As. J. Energy Env. **2007**, 08(04), 650-653

Asian Journal on Energy and Environment

ISSN 1513-4121

Available online at www.asian-energy-journal.info

An Experimental Study on Diesel Engine Performances Using Crude Palm Oil Biodiesel

Hendra Wijaksana* **and Gusti B. W. Kusuma**

Mechanical Engineering Department, Udayana University, Kampus Bukit Jimbaran ,Denpasar ,Bali , Indonesia

*Author to whom correspondence should be addressed, email: hhwwjks@yahoo.co.uk

Abstract: As the diesel oil price keep changing and its reserves keep decreasing, the uses of diesel oil for transportation and or industries should be minimized and replaced as much as possible by an alternative biofuel. One of the alternative biofuel is the crude palm oil bio-diesel, which is produced by mixing crude palm oil with methanol and potassium hydrxide in a certain concentration, so that it would has a close physical characteristics as diesel oil .In accordance to the test for the use of this bio-diesel on the diesel engine, it can be seen very clear that on the top speed of 2050 rpm on the diesel engine, in average, the use of this bio-diesel has a lower fuel consumption compare to the diesel oil, while the bio-diesel has a higher specific fuel consumption than the bio-diesel. In contrast, the use of this bio-diesel has yet been given an improve in torque, effective power, and thermal efficiency as diesel oil.

Keywords: Bio-diesel, Crude Palm Oil, Diesel Oil

Introduction

As the fuel price keeps changing and the reserves keep decreasing, it required some attemption to find other alternative fuel that cheaper and renewable. Some research has been conducted to find the alternative fuel for the diesel oil. It found that the palm oil has 30-60% oil quality for each fruit and the crude palm oil can be prepared to produce an alternative biofuel for diesel oil namely biodiesel [1]. The crude palm oil which is produced from palm oil has contain the most vegetable oil within 50% saturated fat acid within the composition of 1.4% miristic acid, 30.1% palmitic acid, 5.5% stearic acid then 50% unsaturated fat acid in the composition of 52.7% oleic acid and 10.3% linoleic acid. While for the castor oil contains 30% saturated fat acid including 12-17% palmitic acid, 5-6% stearic acid and 70% unsaturated fat acid which is included 37-63% oleic acid, 19-40% linoleic acid [2]. So that the unsaturated fat acid contains of costar oil is larger than the palm oil, this would require more catalyst to neutralize the unsaturated fat acid in its prepared to be the bio-diesel [1].

On the other hand, for the test result on the physical characteristic of crude palm oil bio-diesel, it has indicated that the crude palm oil bio-diesel has a density of 0.8671 kg/ltr (at 15.5 0C) which is 3.24% higher than the diesel oil, while its heat value is 16% lower than the diesel oil ie 867.464 BTU/lb. The flash point of this crude palm oil bio-diesel is 66.4 0C compare to the diesel oil of 63.2 0C, this indicated that the crude palm oil has a close flash point as the diesel oil. Other physical characteristic of this crude palm oil bio-diesel are including the specific gravity (at 60 0F) is 0.86959, then kinematics viscosity at 100 0F is 5.946 cS, and at 70 0C is 3.468 cS, while its viscosity index is 144.74.

Regarding those composition and physical characteristics above, it is important to investigate the use of the crude palm oil biodiesel as an alternative bio-fuel for the diesel oil by examining the diesel engine performances using the crude palm oil.

Methodology

Experimental apparatus

A 47 BHP Diesel Engine DWE-47-50-HS-Av , has been used to carry out this experiment , This diesel engine is a 4 cycles diesel engine , with 4 cylinders, 83 mm cylinder diameter, 100 mm stroke length, and has a 22 : 1 compression ratio. Others auxiliaries equipment including a dynamometer which is used to measure the acting force on the shaft, then tachometer to measure the revolutions on the output shaft, and a stopwatch to measure time required for fuel consumption.

Experimental procedures

At the first time, the diesel engine would be checked its conditions including its lubricating oil, battery, fuel system and any others test equipment to make sure that all of them in a good conditions. Then the engine would be started for warming up for 15 minutes, which is then continuing for the first test using the diesel oil at 650 rpm, after a certain time a breaking is applied on the dynamometer and the load would be measured, this load data would be taken for 5 times for each test also the time required for consuming every 100 ml of fuel would be measured. The test then will be continuing for the 1000 rpm, 1350 rpm, 1700 rpm, 2050 rpm respectively. When the test using the diesel oil has been completed, the test then would be carried on for the use of the crude palm oil bio-diesel on the diesel engine, within as same test conditions and data collections as the test using the diesel oil.

Experimental data

From the test on the diesel engine using the diesel oil and the crude palm oil bio-diesel, it has been collected some data for load applied, time required for fuel consuming, as Table 1.

Table 1 Experiment data collections

ENGINE REVOLUTION (RPM)	FUEL			
	DIESEL OIL		BIODIESEL	
	Load Applied (kg)	Time Required	Load Applied (kg)	Time Required
650	0.54	0.07'.05.6"	0.52	0.10'.16.4"
1000	12.6	0.02'.10.4"	0.52	0.03'.33"
1350	13.0	0.02'.42.4"	6.78	0.02'.53.2"
1700	14.4	0.01'.08.8"	7.0	0.00'.55.8"
2050	24.48	0.00'.35"	8.82	0.00'.43.6"

Experimental Data Analysis

Data analysis has been done for each engine revolution in Table 1, and it found the torque, effective power, fuel consumption, thermal efficiency, that can be resulted in the use of the diesel oil and the crude palm oil bio-diesel, it can be seen in Table 2, in which all of those results is determined based on the experimental data in Table 1 in average

Table 2 Data analysis results

ENGINE REVOLUTION (RPM)	FUEL							
	DIESEL OIL				BIODIESEL			
	Torque (kg.m)	Effective Power (HP)	Fuel Consumption (kg/hr)	Thermal Efficiency (%)	Torque (kg.m)	Effective Power (HP)	Fuel Consumption (kg/hr)	Thermal Efficiency (%)
650	0.193	0.175	0.710	1.48	0.186	0.169	0.508	2.12
1000	4.511	6.295	2.322	16.31	1.518	2.118	1.472	8.35
1350	4.654	8.769	1.862	28.34	2.427	4.573	1.808	16.2
1700	5.155	12.231	2.348	31.34	2.506	5.946	5.618	6.78
2050	8.764	25.074	8.640	17.47	3.157	9.034	7.191	8.05

Results and Discussion

According to the examination result, it can be shawn that the use of the crude palm oil bio-diesel on the diesel engine has given a lower torque than the diesel oil, this was caused by the lower heat value of the bio-diesel than the diesel oil, which has produced a lower work to reach a higher torque on the cylinder and crank shaft. The higher the engine revolution, the higher torque can be result for the diesel oil and the bio-diesel, when the revolution keep increasing the torque resulted tend to decreases, as the diesel engine has a maximum torque can be resulted in 3200 rpm. At the lowest engine revolution i.e. 650 rpm, the bio-diesel has given a close torque as the diesel engine, by then at the highest engine revolution i.e. 2050 rpm, the torque resulted for the bio-diesel has dropped sharply than the diesel oil can be resulted, in which the bio-diesel has only reach 3.157 kg.m while the diesel oil can reach 8.764 kg.m. This was caused by the density of the bio-diesel is higher than the diesel oil, so then the bio-diesel was faster injected to the combustion chamber than the diesel oil, consequently there will be imperfect combustion, and un-burn bio-diesel in the diesel engine, this will decrease the torque that can be produced.

As the lower torque of the bio-diesel can be produced, it would result on the lower of its effective power. For example, on the highest engine revolution of 2050 rpm, the effective power can be resulted by the bio-diesel was only 9.034 HP in average compare to 25.074 HP for the diesel oil. This decreasing was predicted due to the bio-diesel was burned imperfectly as it has a rapid injection to the combustion chamber.

On the other hand, in general, from the lowest engine revolution to the highest engine revolution ie.2050 rpm, the bio-diesel has a lower fuel consumption than the diesel oil. This indicated that the use of bio-diesel in diesel engine would give more fuel saving than diesel oil. The lower fuel consumption of bio-diesel was caused by the higher its flash point and viscosity than the diesel oil. The higher the flash point of bio-diesel, the better atomization process will be performed on bio-diesel and this will minimize the droplet size of bio-diesel and decrease its pre-combustion time, so that the bio-diesel will burn at the time the cylinder pass its Top Dead Center. In the other word, etherification process on crude palm oil bio-diesel has increasing the reaction between bio-diesel and oxygen, so that the combustion process on bio-diesel would be more difficult, consequently the fuel consumption rate of bio-diesel would be lower. For the effective thermal efficiency of the bio-diesel, that is lower than the diesel oil, this was caused by the lower heat value of the bio-diesel i.e. 867.464 BTU/lb compare to 1033.25 BTU/lb for the diesel oil.

Conclusion

According to the result, hence inferential as follows:

1. The crude palm oil bio-diesel as an alternative bio-fuel for the diesel oil, has been given the lower performances on the diesel engine including torque, effective power and effective thermal efficiency in which is mainly caused by the lower heat value of the bio-diesel compare to the diesel oil.
2. It can be proved that the bio-diesel has a lower fuel consumption compare to the diesel oil, as it has a higher flash point and viscosity than the diesel oil.
3. It can be predicted that the crude palm oil bio-diesel would give a better performance when it used for a low speed diesel engine, as it has as high torque, high effective power as the diesel oil and a lower fuel consumption at the lowest engine revolution.
4. In general, it can be concluded that the use of the crude palm oil bio-diesel as an alternative fuel has a close results to the use of diesel oil, even more the use of this bio-diesel is still require some attempts to improve the heat value of the crude palm oil bio-diesel, so that in the future it can be expected to be a better fuel substitute for the diesel oil.

Acknowledgments

This work was supported by the grant of Technological And Professional Skills Development Sector Project (TPSDP) – Batch III– ADB Loan No: 1792 – INO.

References

[1] Fery Setiawan. (2002), ThePprocessing of The Crude Palm Oil to Produce Bio-diesel.

[2] Ketaren, S. (1986), Oil and Fat Food, first edition, Indonesia University,Jakarta.

[3] Arismunandar, W. (1983), Reciprocating Combustion Engine, second edition, Institute Technology Bandung, ITB Bandung.

[4] Arismunandar, W. (1986), High Speed Diesel Engine, sixth edition, PT. Pradnya Paramita Jakarta.

[5] H.Tjokrowisastro, Eddy, Ir, M.E, (1986), Fuel and Combustion Technology, Mechanical Engineering, Industry Faculty, Institute Technology Sepuluh November Surabaya, I.T.S. Surabaya.