International Journal of
Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

Vol.3, Special Issue 1 Aug - 2017

Comparison of Combustion Characteristics of CI Engine-Fueled with Simarouba and Pongamia Biodiesels

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ABSTRACT

The present work is carried out on Simarouba and Pongamia biodiesels for the best performance as an alternative fuels used in Internal Combustion (IC) engine. The biodiesels were prepared by transesterification route as per standard. The combustion characteristics evaluated by considering the parameters like ignition delay, peak pressure development, heat generation rate for biodiesel 20% blend with commercial diesel on single cylinder water cooled diesel engine with constant speed of 1500 rpm. The analysis of P-θ diagrams gave the combustion delay, magnitude of premixed, mixed controlled and late combustion phases. The investigation of combustion of biodiesels revealed that ignition delay is almost same to the pure diesel and the peak pressure attains after TDC are also comparably same as diesel. The B20 of Simarouba and Pongamia biodiesels are emerged as better alternative fuel for an existing CI engine in comparison with other blends.

Keywords*: Simarouba, Pongamia, Ignition Delay, Peak pressure.*

1.0 INTRODUCTION

Energy is one of the most significant material in all fields, including agriculture, industry, and automobiles sectors etc. particularly transportation needed in petroleum energy. Unfortunately no one technology meeting the demand of petroleum fuels. Countries like India manufacture and use enough automobiles but need of fuels to run automobiles almost of all countries depends on the Arab oil resources, means maximum quantity of petroleum fuel importing from other countries. Fast depletion of petroleum resources make us to move towards the research to find some alternative fuels.

Alternate fuels for automotive is biodiesels, because of it appreciable properties and performance as compare with pure diesel. The biodiesel holds the promise of replacing the conventional diesel [1]. These biodiesels have similar behavior when compare with the combustion characteristics. The current investigation objective is the study of combustion characteristics of B20 biodiesels and comparing with diesel fuel.

PONGAMIA AND SIMAROUBA:

Pongamia seeds almost available in all parts of India and yield will starts from 4-5 years of plantation, single tree able to yield upto 9 to 50 kg of seeds. It grown well in the wastelands of Orissa, Karnataka, Gujarat, Andhra Pradesh, Bihar, Chhattisgarh, Maharashtra and Tamil Nadu are potential states where it can be grown successfully. Simarouba tree can grow well in tropical climate with the temperature ranges from 10˚C-40˚C. The rainfall of 700-1000 mm is suitable for its normal growth. All types of well-drained soil having pH range 5.5 to 8.0 are suitable for simarouba plantation. It is most commonly used and important method to reduce the viscosity of vegetable oils.

2.0 ENGINE EXPERIMENTAL SET-UP AND TEST METHOD

A Four Stroke Single Cylinder vertical water cooled engine developing a power of 3.7 kW at the rated speed of 1500 rpm was used for experimentation. The engine was coupled with eddy current dynamometer. The block diagram of experimental apparatus is shown in Fig.1. The all results studies at 25%, 50%, 75% and 100% full load condition by taking Pongamia and Simarouba biodiesel B20 blends with neat diesel. But combustion characteristics made for 100% load.

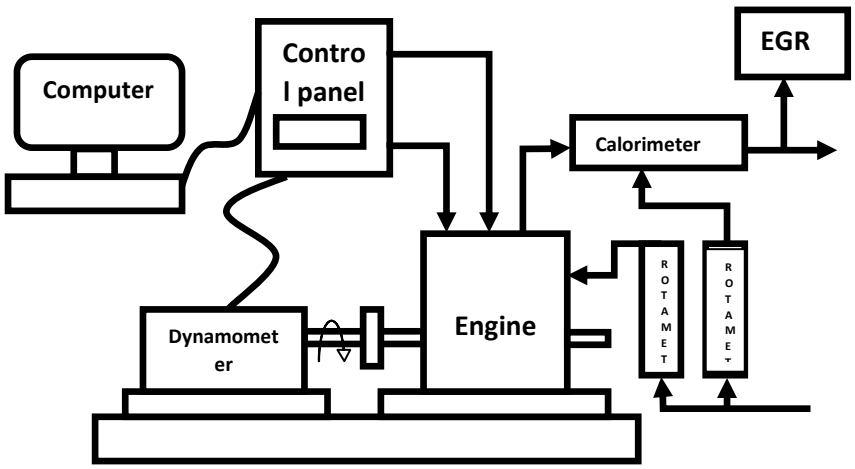

Fig. 1: Schematic diagram of test rig

3.0 RESULTS AND DISCUSSION

Worldwide, many researches are investigating on about the different biodiesels. Biodiesel is an esterified version of vegetable oil, which could be edible or non-edible. Neat biodiesel (100%) can blended at any level with diesel to create biodiesel blends. Just like diesel the biodiesel blends operates on CI engine without any modifications on engine. The performance what it get from biodiesel blends is almost near to commercial biodiesel. Also the use of biodiesel in CI engine results in reduction of unburned hydrocarbons and oxides of carbon. The effect of Pongamia and Simarouba biodiesel on performance and emissions are discussed in following sections.

3.1 Performance characteristics

Performance of the engine is defined as the degree of success in assigned work i.e., the conversion of heat energy into mechanical energy. The performance of the engine is measured by some parameters like Brake thermal efficiency and Brake specific fuel consumption. Here the study made for 100% load and with biodiesel blend B20 and its compared with diesel.

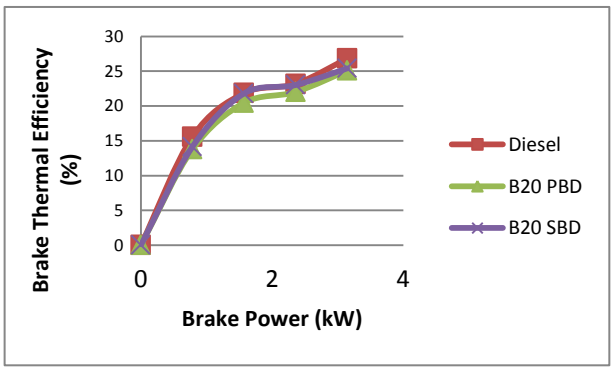

Fig. 2: Variation of Thermal efficiency with BP

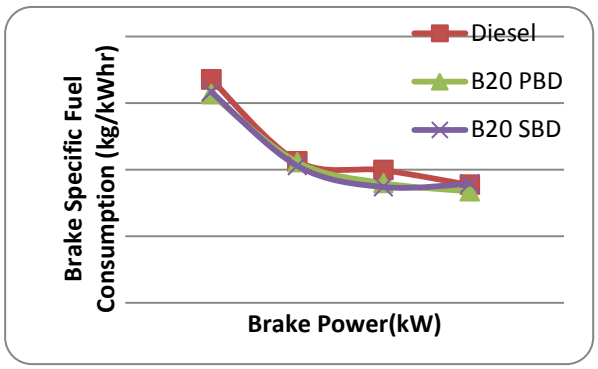

Fig. 3: Variation of BSFC with BP

The Fig. 2 shows the variation of brake thermal efficiency with brake power. It was observed that, with the increase of the brake power the brake thermal efficiency increased for B20 biodiesels and diesel. The brake thermal efficiency for diesel is more than both biodiesel blends because of higher calorific value of diesel [5]. The simarouba biodiesel blend is almost close to diesel with only 5% difference is noticed.

The Fig. 3 depicts brake specific fuel consumption (BSFC) with brake power, it is observed that the specific fuel consumption decreased with the increase of brake power. The specific fuel consumption is mainly depends on the mass flow rate and viscosity of fuel. Here BSFC of biodiesel blends is higher than the pure diesel in full load conditions due to higher viscosity of the biodiesel blends [4]. BSFC curve for both biodiesels almost overlapped but slightly less in compare to diesel.

3.2 Emission characteristics

Internal combustion (IC) engine generates undesirable emissions during the combustion process. The major causes of these emissions are non-stoichiometric combustion, dissociation of nitrogen and impurities in the fuel and air. The main emission of concern of Oxides of Carbon (COx), Oxides of Nitrogen (NOx), Unburned Hydrocarbons (UBHC), etc. Results and effects obtained from emission test on using Pongamia and Simarouba biodiesels with different loads are discussed in following sections.

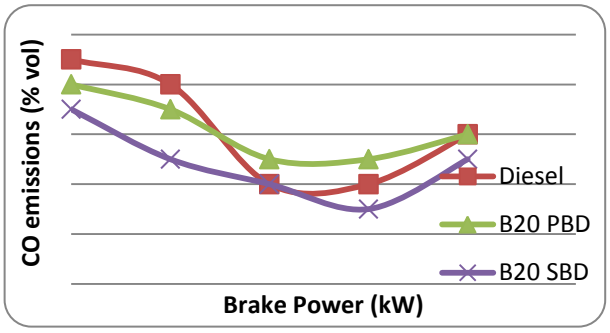

Fig. 4: Variation of CO emission with BP

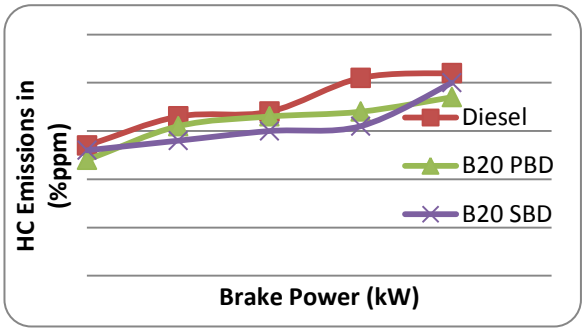

Fig. 5: Variation of HC with BP

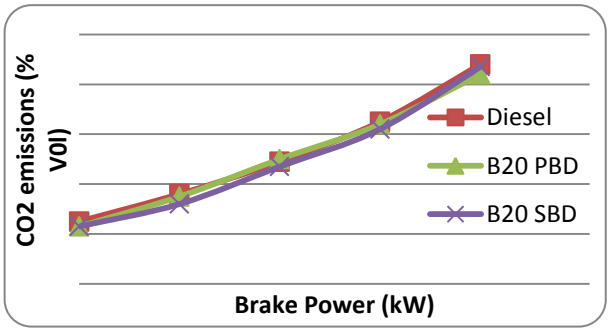

Fig. 6: Variation of CO_2 emission withBP

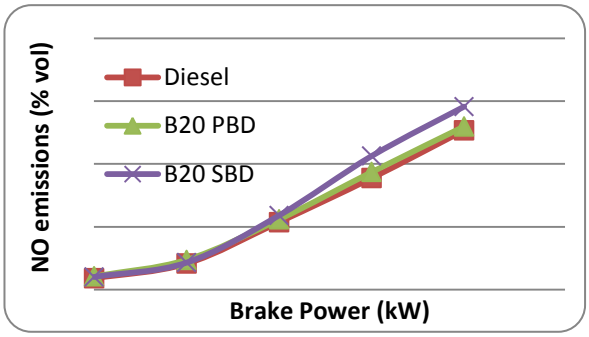

Fig. 7: Variation of NOx emission with BP

Fig. 4-7 are indicates variation of carbon oxide (CO), Unburned UBHC, $CO_2$and NOx emissions with Brake power. Both biodiesel blends are showing very appreciably less emissions as compared to diesel fuel. For all the emissions the curves are increasing gradually as the brake power going to increase. From Fig. 4, 5, 6 can observe that emission of CO, UBHC and CO_2 are less for both biodiesel particularly for simarouba biodiesel. From the Fig. 7 it is observed that NOx production for both biodiesel is more as compared to neat diesel because of high cylinder temperature [6].

3.3 Combustion characteristics

Here the study of combustion characteristics made for diesel and 20% biodiesel of Pongamia and Simarouba biodiesels for full (100%) load and 1500rpm condition. The study of combustion characteristics are to get the information about the parameters like ignition delay, maximum pressure or peak pressure attend in the cylinder and heat release rate analysis. In CI engine the development of cylinder pressure depends on the burnt fuel fraction during the premixed burning phase [1].

The Fig. 8 showing the cylinder pressure and crank angle diagram for diesel, pongamia and simarouba 20% biodiesel investigated with full load condition. The cylinder pressure raised after Top Dead Centre i.e., after 360° of crank angle. The peak pressures for diesel and biodiesel blend is attained at 64 bars. Fortunately diesel and biodiesel peak pressures with full load are overlapped, so it confirms that 20% of both biodiesels are approaching the diesel combustion characteristics. The combustion process of test fuels are similar, consisting of a phase of premixed combustion following by a phase of diffusion combustion. This premixed combustion phase controlled by the ignition delay and flame envelop of the fuel injected [7]. By the all above study can decide the 20 blends are approaching the heat values and combustion characteristics of neat diesel.

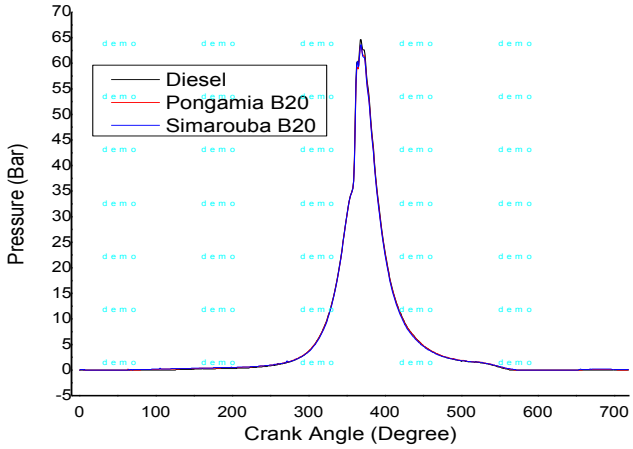

Fig. 8: Cylinder pressure with Crank angle at full load condition for Diesel, Pongamia biodiesel (B20 PBD) and Simarouba biodiesel (B20 SBD)

4.0 CONCLUSION

The comparative investigation can summaries as follows

- Brake thermal efficiency and specific fuel consumption of biodiesel is comparatively acceptable.
- Emission of bio diesel is slightly low in compare to diesel, NOx emission not control because of high temperature developed in engine cylinder due to B20 fuels.
- The comburstion performance of biodiesels are same as diesel, all the pressure curves attended 64-66 bars.
- The B20 pongamia and simarouba can make use as alternative fuel instead of diesel

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