Investigation on performance of waste cooking oil with turpentine oil as an additives in diesel engine

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ABSTRACT: In this study, the performance of a new combination of waste cooking oil (WCO) biodiesel and turpentine oil for diesel engine was observed. WCO biodiesel and turpentine oil are conducive for in a diesel engine. The extensive experimental work was carried out on a YANMAR TF120-M which was fuelled with biodiesel blends; B20, B40, B20T10, and B20T20 tested with different parameters. The test shows that B20T10 and B20T20 have the highest BSFC compared to other tested fuels and B20T10 recorded the lowest BTE. It was found that the addition of turpentine oil improves the performance characteristics of diesel engine.

Keywords: *Waste cooking oil, turpentine oil, diesel engine performance*

1. INTRODUCTION

Biodiesel are renewable fuels that automotive researchers pay more attention to due to their eco-friendly nature and plentiful availability on earth [1]. Biodiesel is more attractive to many factors because it is non-toxic and biodegradable [2]. The availability of possible feedstock plays a major role, contributing to approximately 75% of the total cost of biodiesel. It is therefore very important to choose an economical feedstock to improve the biodiesel production economy [3]. Studies on biodiesel blends prepared from waste cooking oil (WCO) exhibit better fuel properties compared to diesel fuel [4]. Oil undergoes many physical and chemical changes during the frying process which made the oil unfit for human consumption [5]. Repeated use of fried oil for cooking purposes contributes to the creation of high levels of cytotoxic which cause the induction, development and progression of cardiovascular disease [6].

2. METHODOLOGY

2.1 Preparation of WCO biodiesel

Methoxide is prepared by dissolving KOH in MeOH. 1% concentration of KOH with MeOH to oil ratio is 6:1 molar ratio or 25% volume to volume in the methoxide were prepared and the process is optimized for conversion rate/yield. Methoxide is mixed with preheated oil and the reaction carried out under nominal speed stirring by a mechanized stirrer and at a constant reaction temperature of 60°C for 2 hours.

2.2 Properties of biodiesel

There were five samples of fuel used in this study which includes, diesel fuel, B20, B40, B20T10, and B20T20. All the test methods conform to the strict ASTM procedures and conducted under controlled temperature, pressure, and relative humidity. The physical properties of WCO biodiesel and diesel are shown in Table 1. WCO biodiesel is more than that of diesel by 3.72% and the calorific value of diesel is more than that of WCO biodiesel by 10.57% which means more amount of WCO biodiesel needs to be injected into the combustion chamber in order to get the same power output of using diesel fuel. The kinematic viscosity of WCO biodiesel is higher than the diesel fuel.

Table 1: The properties of diesel and WCO biodiesel

	Diesel	WCOME	Testing Procedure
Density (g/cm3)	0.8274	0.85814	ASTM D941
Kinematic Viscosity (mm2/s)	3.471	4.4901	ASTM D445
Calorific Value (kJ/kg)	42-44	39.795	ASTM D240
Cetane Number	62		ASTM D613

2.3 Engine setup

The schematic diagram of the test engine (YANMAR TF120-M) is shown in Figure 1.

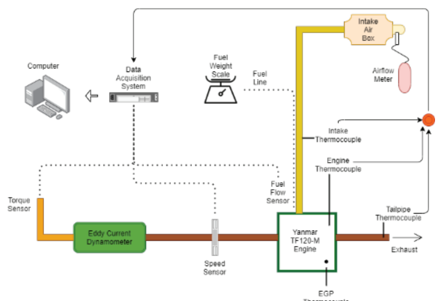
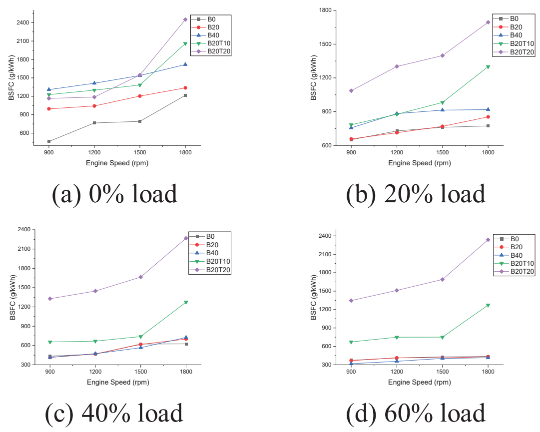


Figure 1: Schematic diagram of test engine

3. RESULTS AND DISCUSSIONS

3.1 Brake Specific Fuel Consumption (BSFC)

Figure 2 depicts the variation in BSFC of different blends of WCO biodiesel and diesel at varying engine speeds and load conditions. The plot it is reveal that as the load increases, the BSFC decreases in order to increase in-cylinder pressure and temperature, improving combustion efficiency. In contrast, a rising of BSFC was noticed with the increasing engine speed since the engine must complete more power stroke per unit time at higher speed. The BSFC is higher in WCO biodiesel as compared to diesel because WCO biodiesel has lower calorific value. Blends of WCO biodiesel with turpentine oil show a higher value of BSFC. BSFC for B20T10 and B20T20 is found better to that of diesel fuel and other WCO biodiesel blends.



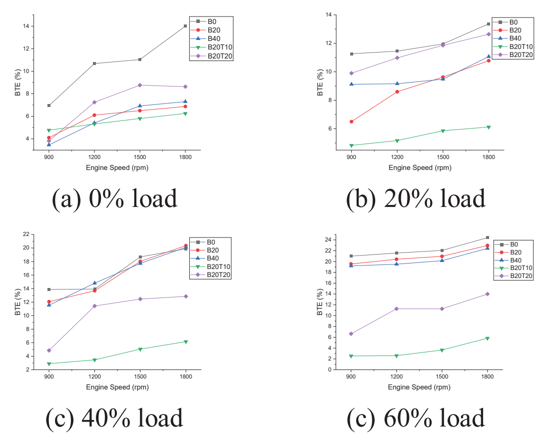
(a) 0% load (b) 20% load

(c) 40% load (d) 60% load

Figure 2: Changes in BSFC with different load

3.2 Brake Thermal Efficiency (BTE)

The result for BTE with various engine speeds and loads as illustrated in Figure 3. As observed from the figures, the BTE increased with the increasing in load condition. Among the fuel tested, B20T10 recorded the lowest BTE. The low BTE obtained could be due to reduction in calorific value and increase in fuel consumption as compared to diesel fuel. It may also due to their low heat input requirement for higher power output at a given load.



(a) 0% load (b) 20% load

(c) 40% load (c) 60% load

Figure 2: Changes in BTE with different load

CONCLUSION

A successful analysis of biodiesel and diesel on test rig is studied for four engine speeds and loads to measure the performance characteristics of biodiesel and diesel. The following outcome is concluded:

- Owing to its prominent properties such as kinematic viscosity, calorific value, and low cetane number, BSFC for B20T10 and B20T20 is found better to that of diesel fuel and other WCO biodiesel blends. The BSFC increase as the engine speed increases but decreases as the load increases.
- Among the fuel tested, B20T10 recorded the lowest BTE due to reduction in calorific value and increase in fuel consumption as compared to diesel fuel. It may also due to their low heat input requirement for higher power output at a given load.

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