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COMBUSTION CHARACTERISTICS OF A DI DIESEL ENGINE FUELED WITH SAFFLOWER METHYL ESTER

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ABSTRACT

The performance of safflower methyl ester and its blend with diesel in a Kirloskar engine has been presented in this paper. Engine performance (brake specific fuel consumption, and brake thermal efficiency) and combustion were analyzed, evaluate and compute the behavior of the diesel engine running on safflower methyl ester. The reductions in brake specific fuel consumption and increasing of brake thermal efficiency together with increase brake power, makes the blend of safflower methyl ester a suitable alternative fuel for diesel

Key words: Safflower methyl ester, Engine performance, Combustion.

INTRODUCTION

The realization that conventional fossil fuels are non-renewable has led to search for more environment friendly and renewable fuels. Among various options investigated for diesel fuel, biodiesel obtained from vegetable oils has been recognized by the world. Several countries including India have already begun substituting the conventional diesel by a certain amount of biodiesel. Worldwide biodiesel production is mainly from edible oils such as soybean, sunflower and canola oils. Some edible oil and non edible seeds available are required to be tapped for biodiesel production. With abundance of forest and plant based edible oils being available in country such as Pongamia pinnata (karanja), Jatropha curcas (Jatropha), Madhuca indica (mahua), Shorea robusta (Sal), Azadirachta indica A Juss (neem) and Hevea braziliensis (rubber). Not much attempt has been made to use esters of these non-edible oils as substitute for diesel except Jatropha. Moreover, there are plenty of wastelands available in worldwide, which can be utilized for growing such oil seed crops. Few investigators have already obtained biodiesel from some of these oils[1-5]. As compared to

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other edible oils, not much work has been reported on biodiesel production from safflower oil. In the light of the above facts, present study was undertaken at Anna University, Chennai, India to determine the suitability of Safflower methyl ester as a substitute for diesel.

Safflower

The fuel used in this study is the safflower methyl ester extracted from safflower seeds. The neat safflower plant can be grown in any waste land with average rainfall availability 500-2500 mm. The plant starts yield from 3 to 4 tons per acre. There are various stages in production of safflower oil from the plant. By the transestrification of Safflower oil with methanol, Safflower Methyl Ester is produced.

Transestrification

A 500 mL round bottom flask equipped with magnetic stirrer, thermometer and condenser with guard tube to prevent moisture entering into the system was heated to excel residual moisture. After cooling, 200 mL of Safflower oil was added in the flask. It was stirred and heated to 60ºC in which recently prepared sodium hydroxide [1 g] along with methanol was added rapidly. The stirring was continued in the above temperature for two hours. Two layers were observed clearly on cooling. The top layer was safflower methyl ester and bottom layer was glycerol. The safflower methyl ester was neutralized by diluted acetic acid and washed with distilled water.

EXPERIMENTAL

Instrumentation

The performance of prepared safflower methyl ester was studied in comparison with diesel fuel. The obtained safflower methyl ester was used in a single cylinder diesel engine. The single cylinder diesel engine used for the study was Kirloskar direct injection engine. The operating conditions are 25%, 50%, 75% and full load at a speed of 1500 rpm. The performances and emissions characteristics of the engine fuelled with Diesel, B20, B60 and B100 are tested

Engine performance

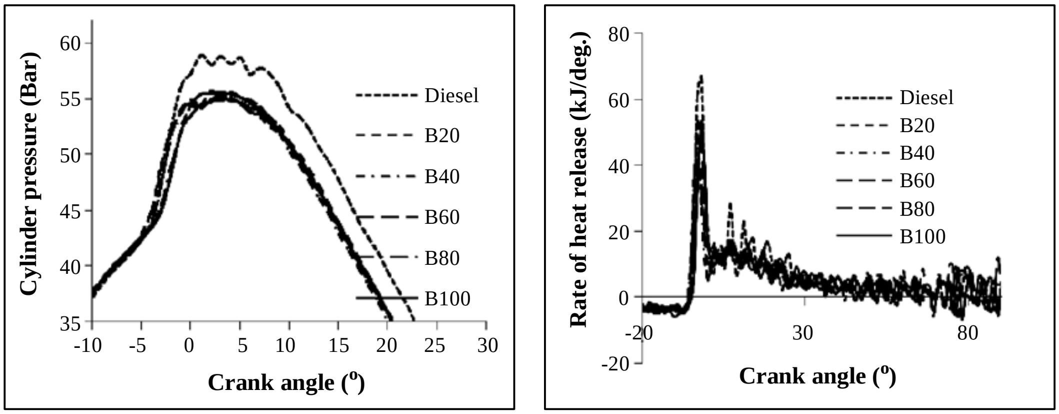
The safflower methyl ester (B100), diesel and their blends (B20, B40, B60 and B80) were used to test a single cylinder, four stroke, air cooled Kirloskar engine at a compression ratio of 17.5:1 and injection timing of 23° before TDC with a rated output of 4.4 kW at 1500 rpm. The performance of the engine and combustion characteristics were studied at 25%, 50%, 75%, and 100% of the load corresponding to the load at maximum power at an average speed of 1500 rpm. After the engine reached the stabilized working condition, combustion characteristics were analyzed.

RESULTS AND DISCUSSION

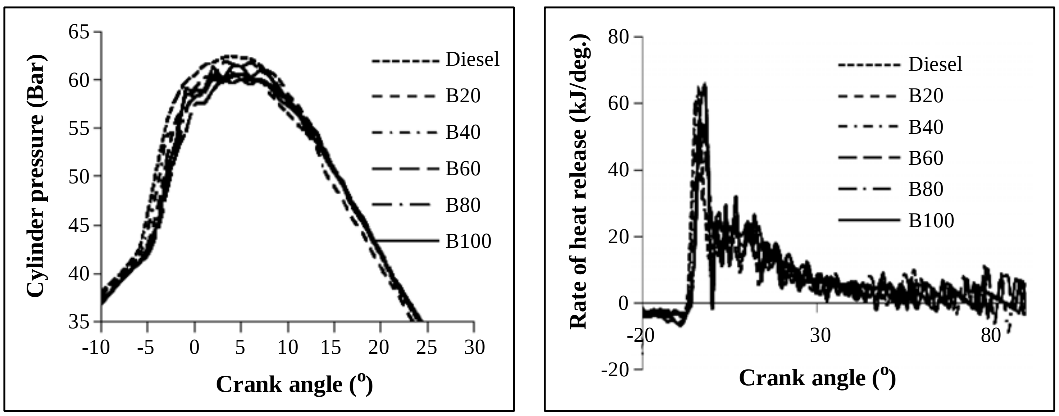
Combustion characteristics

The in-cylinder pressure and heat release rate, for the different fuels, are compared in Fig. 1 for the engine loads of no load,25% load,50% load,75%load and full load condition respectively. It can be seen from the figure that, at the same operating condition, the in-cylinder pressure curves of safflower methyl ester are similar to that of diesel fuel. With increase in engine load, there is a corresponding increase in the maximum in-cylinder pressure, while the maximum pressure occurs further away from the top dead centre (TDC) with increase in engine load. The heat release rates of all the fuels have similar shape; having a premixed combustion phase followed by a diffusion combustion phase[6]. It can be found that the premixed combustion phase for all the fuels is shortened, while the diffusion combustion phase is lengthened, with the increase of engine load. The maximum heat release rate increases with an increase in engine load from low to the medium, but decreases at high engine load for all fuels, which is similar to the results of Lu et al.[7]

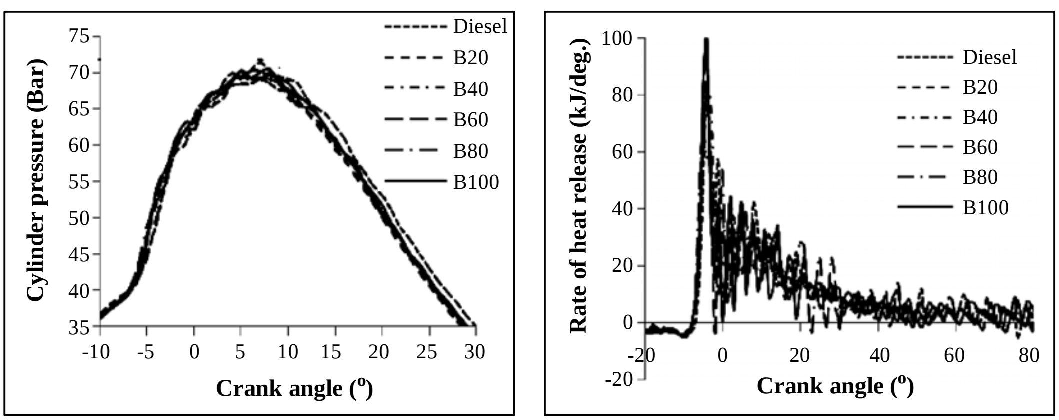
Moreover, with increase of engine load, the maximum heat release rate occurs slightly closer to the TDC, which is opposite to that of the in-cylinder pressure. Compared with diesel fuel, safflower methyl ester gives almost the same level of maximum pressure at low and medium engine loads, but higher maximum pressure at the high engine load[6]. For Safflower Methyl Ester, the maximum heat release rate at the premixed combustion phase is lower than that of diesel fuel in all test modes, and occurs earlier. While the heat release rate of diffusion combustion phase is higher for safflower methyl ester, in comparison with that of diesel fuel, especially at the high engine load. This trend is similar to that of Yu et al.[8] Safflower Methyl Ester vaporizes more slowly than diesel fuel and contributes to less air–fuel mixture prepared for combustion in the premixed phase[9]. In addition, safflower methyl ester injected into the engine cylinder could form gaseous compounds of low molecular weight through thermal cracking[9]. The gaseous compounds could be ignited earlier, leading to earlier ignition timing. In order to understand the combustion characteristics, another combustion parameter is obtained based on the heat release analysis. Fig. 1 shows the effect of different fuels and engine loads on the crank angles corresponding to 10%, 50% and 90% of the total heat release. As seen in the figure, all the B60 and B80 blends give faster combustion in all test modes than diesel fuel, which could compensate the initial ignition delay in start of combustion. Also, the faster combustion process in each stage could lead to the increase in brake thermal efficiency (BTE).



At no load condition



At 25% load condition



At 50% load condition

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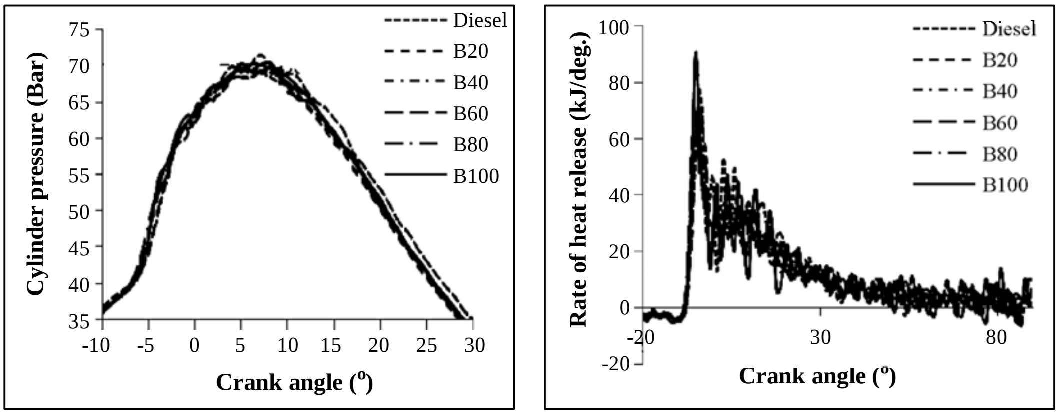
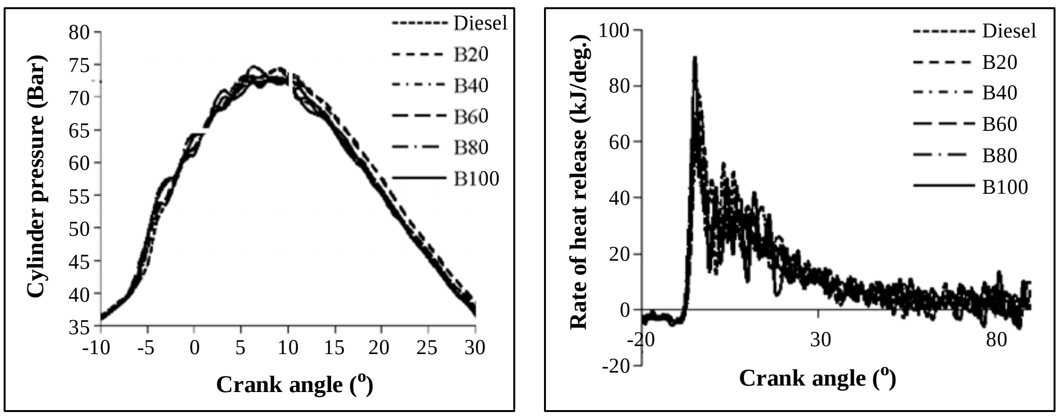


At 75% load condition



At full load condition

Fig. 1: In cylinder pressure and rate of heat release

CONCLUSION

The result obtained with various engine loads at constant engine speed can be summarized as follows. Based on all these detailed combustion investigation, it can be concluded that safflower methyl ester has the capability to replace petroleum diesel in near future.

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