Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 00 (2013) 000–000

Procedia Engineering

www.elsevier.com/locate/procedia

The Malaysian International Tribology Conference 2013, MITC2013

Impacts of Biodiesel Storage Duration on Fuel Properties and Emissions

Amir Khalid[a], N.Tamaldin[b], M. Jaat[a], M. F. M. Ali[a], B. Manshoor[a], Izzuddin Zaman[c]

[a]*Centre for Energy and Industrial Environment Studies (CEIES), Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400 Johor, Malaysia*

[b]*Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.*

[c]*Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400 Johor, Malaysia.*

Abstract

Biodiesel produced from any fat or oil blended with diesel in different percentage has emerged as an alternative diesel and renewable energy. In Malaysia, crude palm oil (CPO) is the most preferable feedstock to be converting into biodiesel via transesterification process. This study aimed to investigate the effects of storage duration of variant blending biodiesel ratio under different storage temperature on fuel properties and exhaust emissions. The biodiesel samples were stored in clinical compartment, at different temperatures and were monitored at regular interval over a period of 60 days. Blending of biodiesel was varied from 5vol%(B5)~ 45vol%(B45) and storage temperature from 5°C~30°C. The tests subject presented in this research is performed with ASTM D6751 and EN 14214 standard. The effects of storage conditions on properties of biodiesel such as density, kinematics viscosity, acid value, water content and flash point of biodiesel were discussed in detail. Furthermore, the experimental with burner system was carried out to observe the influences of storage method on emission aspects. Analysis of the measurement performed shows that the biodiesel density, viscosity and carbon monoxide are affected by storage duration and storage temperature. High blending ratio exhibits relative variant in emissions production due to the higher oxygenated fuel.

Selection and peer-review under responsibility of The Malaysian Tribology Society (MYTRIBOS), Department of Mechanical Engineering, Universiti Malaya, 50603 Kuala Lumpur, Malaysia.

Keywords: Biodiesel Storages Time; Crude Palm Oil; Viscosity; Water Content; Emission

1. Introduction

In Malaysia, crude palm oil (CPO) is the most preferable feedstock that had been used to produce biodiesel due to the ability of production and low production cost. Biodiesel produced from any fat or oil such palm oil, through a refinery process called transesterification. Biodiesel can be used as fuel or blended with petroleum in any percentage. However, the standard storage and handling procedures used for biodiesel are the main issue due to the biodiesel fuel specifications [1-4]. Several studies have shown that biodiesel storage duration and temperature are associated with adoption of biodiesel properties and quality of biodiesel. It was reported that the fatty acid methyl ester molecules are broken down during degradation and the fatty acid chains increase the acid value of the biodiesel. Thus, the more the degradation, the higher will be its acidity [5]. In addition, acid value, peroxide value, viscosity and insoluble impurities increased while iodine value decreased with increasing storage time. Thus, decreasing in fuel stability significantly increased in acid value and viscosity of the biodiesel blends [6-7].

* Amir Khalid. Tel.:+6-07-4538484; fax: +6-07-4536080.
E-mail address: amirk@uthm.edu.my

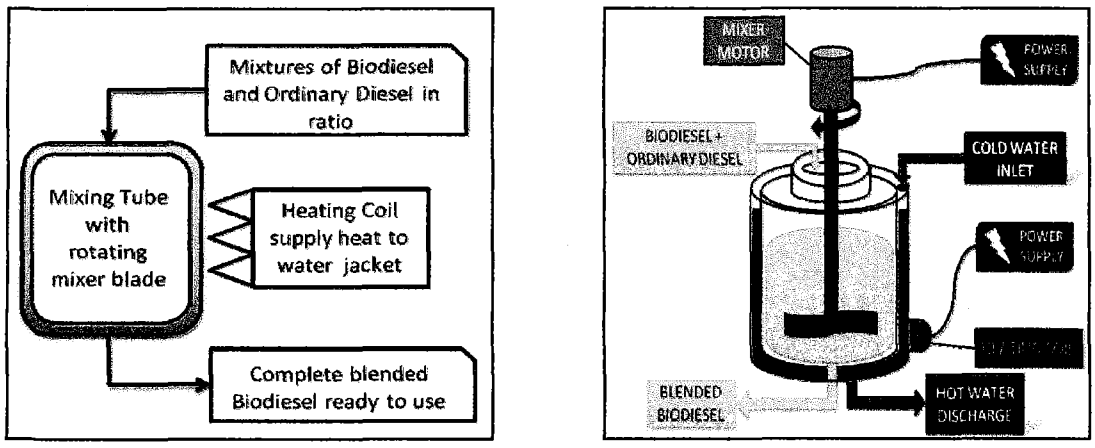
Furthermore, ambient temperature is one of the important factors that affect the degradation of biodiesel that contain organic components. It shows that temperature will also affect the degradation rate of biodiesel. Accordingly, the increasing of degradation rate might best be viewed as high humidity conditions and high ambient temperature [8-10]. In addition, the enrichment of oxygen due to the storage method and humidity exposure, increase in the proportion of oxygen will promote the further oxidation of CO exhaust emission during the combustion process. It seems that high oxygen contents are also important consideration due to the oxygenated nature of palm oil and the lower amount of carbon in the palm biodiesel blends [11-12]. Purpose of this study is to analyze the effects of storage duration of variant blending biodiesel fuel on the fuel properties and burning process that strongly affects the exhaust emissions.

In this study, the sample of biodiesel with variant percentage will keep at the variant storage condition of low temperature (6°C), ambient temperature (25°C) and high temperature (30°C). The observations of sample were tested every week for a period of 63 days. The storage method, fuel properties and combustion were very effective in response to the improvement of exhaust emission and to meet the emission standards. It is expected that this work will provide knowledge to the best storage method on the fuel properties and parametric of burning process in biodiesel combustion by changing storage method that strongly affects the quality of exhaust emissions.

2. Experimental set up

2.1 Fuel Properties Testing

This study used three kinds of biodiesel fuel (BDF) derived from CPO and the fuels tested were a grade II diesel (STD) and blends of B5, B10 and B15 palm oil with the diesel fuel. A block diagram of blending process and schematic view of blending process are shown in Fig.1 (a) and Fig.1 (b), respectively. The purified palm oil methyl ester was then blended with STD in various concentrations for preparing biodiesels blend. During blending process, the laboratory scale blending machine was operated at 60°C and the mixture was stirred at 70°C for 1 hour. The rotating blade speed was adjusted to maintain the same speed at 270 rpm.



(a) Block diagram blending process (b) Schematic of blending process

Fig.1. Illustrating the blending process of producing oil palm blended fuel

Table 1: Biodiesel properties at ambient temperature

Fuel Type	Properties			
	Density (g/cm^3)	Kinematic Viscosity (cP)	Flashpoint (°C)	Water Content (ppm)
STD	0.833736	3	80	79.6
B5	0.837048	3	91.5	120.1
B10	0.837664	2.9	92	158.6
B15	0.840428	3	93.5	219
B20	0.841172	3.1	94.5	294.7
B25	0.841716	3	97	363.3
B30	0.845852	3.2	97.5	397.1
B35	0.844816	3.4	99.5	426.9
B40	0.848236	3.2	100	558

The properties tests that will be considered in this study are included density, kinematic viscosity, moisture content, acids value and flash points test. In this research, the kinematic viscosity of palm oil blend was measured by Viscolite 700 model VL700-T15. The density properties were measured by Metter Toledo Diamond Scale modeled JB703-C/AF. Kinematic viscosity is referring to the time taken by a volume of sample (liquid form) to flow under gravity through a calibrated glass capillary viscometer. The water content and acid value in biodiesel sample were measured by Volumetric KF Titrator model v20 and titration process. The term of acid value is expressed as the amount (mg) of potassium hydroxide required to neutralize one gram of the biodiesel. During acid value measurement, sample is titrated with alcoholic KOH using phenolphthalein as indicator.The flash point measured by Pensky-Martens PMA 4. The particulars of the tested fuels are detailed in Table 1 and Table 2.

Table 2 Properties of blending biodiesel ratio at variant temperature

Blending of Biodiesel	Acid Value (mgKOH/g)			Flashpoint (°C)		
	30°C	25°C	6°C	30°C	25°C	6°C
B5	0.2805	0.2591	0.2943	86.1667	85.3333	85.3333
B10	0.3084	0.2662	0.3013	84	85	86.1667
B15	0.3224	0.3221	0.3853	87.5	87.1667	85.5
B20	0.3506	0.3644	0.3783	87.8333	89	86
B25	0.5184	0.4201	0.5044	89.1667	92	93.1667
B30	0.5055	0.4903	0.4626	87.8333	91.6667	88.1667
B35	0.5323	0.5329	0.56	91.1667	92	93.1667
B40	0.5464	0.6163	0.5741	98	102	99.3333
B45	-	-	-	102.8333	104.3333	100.1667

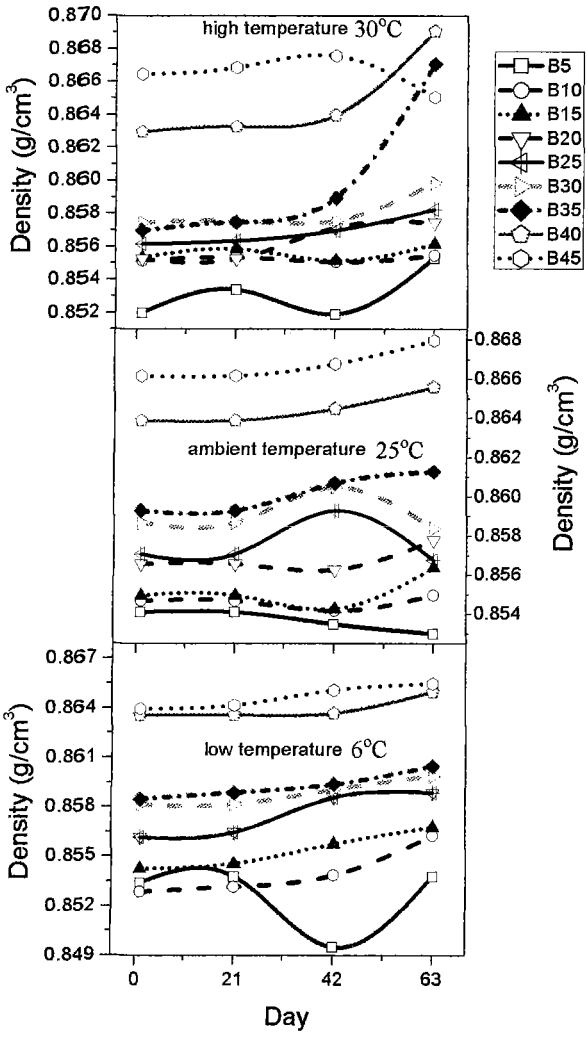


Fig. 2. Influences the storage duration at variant temperature on biodiesel density

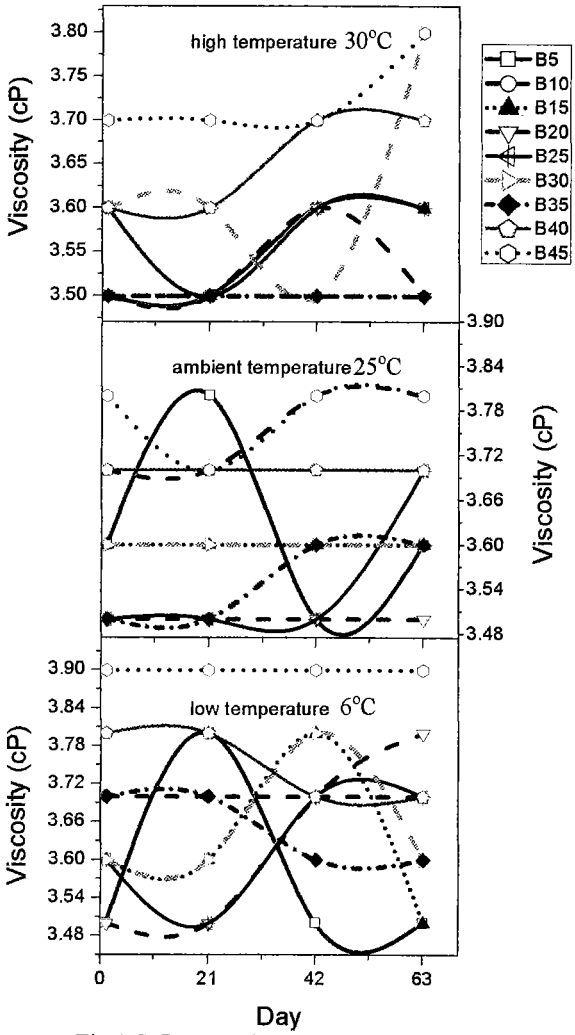


Fig.3. Influences the storage duration at variant temperature on biodiesel viscosity

3. Result and discussion

Effect of the influences of the storage duration at storage temperature on biodiesel density and viscosity were firstly investigated. The effect storage duration of biodiesel blending ratio on biodiesel properties was investigated at the base standard diesel fuel (STD fuel) for biodiesel fuel (BDF) of 5 (B5), 10 (B10), 15 (B15), 20 (B20), 25 (B25), 30 (B30), 35 (B35), 40 (B40) and 45vol%(B45) for variant storage temperature of low temperature (6°C), ambient temperature (25°C) and high temperature (30°C). Figure 2 clearly demonstrate that the increasing storage duration promote more biodiesel density especially the higher biodiesel blending ratio B45. For all variant storage condition the increasing of blending ratio thus predominantly influences the increasing of fuel density, at which time the density of biodiesel is expected to be strongly influenced by the purified palm oil methyl ester.

Figure 3 depicts the variant in biodiesel viscosity as blending ratio and storage temperature are varied. As seen in Fig. 3, the overall viscosity rate with the time changes are nearly parallel for ambient conditions. However, increased storage temperature thus predominantly influences the reductions of biodiesel viscosity, while having little impact on the viscosity behavior especially under high blending ratio B45. By evaluating the density and viscosity of biodiesel properties, we find that the increasing storage temperature and storage duration are likely to provide significant additional benefits to the fuel-air premixing and exists for achieving the best mixture preparation and evaporation; as such behavior could be influenced to combustion process and emissions production.

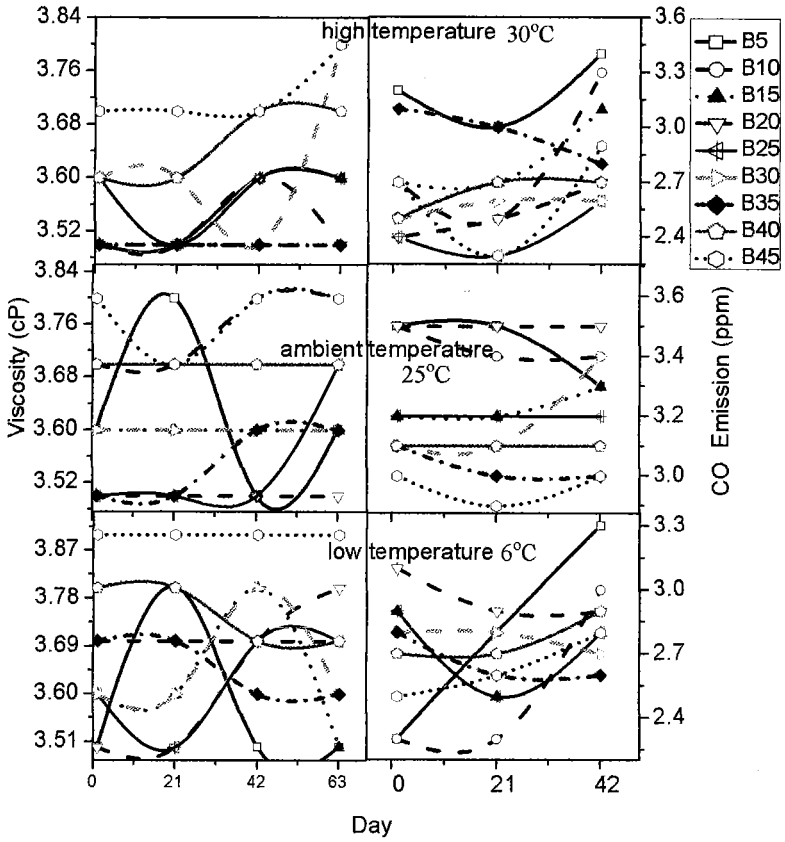


Fig.4 Effects of storage duration on viscosity and CO emissions

The effect of storage duration on CO emission was investigated in a manner similar to that employed to study the effects of biodiesel properties behavior with the time changes. The relation of biodiesel viscosity and CO emission are more clearly observed by examining the characteristics of CO emissions production presented in Fig.4. As seen in Fig.4, high blending ratio B45 also exhibits relatively small variant in CO emissions, despite significant higher biodiesel viscosity at the higher blending ratio. This behavior could be attributed to combustion process because of higher oxygenated fuel under B45 condition, the CO emissions becomes more advanced for the lower blending ratio. The complete combustion and fully utilized high oxygen content in fuel associated with the decreasing of CO emission. This correlation suggest that the storage duration, blending ratio and the oxygenated fuel contents responsible for the physical fuel properties is also the mechanism responsible for the decreased CO emissions.

4. Conclusion

This study investigated the effects of storage duration of variant blending biodiesel on fuel properties and emissions production. Fuel properties such as density, kinematic viscosity, moisture content, acids value and flash points were measured in detail using laboratory equipment and based on ASTM standard. The results are summarized as follows.

1. Increasing storage duration for all variant blending ratios are found to influences the increasing of the fuel density, resulting in increased the biodiesel viscosity especially under high storage temperature (30^0C) and higher biodiesel blending ratio (B45).
2. High blending ratio B45 exhibits relative variant in CO emissions. This behavior could be attributed to combustion process because of higher oxygenated fuel under B45 condition, the CO emissions becomes more advanced for the lower blending ratio.

Acknowledgements

The authors also would like to thank the Universiti Tun Hussein Onn Malaysia for the Short Term Grant (STG) VOT.0997 and Ministry of Higher Education, Malaysia for supporting this research under COE-MTUN Grant Scheme VOT.C009 and Fundamental Research Grant Scheme (FRGS) vot.1054.

References

[1] Yo-Ping Wu, Ya Fen Lin and Jhen-Yu Ye (2011), *"The Effect Storage Condition on Biodiesel"*, Department of Chemical and materials Engineering, National Ilan University Taiwan, R.O.C.

[2] J.A. Kinast (2003), "Production *of Biodiesels from Multiple Feedstocks and Properties of Biodiesel and Biodiesel / Diesel Blends"*, Gas Technology Institute Des Plaines, Illinois, Final Report 1 in a series of 6.

[3] Amir Khalid and Bukhari Manshoor, *"Analysis of Mixture formation and Flame Development of Diesel Combustion using a Rapid Compression Machine and Optical Visualization Technique"*, Applied Mechanics and Materials Vols. 315(2013), Trans tech Publications, Switzerland, pp 293-298

[4] Amir Khalid, Osman S.A, M. Jaat, Mustaffa N., Basharie S.M., B. Manshoor, *"Performance and Emissions Characteristics of Diesel Engine Fuelled by Biodiesel Derived from Palm Oil"*, International Conference on Mechanical & Manufacturing Engineering (ICME2012), pp.1-5, 2012.

[5] Jinllin Xue, Tony E. Grift, Alan C. Hansen, *"Effect of biodiesel on engine performances and emission"*, Department of Agricultural and Biological Engineering, University of Illinois at Urbana-Champingn, Urbana, USA. (2011).

[6] Leung, D.Y.C; Koo, B.C.P. & Y. (2006) *"Degradation of biodiesel under different storage conditions"*. Bioresource Technology. Vol 97, pp. 250-256. ISSN 23.

[7] Prommes Kwanchareon, Apanee Luengnaruemitchai, Samai Jai-In (2007), *"Solubility of a diesel-biodiesel-ethanol blend, its fuel properties, and its emission characteristics from diesel engine"*. Fuel. Vol. 86, pp. 1053-1061.

[8] Xiaoyan Shi, Xiaobing Pang, Yujing Mu, Hong He, Shijin Shuai, Jianxin Wang, Hu Chen, Rulong Li (2006) *" Emission reduction potential of using ethanol-biodiesel-diesel fuel blend on a heavy-duty diesel engine"*, Atmospheric Environment. Vol. 40, pp. 2567-2574.

[9] Amir Khalid, Tomoaki Yatsufusa, Takayuki Miyamoto, Jun Kawakami, Yoshiyuki Kidoguchi, *"Analysis of Relation between Mixture Formation during Ignition Delay Period and Burning Process in Diesel Combustion"*, Small Engine Technology Conference 2009 (SETC2009); Society of Automotive Engineering (SAE), SAE Paper No. 2009-32-0018, 2009.

[10] C. Carraretto, A. Macor, A.Mirandola, A. Stoppato, S. Tonon (2004), *"Biodiesel as a alternative fuel: Experimental analysis and energetic evaluations"*. Energy. Vol. 29, pp. 2195-2211.

[11] Anja Oasmaa, Stefan Czernik (1999), *"Fuel Oil Quality of Biomass Pyrolysis Oils – State of the Art for the End User"*. Energy & Fuel. Vol. 13, pp. 914-921.

[12] A.A.Aziz, M.F. Said, M. A. Awang and M. Said, *"The Effects of Naturalized Palm Oil Methyl Esters (NPOME) on Performance and Emission of a direct Injection Diesel Engine"*, in Proc. the 1st International Conference on Natural Resources Engineering and Technology INRET 2006, 24-25 July 2006.