Effect of Brake Thermal Efficiency of a Variable Compression Ratio Diesel Engine Operating with Pongammia Pinnata Oil Blends under Different Loading Conditions

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Abstract

In this experimental study Brake Thermal Efficiency of a variable compression ratio (VCR) Diesel engine operating with diesel and Pongamia pinnata oil blends were studied under different five different loading conditions (0,3,6,9 & 12 kg), two compression ratio (17:01 & 18:01) and three different Pongamia pinnata oil blends (B10, B15 & B20) which are blended with diesel by volumetric basis (100 ml Pongamia pinnata oil: 900 ml pure Diesel, 150 ml Pongamia pinnata oil: 850 ml pure Diesel, 200 ml Pongamia pinnata oil: 800 ml pure Diesel) respectively. For comparative purpose initially the engine was run by pure Diesel. This study shows that the Brake Thermal Efficiency is maximum (34.14%) when the engine operates with Pongamia pinnata oil (B15 blend) which was blended with pure Diesel on full load conditions (12 kg) and compression ratio of 18:01. This study shows that the Brake Thermal Efficiency is minimum (1.31 %) when the engine operates with Pongamia pinnata oil (B15 blend) which was blended with pure Diesel on no load conditions (0 kg) and compression ratio of 17:01.

Keywords- VCR Diesel engine, pongamia pinnata oil blends, loads, compression ratio, brake thermal efficiency

I. INTRODUCTION

The preservation of energy is decreasing now a days and it alleged that it leads to energy demand. In the last two decades, alternative fuels have obtained and identified as essential. A potential biodiesel substitutes diesel oil, consisting of ethyl ester of fatty acids produced by the trans esterification reaction of triglycerides of vegetable oils and ethanol with the help of a catalyst. In addition, biodiesel is better than diesel fuel in terms of very low sulfur content and it is also having higher flash and fire point temperatures than in diesel fuel. A lot of research work pointed out that biodiesel has received a significant attention and it is a possible alternative fuel. Biodiesel and its blends with diesel were employed as a fuel for diesel engine without any modifications in the existing engine [1]. The research on the production of biodiesel has increased significantly in recent years because of the need for an alternative fuel which endows with biodegradability, low toxicity and renewability [2].The biodiesel produced by trans esterification showed similar properties to the standard biodiesel [3]. The process of Trans esterification is found to be an effective method of reducing viscosity of vegetable oil [4]. The lower blends of biodiesel increased the brake thermal efficiency and reduced the fuel consumption. In addition to this, biodiesel blends produce lower engine emissions than diesel [5]. The new fuel Die sterol (combination of diesel fuel, bio ethanol and sunflower methyl ester) as a fuel for diesel engines. The authors revealed that, as the percentage of bio ethanol in the blends is increased, the percentage of CO concentration in the emission is reduced. This trend is due to the fact that bio ethanol has less carbon than diesel [6]. The diesel engine runs with waste plastic oil as fuel. The authors concluded that, the smoke was reduced by 40% than diesel [7]. The new type of biodiesel is prepared from non-edible pongamia pinnata oil by trans esterification and used as a fuel in C.I engine. The authors reported that blend B5 exhibits lower engine emissions of unburnt hydrocarbon, carbon monoxide, oxides of nitrogen and carbon dioxide at full load [8]. The experiments were performed in a single cylinder DI diesel engine fueled with a blend of pungam methyl ester for the proportion of PME10, PME20and PME30 by volume with diesel fuel for validation of simulated results. The authors observed that there is a good agreement between simulated and experimental results [9]. From the review of literatures, numerous works in the utilization of biodiesel as well as its blends in engines have been done. However, most of the literatures focused on single biodiesel and its blends. From previous studies, it is evident that single biodiesel offers acceptable engine performance and emissions for diesel engine operation.

II. EXPERIMENTAL PLAN

The biodiesel (pongamia pinnata oil and pure diesel) are prepared by the transesterification process. The biodiesel blends were prepared in three different proportions as: Diesel 90%, pongamia pinnata oil 10%; Diesel 85%, pongamia pinnata oil 15%; Diesel 80%, PPEE 10% by volume basis. The various properties like kinematic viscosity, specific gravity, calorific value, flash point temperature and fire point temperature of baseline fuel, raw oils and biodiesel mixed blends were determined by using ASTM methods and compared with diesel properties. The experiments were conducted on a stationary, single cylinder, vertical, four strokes, water cooled, variable compression ratio, diesel engine with electrical loading and the mean gas temperatures were compared with baseline data of diesel fuel.

Table 1: Test Engine Specifications

Sl.No.	*Items*	*Specifications*
1	*Type*	*Vertical, four strokes, single cylinder, VCR engine.*
2	*Made*	*Kirloskar oil engines Ltd, Pune, India.*
3	*Loading device*	*Eddy current dynamo meter*
4	*Type of cooling*	*Water cooled*
5	*Speed*	*1500 rpm*
6	*Power*	*3.5 kW*
7	*Bore*	*87.5mm*
8	*Compression ratio*	*12:1to 20:1*
9	*Stroke*	*110mm*
10	*Fuel*	*Diesel*

Tests were conducted at a constant speed and at varying loads for all biodiesel blends. Engine speed was maintained at 1500 rpm (d speed) during all experiments. The mean gas temperatures of the exhaust gases were measured by the AVL make smoke meter. The exhaust emissions were measured by the Crypton make five gas analyzer. The experimental set up is shown in Fig. 1 and the detailed engine specifications are also given in Table 1.

Fig. 1: Experimental setup

III. RESULTS AND DISCUSSIONS

The following results were obtained from this experimental study which was carried out to evaluate the Brake Thermal Efficiency of a Variable Compression Ratio (VCR) Diesel engine operating with Diesel and three Pongamia pinnata oil blends (B10, B15 & B20) under five different percentage loading conditions (0, 3, 6, 9 & 12 kg) and two compression ratio (17:01 & 18:01) respectively.

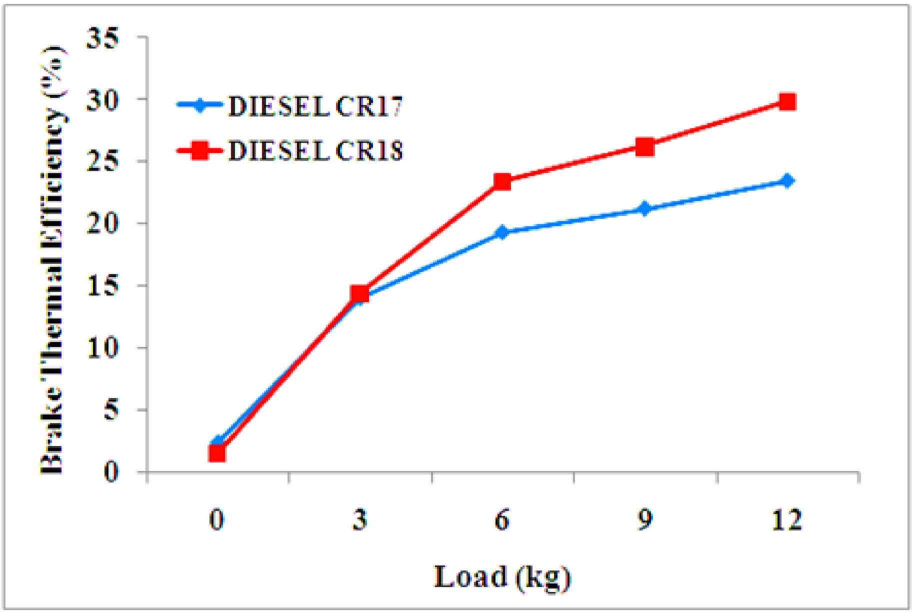

Fig. 2: Effect of Brake Thermal Efficiency of the VCR engine operating with diesel and compression ratio 17:01& 18:01

A. Effect of engine Brake Thermal Efficiency operating by Pongamia pinnata oil blend (B10) at a compression ratio of 17:01 under different loading conditions

Effect of Brake Thermal Efficiency of the engine operating by Pongamia pinnata oil blend (B10) and compression ratio 17:01 for various loading conditions were sown in figure.4. The minimum and maximum Brake Thermal Efficiency obtained in this case is 2.12% and 30.63% at load of 0 and 12 kg respectively. At full load and no load conditions the engine cylinder exhibits a maximum and minimum Brake Thermal Efficiency at a compression ratio of 17:01.

B. Effect of engine Brake Thermal Efficiency operating by Pongamia pinnata oil blend (B10) at a compression ratio of 18:01 under different loading conditions

Effect of Brake Thermal Efficiency of the engine operating by Pongamia pinnata oil blend (B10) and compression ratio 18:01 for various loading conditions were sown in figure.4. The minimum and maximum Brake Thermal Efficiency obtained in this case is 1.83% and 29.36% at load of 0 and 12 kg respectively. At full load and no load conditions the engine cylinder exhibits a maximum and minimum Brake Thermal Efficiency at a compression ratio of 18:01.

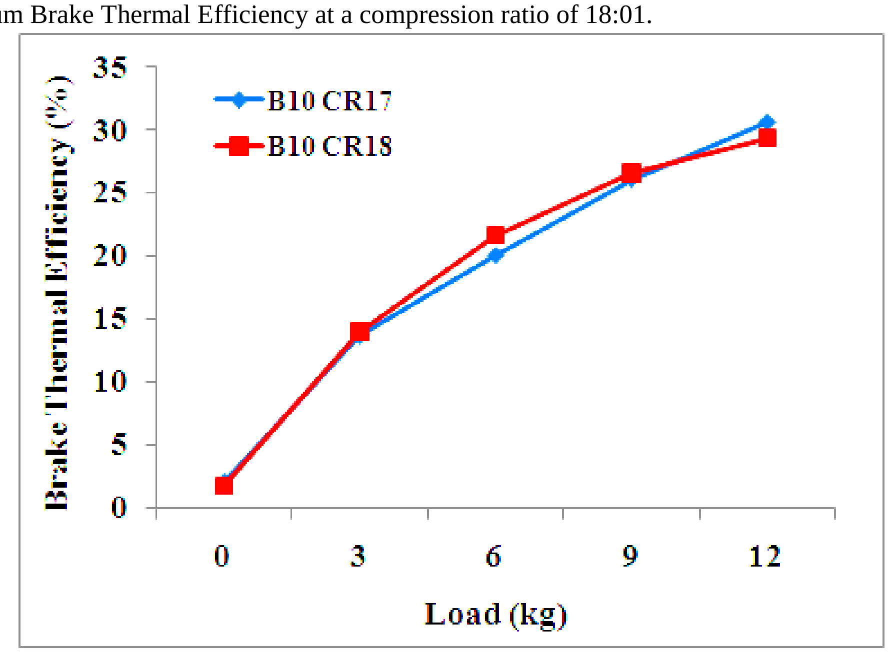

Fig. 3: Effect of Brake Thermal Efficiency of the VCR engine operating with Pongamia pinnata oil blend (B10) and compression ratio17:01&18:01

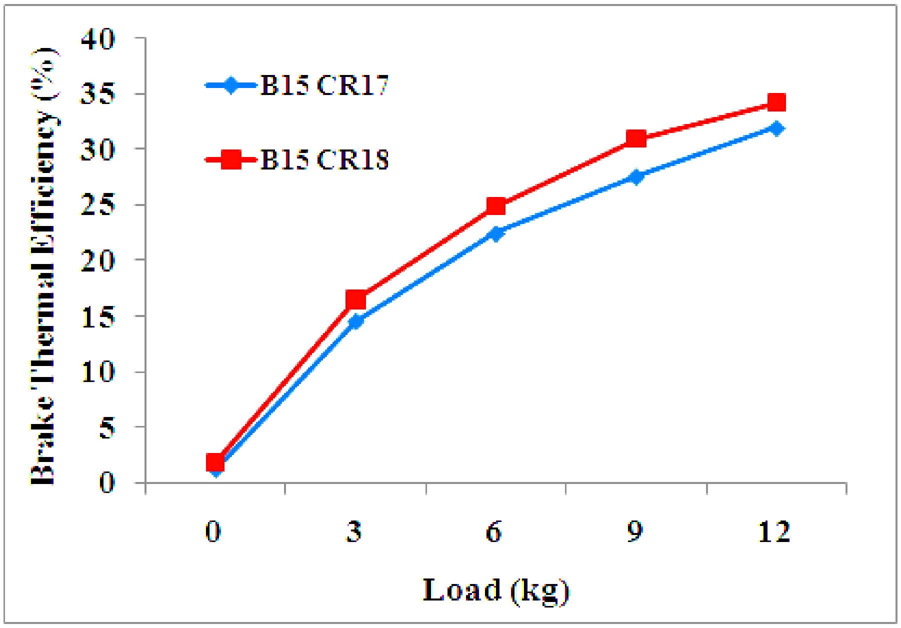

Fig. 4: Effect of Brake Thermal Efficiency of the VCR engine operating with Pongamia pinnata oil blend (B15) and compression ratio17:01&18:01

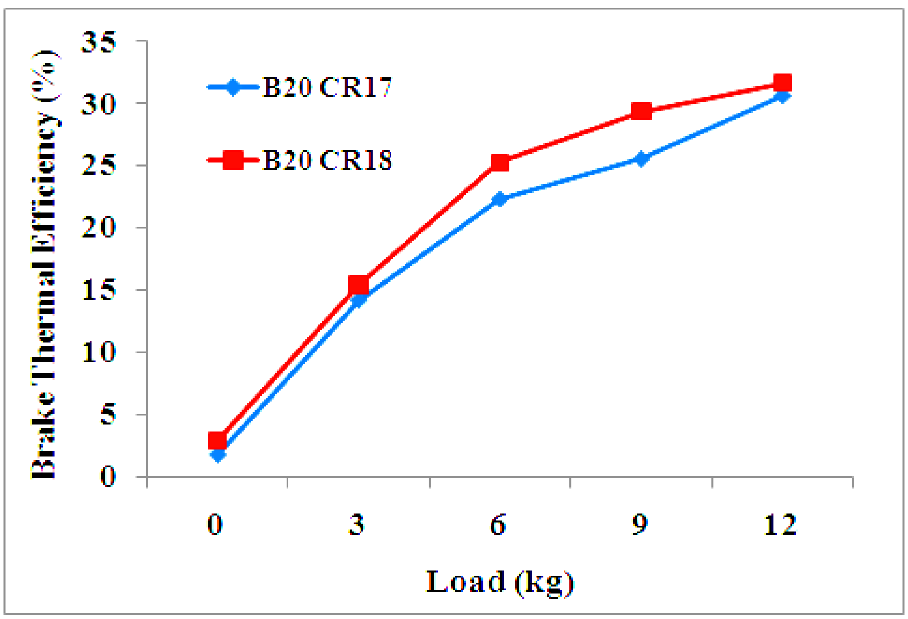

Fig. 5: Effect of Brake Thermal Efficiency of the VCR engine operating with Pongamia pinnata oil blend (B20) and compression ratio17:01&18:01

C. Effect of engine Brake Thermal Efficiency operating by Pongamia pinnata oil blend (B15) at a compression ratio of 17:01 under different loading conditions

Effect of Brake Thermal Efficiency of the engine operating by Pongamia pinnata oil blend (B15) and compression ratio 17:01 for various loading conditions were sown in figure.4. The minimum and maximum Brake Thermal Efficiency obtained in this case is 1.31% and 31.97% at load of 0 and 12 kg respectively. At full load and no load conditions the engine cylinder exhibits a maximum and minimum Brake Thermal Efficiency at a compression ratio of 17:01.

D. Effect of engine Brake Thermal Efficiency operating by Pongamia pinnata oil blend (B15) at a compression ratio of 18:01 under different loading conditions

Effect of Brake Thermal Efficiency of the engine operating by Pongamia pinnata oil blend (B15) and compression ratio 18:01 for various loading conditions were sown in figure.4. The minimum and maximum Brake Thermal Efficiency obtained in this case is 1.96% and 34.14% at load of 0 and 12 kg respectively. At full load and no load conditions the engine cylinder exhibits a maximum and minimum Brake Thermal Efficiency at a compression ratio of 18:01.

E. Effect of engine Brake Thermal Efficiency operating by Pongamia pinnata oil blend (B20) at a compression ratio of 17:01 under different loading conditions

Effect of Brake Thermal Efficiency of the engine operating by Pongamia pinnata oil blend (B20) and compression ratio 17:01 for various loading conditions were sown in figure.4. The minimum and maximum Brake Thermal Efficiency obtained in this case is 1.82% and 30.62% at load of 0 and 12 kg respectively. At full load and no load conditions the engine cylinder exhibits a maximum and minimum Brake Thermal Efficiency at a compression ratio of 17:01.

F. Effect of engine Brake Thermal Efficiency operating by Pongamia pinnata oil blend (B20) at a compression ratio of 18:01 under different loading conditions

Effect of Brake Thermal Efficiency of the engine operating by Pongamia pinnata oil blend (B20) and compression ratio 18:01 for various loading conditions were sown in figure.4. The minimum and maximum Brake Thermal Efficiency obtained in this case is 2.97% and 31.58% at load of 0 and 12 kg respectively. At full load and no load conditions the engine cylinder exhibits a maximum and minimum Brake Thermal Efficiency at a compression ratio of 18:01.

IV. SUMMARY

The following conclusions were made from this experimental study which was carried out to evaluate the effect of Pongamia pinnata oil blends for Brake Thermal Efficiency of a Variable Compression Ratio (VCR) Diesel engine operating with Diesel and three Pongamia pinnata oil blends (B10, B15 & B20) under five different loading conditions (0, 3, 6, 9 & 9 kg), and two compression ratio (17:01 & 18:01) respectively.

- Brake Thermal Efficiency is maximum at full load condition and minimum at no load conditions.
- Brake Thermal Efficiency is maximum when the engine operates at a compression ratio of 18:01.
- Brake Thermal Efficiency is gradually increases with the increasing Pongamia pinnata oil blends.
- The minimum and maximum Brake Thermal Efficiency of the engine is obtained when the engine is run by Pongamia pinnata oil blend (B15).
- The maximum engine Brake Thermal Efficiency obtained from this experimental study is 34.14% when the engine operates with Pongamia pinnata oil blend (B15) on full load conditions (12 kg) at a compression ratio of 18:01.
- The minimum engine Brake Thermal Efficiency obtained from this experimental study is 1.31% when the engine operates with Pongamia pinnata oil blend (B15) on no load conditions (0 kg) at a compression ratio 17:01.

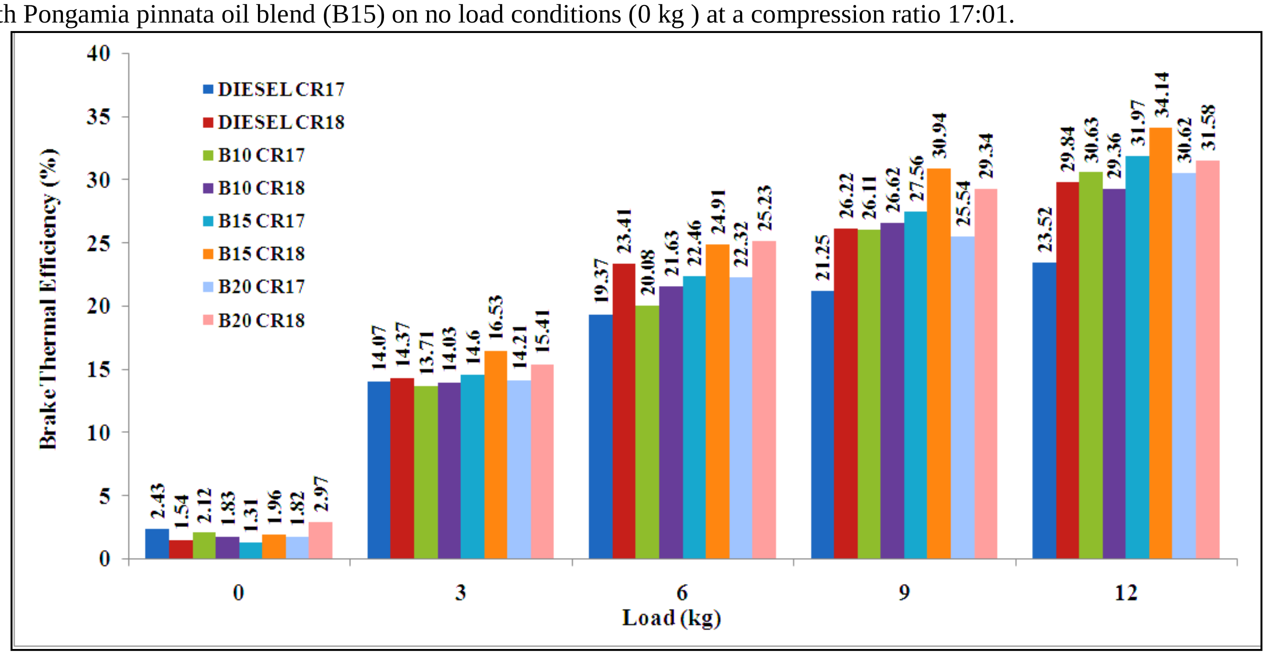

Fig. 6: Effect of Brake Thermal Efficiency under different loading conditions

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