion [8–10]. Usually the smaller fuel size will give the better combustion. The high injection pressure also lessens the emission. In this study, the performance of Karanja methyl ester mixed with diesel in ratio of 20% (B20) was investigated by changing the fuel injection pressure in terms of performance and pollutants in a 4 S single-cylinder DI diesel engine.

3. Experimental setup

After the completion of forming required biodiesel blend, it is experienced in the KIRLOSKAR SV1 single cylinder, water cooled, 4 S, DI diesel engine by varying the fuel injection pressure in terms of 180, 190, 200, 210, 220 and 230 bar. The load is changed by the load cell for loading the engine. The test engine is run with the varied fuel injection pressures and the time taken for 10 cc fuel utilization is considered. The measurements are done and the

* Corresponding author.
E-mail address: karilk2005@yahoo.co.in (L. Karikalan).

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Table 1
Engine specifications.

Make & model	KIRLOSKAR, SV1
Power output	6.02 kW at 1800 rpm
Compression ratio	17.5:1
Bore × Stroke	87.5 mm × 110 mm
Cooling method	Water cooled
Injection timing	23° btdc

values are listed for BTE and SEC. AVL 444 gas analyzer is utilized to assess the emission from tail pipe. The engine specification is listed in the Table 1 and the experimental set-up is displayed in the Fig. 1.

4. Result and discussions

4.1. Brake thermal efficiency

The change in BTE for biodiesel blend against the brake power is exposed in Fig. 2. In every case the BTE is improved with the raise in load with increased nozzle pressure. This could be endorsed to reduced heat loss and increased power with the raise in load. The increase in BTE for B20 at 200 bar might be owing to enhanced atomization and vaporization of biodiesel at high injection pressure, ensuing in improved combustion and thus increases the brake thermal efficiency.

4.2. Specific energy consumption

The change in SEC for biodiesel blend against the brake power is displayed in Fig. 3. For every case, SEC reduced with increased load. The reverse tendency in the SEC might owe to rise in biodiesel in the blend ensuring lesser calorific value of the fuel. The decrease in SEC might be owing to enhanced atomization and vaporization of biodiesel at 200 bar injection pressure than the other two nozzle opening pressures.

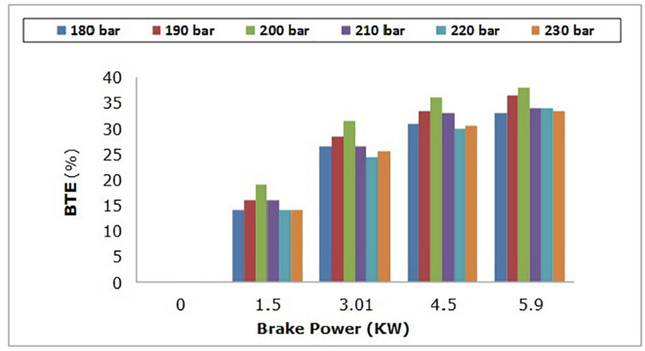

Fig. 2. BTE vs. BP.

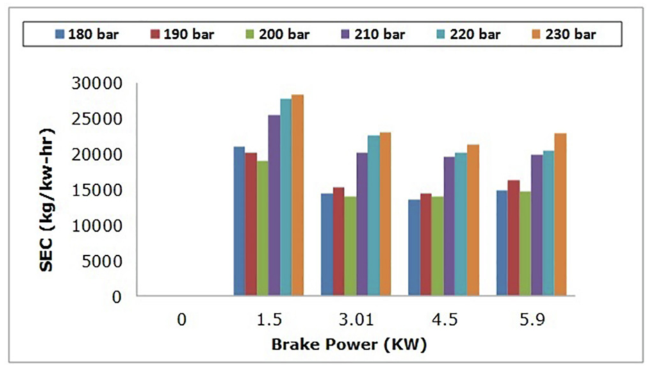

Fig. 3. SEC vs. BP.

4.3. Hydrocarbon emission

The change in HC for biodiesel blend against the brake power is displayed in Fig. 4. The decrease in HC emission for B20 at 200 bar

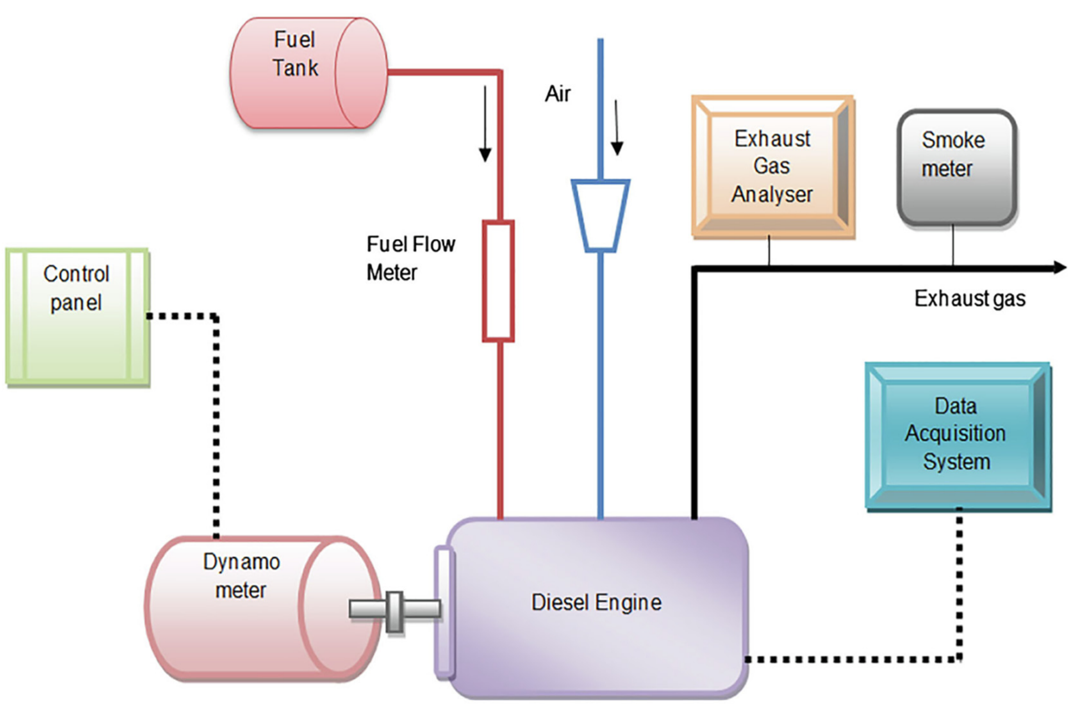

Fig. 1. Experimental set- up.

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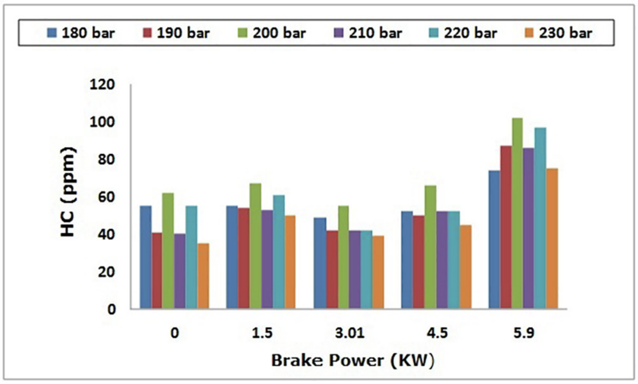

Fig. 4. HC vs. BP.

might be owing to enhanced vaporization of biodiesel fuel at high injection pressure and more O_2 presence in the biodiesel, ensuing in absolute combustion.

4.4. Carbon monoxide emission

Fig. 5 displayed the CO emissions of biodiesel blend operation at dissimilar load condition. The decline in CO emission for biodiesel is owing to more oxygen molecules presence in the fuel and more fuel atomization. The decrease in CO emission for B20 at 200 bar may be due to enhanced vaporization biodiesel at high injection pressure and more O_2 presence in the biodiesel, ensuing in perfect combustion.

4.5. Nitrogen oxide emission

The change in NO_X emissions at dissimilar engine load and varied injection pressures are displayed in Fig. 6. This increased NO emission for B20 at 180 bar might be owing to more O_2 atoms presence in the biodiesel and improved atomization of biodiesel by the high injection pressures resulting in high NO_X emissions.

4.6. Smoke emission

The change in smoke emission at dissimilar engine loads and varied injection pressures are displayed in Fig. 7. The decrease in smoke for biodiesel blend at 200 bar might be owing to improved atomization and vaporization of biodiesel at high injection pressure and more O_2 presence in the biodiesel, resulting in total combustion.

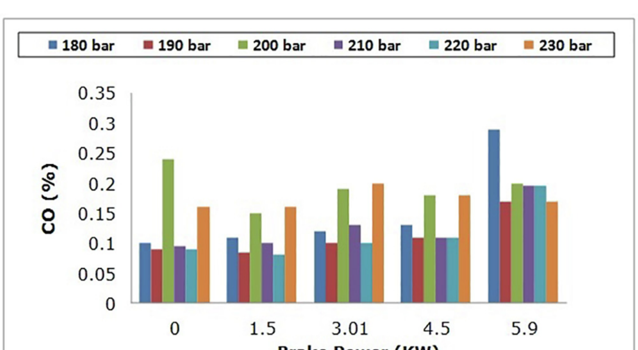

Fig. 5. CO vs. BP.

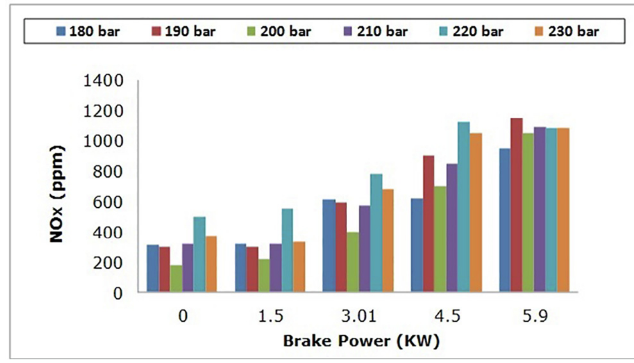

Fig. 6. BTE vs. BP.

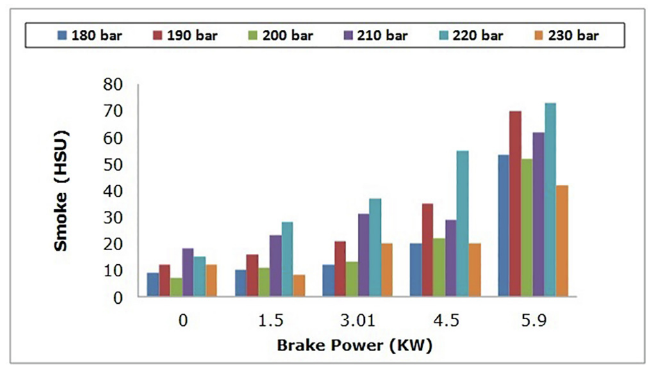

Fig. 7. Smoke vs. BP.

5. Conclusions

- Performance of engine was greater at lesser fuel injection pressures leads to lesser SEC. Cylinder pressure enlarged with increased engine load and increased injected fuel size, which burnt more competently therefore SEC decreased.
- Observed improved brake thermal efficiency at all engine loads. BTE was considerably low at very higher fuel injection pressures.
- Lesser emission of CO, HC, NOx and Smoke was observed at lower fuel injection pressures.
- HC and CO emission reduced with increased fuel pressure owing to better air/fuel integration in the burning chamber.
- NOx emission enlarged considerably with increased fuel pressure throughout premixed burning phase.

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