Experimental Investigation of engine performance and emission for biodiesel at various storage conditions

N. Tamaldin[1,2,*], A.S. Mohamad[1], Y. Humairak[1] , M.H.M. Husin[1,2], M.F.B. Abdollah[1,2]

[1)] Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[2)] Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding e-mail: noreffendy@utem.edu.my

Keywords: High blending biodiesel; performance engine

ABSTRACT – The aim of this paper is to evaluate the engine performance of high blending biodiesel. Biodiesel palm oil will be used as the main blending material. The types of biodiesel for this study are B7x, B8x and B9x. All biodiesel were blended and stored at three different storage conditions. Based on the best properties, one type of biodiesel is chosen to be tested to get the engine performance. Results, performance by using biodiesel B7x is slightly decreasing about 2-8% less of engine horse power and 4-10% less in torque. Biodiesel B7x can perform satisfactorily during diesel engine.

1. INTRODUCTION

Biodiesel is a biodegradable and nontoxic renewable fuel [1]. It has reduced the molecular weights, reduced viscosity and improves volatility [2]. Most of the combustion engines can run on biodiesel without modification [3]. Blending of biodiesel is one way to keep the performance of the fuel in combustion engine remaining great [4]. In 1895, Rudolf Diesel developed a new engine that can be run by using variety of fuels including vegetable oil [5]. Different types of biodiesel blends give different properties such as kinematics viscosity, flash point, water content and acid value.

The higher viscosity can leads to choking of injector tips which can cause the engine to lose its power [6]. Zakaria et al. [7] stated that in long storage duration, biodiesel fuel become oxidize, fuel degraded and microbial growth. The investtigation on power, torque, the brake specific fuel consumption (BSFC) and emission of the exhaust of both pure diesel fuel and different types of biodiesel of Sunflower Methyl Ester (SME) has been done by Moreno et al. [8]. While, in this study, the performance of high blending biodieslel (B7x) were evaluated and the standard biodiesel was used as benchmark.

2. METHODOLOGY

Three types of biodiesel will be used in these experiments which are B7x, B8x and B9x. B7x represents 70% of biodiesel and 30% of standard diesel (STD). Where, STD contains 5-7% of biodiesel. The fuel was mixed together and blended for an hour and heated around 70°C [9]. In this experiment, after biodiesel was blend, it will be stored in the storage box at three different conditions of temperatures which are low, ambient and high temperature. Then they are tested for parameter study which is the flash point. These fuels are then analyzed for the best condition to be tested on the engine.

Based on the data of the flash point, for standard diesel has the overall temperature of 90 °C flash points in all three conditions. Meanwhile, for blending biodiesel samples, B7x sample shows a precisely flash point result at lowest temperature compare to all storage condition samples. Thus, in this experiment, biodiesel B7x at ambient was selected for the diesel engine performance testing compare to the standard diesel.

The diesel engine performance testing was conducted by a single cylinder engine diesel engine model 170 F Single Cylinder Diesel Engines that runs at 3500 rpm to 1500 rpm. During this test, the engine will be connected to DAQ board such as the value for its power and torque which called. When the engine is running, all the data can be obtained from the device and the data will be recorded and analyzed.

3. RESULTS AND DISCUSSION

The performance of the engine can be defined into two types of performance which are horsepower and torque.

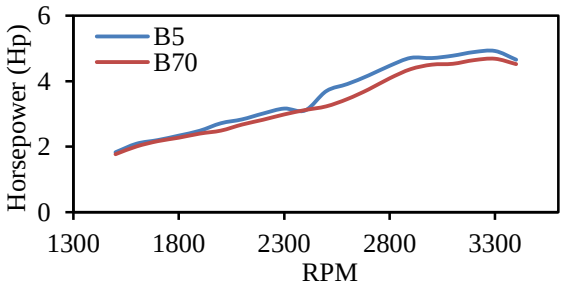

Figure 1 Horsepower (Hp) against rotation per minute (RPM).

Figure 1 shows the graph of horsepower against rotation per minute (RPM). The figure shows that all the values of horsepower have slightly decrease compared to performance of horsepower by standard diesel (STD). That means the used of biodiesel can decreasing the

© Centre for Advanced Research on Energy

performance of the engine. This is due to the ability of B7x to ignite for minimum temperature (flash point) is higher compare to standard diesel which is 120 ˚C and 90 ˚C respectively. . Table 1 below shows the percentage differences between the value of horsepower by B5 and B7x.

Table 1 Percentage of differences in horsepower between B5 and B7x.

RPM	HP for B5	HP for B7x	Differences	Percentage (%)
1500	1.8834	1.7844	0.0990	5.26
2000	2.7670	2.5778	0.1892	6.84
2500	3.6236	3.2770	0.3466	9.57
3000	4.6998	4.5228	0.1770	3.77
3400	4.7778	4.7690	0.0088	0.18

From the Table 1, decreasing of biodiesel engine performance for horsepower was up to 10% compared to standard diesel. For performance by horsepower, the lowest reduces percentage is 0.18%. A very small reduces percentage happens at the highest speed of the engine. This shows that the engine performance of biodiesel blend is slightly reduce compare to performance of engine by using a standard diesel. But at the speed of engine in 2500rpm, the highest percentage of reduced in horsepower is 9.57%. That means the use of biodiesel can reduces the performance of an engine by maximum of 10% or below.

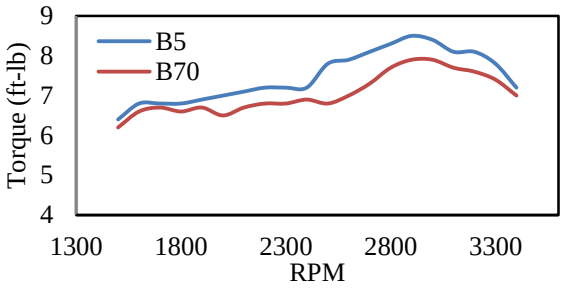

Figure 2 Torque (ft-lb) against rotation per minute (RPM).

Figure 2 shows the graph of torque against rotation per minute. The figure shows that there are no significant effects to the torque when the B7x is used in the diesel engine. In terms of values, the performance by torque for B7x is at the speed of 1500rpm until 2000rpm. After that, the values are always less than the values of performance by torque for standard diesel (B5). The value of torque is increasing as the speed is increase until it reach at the highest value of torque recorded which is at the speed of 3000rpm. Then, the performance by torque is decreasing as the speed continues to increase.

For the performance by torque, the lowest reduces in percentage is at the speed of 3000rpm which is 4.57% and the highest is at the speed of 2500rpm which is 9.47%. This shows that the performance of biodiesel is reduced by maximum of 10% compared to the uses of standard diesel on the engine. By combining the two results, it can be concluded that the use of biodiesel on the engine can reduces its performance of power and torque by 5-10%. Other than that, the maintained data gained from the experiment proved that biodiesel can perform satisfactorily during diesel engine operation.

4. CONCLUSIONS

As conclusion, the performance of biodiesel is reducing from 5-10% compared to standard diesel. In addition with that, further investigation should be conducted to test all the blend level of the biodiesel to be compared to the conventional diesel.

ACKNOWLEDGEMENT

The authors would like to be obliged to Universiti Teknikal Malaysia Melaka (UTeM) for providing laboratory facilities and financial assistance under MTUN grant project no. RAGS/1/2014/TK06/FKM/B00071.

REFERENCES

[1] M., Bowman, D., Hilligoss, S. Rasmussen and R. Thomas., "Biodiesel: a Renewable and Biodegradable Fuel Hydrocarbon Processing," 2006, Retrieved September 23, 2013 from, http://www.perkinelmer.com/pdfs/downloads/ATL_BiodieselHydrocarbProcessing.pdf.

[2] G. Knothe, "Biodiesel and renewable diesel: A comparison," *Progress in Energy and Combustion Science*, vol. 36, no. 3, pp. 364-373, 2010.

[3] R. Senthilkumar, K. Ramadoss and M. Prabu, "An effective experimental investigation on 4-stroke single cylinder C.I. engine using cottonseed biofuels," *International Conference on Advances in Engineering, Science and Management*, pp. 341-345, 2012.

[4] J.A. Kinast, "Production of Biodiesel from Multiple Feedstocks and Properties of Biodiesel and Biodiesel/Diesel Blends: Final Report, Report No. NREL/SR-510-31460," National Renewable Energy Laboratory, Golden [CO]: March 2003.

[5] A.C. Pinto, L.L.N. Guarieiro, M.J.C. Rezende, N.M. Ribeiro, E.A. Torres, W.A. Lopes, P.A.P. Pereira and J.B. Andrade, "Biodiesel: An Overview", *Journal of the Brazilian Chemistry Society*, vol. 16, no. 6B, pp. 1313-1330, 2005.

[6] G. Knothe, J.V. Gerpen and Krahl, *In the Biodiesel Handbook*. AOCS Press, Illinois, 2004.

[7] H. Zakaria, A. Khalid, M.F. Sies and N. Mustaffa, "Overview effect of biodiesel storage on properties and characteristics," *Applied Mechanics and Materials*, vol 465 – 466, pp. 260-264, 2014.

[8] F. Moreno, M. Munoz and J. Morea-Roy, "Sunflower Methyl Ester as a Fuel for Automobile Diesel Engines," *in Transaction of the ASAE, vol.* 42, no. 5, pp. 1181-1185, 1999.

[9] A. Khalid, N. Tamaldin, M. Jaat, M.F.M. Ali, B. Manshoor and I. Zaman, "Impacts of biodiesel storage duration on fuel properties and emissions," *Procedia Engineering*, vol. 68, pp. 225-230, 2013.