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Research Article

Experimental Investigations on Performance of Dual Biodiesels Blended with Diesel on VCR Diesel Engine

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Abstract

This paper is an attempt to present the performance analysis of dual biodiesels pongamia oil and cotton seed oil at different blending ratios with diesel (B10=10% of biodiesel, B20=20% biodiesel, B30=30% of biodiesel). Performance of duel biodiesel and exhaust temperatures were examined in a single cylinder VCR diesel engine with electrical dynamometer by direct injection, at various engine loads with an average engine speed of 1550rpm. The influences of blends on break power, break thermal efficiency, specific fuel consumption, air fuel ratio and exhaust temperatures were investigated and compared with mineral diesel. The brake thermal efficiency of blend B10 was found higher than diesel. The exhaust gas temperature for dual biodiesel blends was lower than diesel.

Keywords: *Duel biodiesel, pongamia oil, cotton seed oil, performance analysis of dual biodiesel*

1. Introduction

Energy is an essential factor for economic growth and sustainable development of any country. Conventional energy resources are depleting day by day at the same time demand for energy is increasing and also the exhaust of petroleum and diesel is the main reason for air pollution. Because of these two reasons researchers focuses on renewable, self-sustainable, biodegradable and environment friendly alternate fuels. In recent years, biodiesel utilization in diesel engines has been popular due to depletion of petroleum-based diesel fuel (Guven Gonca *et al*, 2016; A.E. Atabani *et al*, 2012). Biodiesel, which is fatty acid methyl ester (FAME) is environment friendly, releases less NO_x and HC and absolutely no So_x and no increase in CO_2, when used in different blend ratios with diesel. There has been a lot of research work on biodiesel, but very few studies are conducted on duel biodiesel fuel in diesel engine (K. Srithar *et al*, 2014; Mohammed Takase *et al*, 2015). Duel biodiesel fuel is combination of any two biodiesels with diesel, so that it has advantages of both the biodiesels.

Prabhakar *et al*. studies on pongimia and madhuca oils on diesel engine and reveals that 20% hybrid vegetable oil and 80% diesel can be used to replace diesel without modifying the diesel engine with less power loss and less HC and CO emissions. K.Srithar conducted experiments on CI engine using pongamia oil and mustard oil with diesel. They have studied performance analysis of diesel engine and exhaust emissions. From the experimental results they concluded that thermal efficiency and mechanical efficiency of blend A-Diesel90%, Pongamia5% and Mustard oil 5% were slightly more that the diesel.

VenkateswaraRao P Conducted the experiments on C I engine with dual biodiesels of pongamia and jatropha along with diesel. The results shows thatD90PJBD10 (Diesel 90%, pongamia and jatropha 10%) and D80PJBD20 Diesel 80%, pongamia and jatropha 20%) were very closer to diesel fuel values so that diesel can be replaced with pongamia and jatropha.

2. Experimental Procedure

The two biodiesels pongamiapinnata oil (also called karanja oil) and cotton seed oil are prepared by the transesterification process. The dual biodiesel blends were prepared in different proportions as given the table 1: Blend B10-Diesel 90%, Karanja oil methyl ester (KOME) 3% and Cotton seed oil methyl ester (CSME) 7% by volume basis; B20-Diesel 80%, KOME 6% and CSME 14% by volume basis; and B30-Diesel 60%, KOME 12% and CSME 28% by volume basis.

Table 1 Blending Percentage of Fuel

Notation	Fuel Quantity	Bio-Diesel Quantity		Diesel Quantity
		CSME	KOME	
B10	1 litre	70 ml	30 ml	900ml
B20	1 litre	140 ml	60ml	800ml
B30	1 litre	210 ml	90 ml	700 ml
Diesel	1 litre	-	-	1000ml

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Table 2 Properties of Duel biodiesel blends

Properties	Diesel	Karanja oil	Cotton Seed oil	B10	B20	B30
Density(kg/m^3)	0.84	0.86	0.88	0.854	0.859	0.863
Viscosity (cSt)	4.2	5.14	4.1	4.2212	7.018	8.427
Flash point (°c)	66	128	224	78.92	443.2	631.8
Fire point (°c)	72	134	476	81.14	384.4	536.4
Calorific value (kJ/kg)	43000	37700	38510	40924	38847	36771

Table 3 Specifications of diesel engine

Type	4-stroke, Single-cylinder diesel engine (Water Cooled)
Made	HM-ISUZU
Stroke	82mm
Compression ratio	20:1
Cylinder capacity	1800cc
Starting	Auto start
Loading	Hydraulic loading
Engine Oil	SAE 20 W/40 (4.5 liters capacity)
Rated Power	75 HP
Speed	5000 rpm
Bore diameter	84mm

Various physical and thermal properties of dual biodiesels of karanja oil and cotton seed oil and its blends were evaluated as per standards. Detailed properties of duel biodiesel blends along with diesel, karanja oil and cotton seed oil are given in Table 2. The details of experimental setup are represented in schematic diagram as shown in Fig. 1. The Experiments are conducted on the four stroke single cylinder water cooled VCR diesel engine test rig (Fig. 2.) at constant speed (1500 rpm) with varying 0 to 100% loads with diesel and different blends of CSME & KOME with blended dual bio-diesel in the ratios of B10, B20, and B30. Specification of diesel engine is listed in Table 3. Fuel consumption and exhaust gas temperatures were measured along with performance analysis.

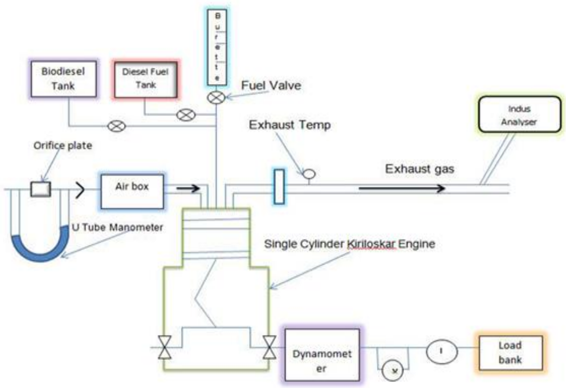

Fig. 1 Schematic diagram of experimental setup

The engine was first operated on diesel fuel with no load for few minutes at rated speed of 1500 rpm until the cooling water and lubricating oil temperatures comes to certain temperature. The same temperatures were maintained throughout the experiments with all the fuel modes. The baseline parameters were obtained at the rated speed by varying 0 to 100% of load on the engine.

Fig. 2VCR diesel engine test rig

The diesel fuel was replaced and in the same manner tests were conducted for three blends of B10, B20 and B30 by varying the load on the engine. The brake power was measured by using an electrical dynamometer. The mass of the fuel consumption was measured by using a fuel tank fitted with a burette and a stop watch. The brake thermal efficiency and brake specific fuel consumption were calculated from the observed values. The exhaust gas temperature was measured by using thermocouple.

3. Results and discussion

Specific fuel consumption

The effect of load on specific fuel consumption (SFC) is shown in Fig. 3. As load increases the SFC decreases for all the dual biodiesel blends. The reason is due to high percentage increase in break power with load as compared to increase in the fuel consumption. It could be due to the presence of oxygen in the biodiesel and its blends that enable complete combustion and the negative effect of increased viscosity would not have been initiated. For the maximum load, the value of SFC of B10 is0.401 kg/kWh, B20 is 0.441 kg/kWh, and B30 is 0.458 kg /kW h, whereas mineral diesel fuels have 0.496 kg /kW h.

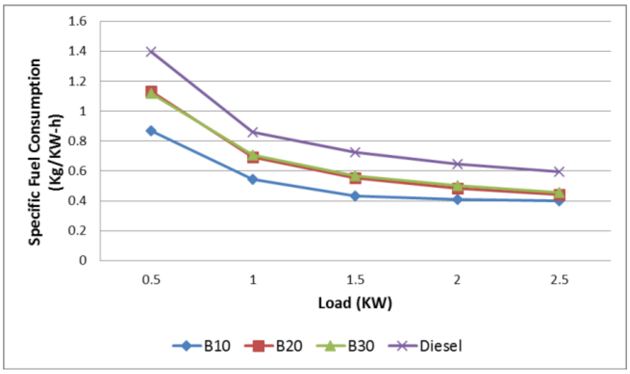

Fig. 3 Variation of Load with Specific fuel consumption

Break Thermal Efficiency (%)

The effect of load on break thermal efficiency is shown in Fig. 4. It shows that the break thermal efficiency is the high for all dual bio-diesel blends compared with mineral diesel. The reason is excess oxygen molecules in biodiesel blends will helps in complete combustion of fuel and which in turn results in maximum efficiency than the mineral diesel fuel. The break thermal efficiency is an ideal variable because it is dependent on calorific value of the fuel, the high break thermal efficiency is due to lower calorific value of the dual bio-diesel.

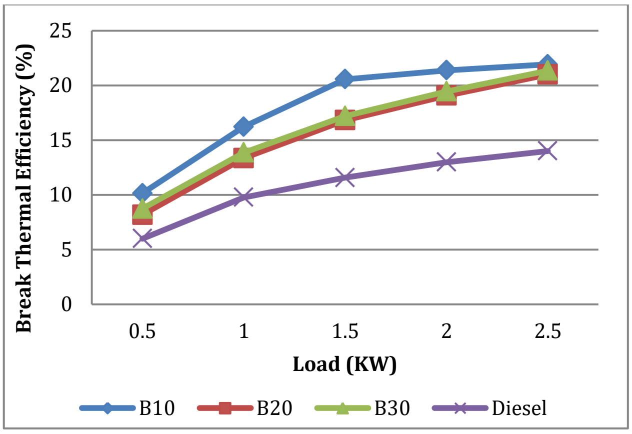

Fig. 4 Effect of load on break thermal efficiency

Brake power

The effect of load on brake power is shown in Fig. 5. The break power increases with increase in load on the engine. The break power was maximum of 2.28 kW for B10 than diesel of 2.115 kW for the same maximum load. The break thermal efficiency for the B20 and B30 were lower than B10, this due to lower specific fuel consumption for blend B10.

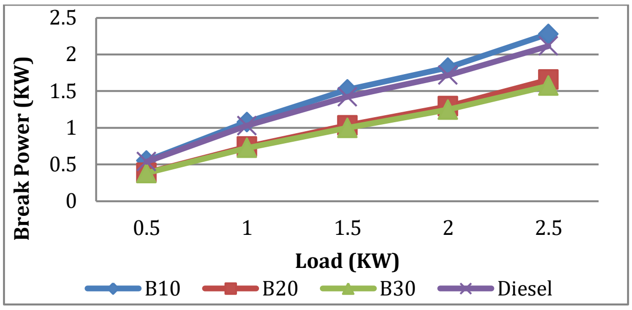

Fig. 5 Effect of load on break power

Exhaust Gas Temperature

The effect of load on exhaust temperature is shown in Fig. 6 which is similar to break power versus load (Fig. 5.). Exhaust temperature increases with the increase in brake power in all cases. This is because of more amount of fuel is required with additional load on engine. B20, B30 blends are having less exhaust temperature than the diesel values for any brake power due to its lower heating values and the improved oxygen content provided by the dual bio diesel which increases better combustion.

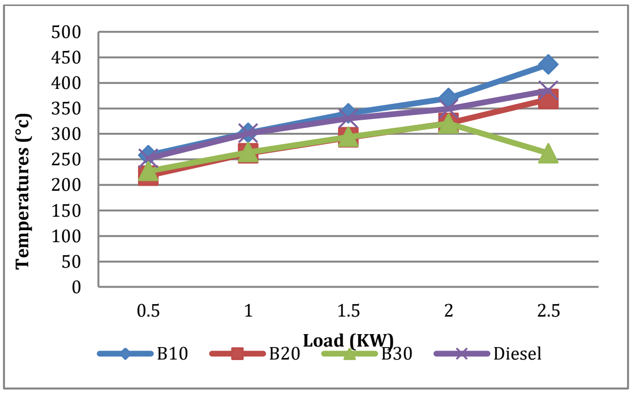

Fig. 6 Variation of Temperature with Load using Diesel CSME& KOME Blend

Air Fuel Ratio

The air fuel ratio decreases with increase in engine load. The air fuel ratio is lowest for the diesel and maximum for the dual bio-diesel B20 &B30.

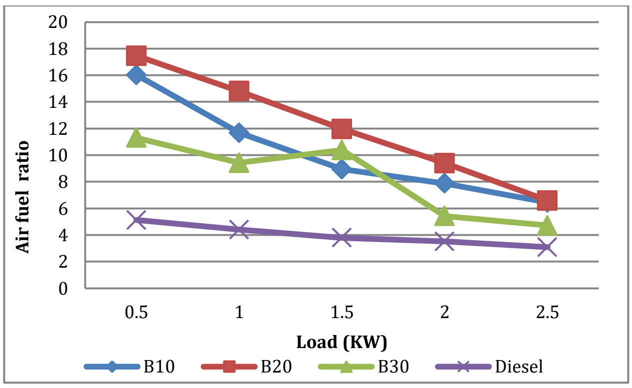

Fig.7 The effect of load on air fuel ratio

The engine consumes lean mixture for dual biodiesel blend B10 compared to blend B30 and pure diesel at maximum load.

Conclusion

Single cylinder VCR diesel engine ran successfully during tests on dual biodiesels blends of pongamia oil, cotton seed oil. The blends of diesel and the dual biodiesels of pongamia oil and cotton seed oil were characterized for their physical, chemical and thermal properties. From the experimental analysis results, the brake thermal efficiency of B10% was higher than diesel. B20% and B30% were close to the diesel values. The specific fuel consumption values of dual biodiesel blends were lower than mineral diesel. The specific fuel consumption for B20% and B30% are almost same. This is due to presence of oxygen in the biodiesel and its blends that enable complete combustion. At the same time, these two blends were having less exhaust temperature than the diesel values for any brake power due to its lower heating value. Performance of different dual biodiesel blends with diesel at varies mixing ratios can be studied on diesel engine in future for better results in duel biodiesel applications.

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