Biodiesel Production from Cerbera Manghas Using Different Catalyst; NaOH and Zeolite

Annisa Bhikuning and M. Hafnan

Abstract—**Biodiesel is one of the alternative energy for the future. Many scientists research for the new alternatives energy fuel from plants. One of the promising raw material for making biodiesel is made from *cerbera manghas*. *Cerbera manghas* can be found in the tropical plant in Indonesia usually in Bintaro area or Bumi Serpong Damai (BSD) area in Tangerang- city, Indonesia. *Cerbera manghas* has poison fruits and usually it is used for rat repellent in the housing area. In this research, Biodiesel was made from *cerbera manghas* using different catalyst, NaOH, and zeolite. There are four samples; blended between diesel fuel (90%) and Biodiesel cerbera manghas using catalyst NaOH (10%) (CMNaOH10), blended between diesel fuel (95%) and biodiesel *carbera manghas* using catalyst NaOH (5%) (CMNaOH5), blended between diesel fuel (90%) and biodiesel *Carbera manghas* using catalyst zeolite (10%) (CMZ10) and blended between diesel fuel (95%) and biodiesel *carbera manghas* using catalyst zeolite (5%) (CMZ5). In the results, CMNaOH10 and CMNaOH5 have higher in ash and sediment content. Nevertheless, CMZ10 and CMZ5 have good results as they meet all the requirements for the Biodiesel specification.**

Index Terms—**Carbera mangas, biodiesel, catalyst, zeolite, NaOH.**

I. Introduction

Biodiesel is one of the alternative energy for the future. Nowadays, the source of Biodiesel or fatty acid methyl ester (FAME) is from edible oils such as rapeseed oil [1], sunflower oil [2], coconut oil [3], palm oil [4] and soybean oil [5]. Those oils are made from vegetable and unfortunately that human beings still need for the food stock resource. Therefore, it is important to find another biodiesel source that non-edible as prospective feedstock for production of biodiesel.

For the production of biodiesel, a suitable catalyst is required to promote the trans esterification reaction in order to obtain reasonable conversion to the mono-alkyl ester (biodiesel) [6]-[9]. Homogeneous alkaline and acidic catalyst have several problems, making the cost of biodiesel is not economical and affect the environmental impact of biodiesel manufacture. Such as corrosion, formations of soap and catalysts loses [10].

Zeolite as based for catalyst can be able to substitute the ordinarily catalyst in biodiesel production. Zeolite as catalyst can also more environmental friendly and more economical than the ordinarily catalyst.

The use of zeolite catalyst for trans esterification of waste vegetable oils into biodiesel has been investigated in some literatures. Noor Al-Jammal, *et al* [10] used zeolite based catalyst from zeolite tuft for trans esterification of sunflower oil. As the result that 1-4M KOH treated by zeolite tuff catalyst provided the maximum biodiesel yield of 96.7% at 50oC reaction temperature. Ramos M.J *et al* [11] used zeolite (mordenite, beta and X) as a heterogeneous catalyst for trans esterification of sunflower oil. The result, zeolite X was agglomerated with sodium bentonite as a binder. At 60 ℃ methyl ester was obtained with or without sodium bentonite with the content of 93.5 and 95.1 wt%.

One of the promising biodiesel production sources is from *carbera manghas*. *Cerbera manghas* sometimes called *carbera odollam* belongs to the notoriously poisonous *Apocynaceae* family, which also includes the yellow oleanders (*Thevetioaperuviana* and *Thevetianerifolia*) and common \oleanders (*Nerium* oleander and *Neriumindicum*) [12]. The fruit, when still green looks like a small mango, with a green fibrous shell enclosing an avoid kernel measuring approximately 2 cm × 1.5 cm and consisting of two cross-matching white fleshy halves [12].

There are limit studies further to suggest and propose the use of *carbera manghas* as a feedstock for biodiesel production [13]. The oil content of *cerbera manghas* seeds is 54% [14]. Ong H C, *et al* [13] studied the production of *cerbera manghas* by two step-alkaline trans esterification using H2SO4 (acid catalyst) and KOH (alkaline catalyst). The result that the viscosity of biodiesel *carbera manghas* can reduced up to 3.54 mm^2/s. Hendra D, *et al* [15] studied the modification process in production of *cerbera manghas* using bentonite 1.5% for degumming, zeolite 1.5% for esterification and methanol 20% (v/v), KOH 0.6% (b/v) for transesterification. The result that the acid number in c*erbera manghas* can be reduced up to 0.47 mg base/g.

Therefore, the main objectives of this study are to produce Biodiesel from *cerbera manghas* from two different catalysts, there are NaOH and Zeolite. Then, the results were studied and evaluated based on ASTM standard specification for Indonesian diesel fuel 48 [15].

II. Material and Method

A. The Material

The fruits of *cerbera manghas* were collected around Bumi Serpong Damai (BSD), Tangerang-City, Indonesia. All the chemicals and solvents were purchased from Jakarta, Indonesia. Prior the extraction process, *cerbera maghas* seeds were dried under the sun for 3-5 days to remove the excess moisture from the seeds. The oil was then extracted

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using a pressing tool. Then the oil was measured to calculate the content of oil using the different catalyst. Next step was degumming process to the oil in order to remove the gum, residue, water, mucus, etc from the *carbera mangas* crude oil. Degumming processed were using H3PO4 (0.3% v/w). Then *carbera mangas* crude oil washed with the pure water with the composition 1:1 in several times until the waste water is becoming a neutral (PH neutral).

B. Using Catalyst NaOH

Methanol 20% v/w and NaOH 0.3% v/w were mixing in the temperature between 60-65oC in one hour with the speed of 400 rpm. After the trans esterification reaction processed, the mixture was allowed to cool down overnight. The reaction product was separated into two layers which the upper layer was methyl ester or biodiesel and the lower layer was glycerin. Furthermore, the *carbera manghas* biodiesel blends with diesel fuel were based on volume ratio of 95:5 and 90:10.Then, The mixture of *cerbera manghas* called CMNaOH5 and CMNaOH10.

C. Using Catalyst Zeolite

Natural zeolite sized of 0.7-1.4 mm. In order to activate the zeolite, 10 grams of zeolite were heated in the oven at the temperature of 110oC for two hours to remove the excess of moisture. Then, zeolite was reconstituted by 250 ml (1MHCl) for 24 hours. Next zeolite was washed and dried into the oven for 6 hours at the temperature of 120°C and the calcination process at the temperature of 500oC for 3 hours. Furthermore, 100 grams *cerbera manghas* oil heated to 60 °C for 30 minutes, activated zeolite was added with 10 grams into 20 cc of methanol. The last, the *cerbera manghas* biodiesel blends with diesel fuel were based on volume ratio of 95:5 and 90:10.

The mixture of *cerbera manghas* called CMZ5 and CMZ10.

TABLE I: FATTY ACID COMPOSITION FROM CARBERA MANGAS CRUDE OIL [16]

Components	Carbera Mangas Crude Oil
Myristate Acid (C14:0)	-
Palmitate Acid (C16:0)	19.68
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Arachidate Acid (C20)	-
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Behenate Acid (C22:0)	-
Lignocerate Acid (C24)	-

III. RESULTS AND DISCUSSION

A. Fatty Acid Composition

The fatty acid composition of *cerbera mangas* is shown in Table I.

The fatty acid components in *cerbera mangas* are dominated from fatty acids such as oleate acid 38.13%, palmitate acid 19.68% and linoleate acid 14.19%. This fatty acids came from the hydrolysis of the lipase enzyme in *carbera mangas* seeds. The hydrolysis occurs when the *carbera mangas* seeds are peeled off and the enzyme will come in contact with cells that contain oil in the seeds. This hydrolysis can produce some fatty acids and glycerol [17].

Sudrajat, *et al* [18] studied that *carbera mangas* crude oil has higher palmetat acid and oleat acid than jatropha curcas. Linoleat acid in carbera mangas crude oil is also lower than jatropha curcas.

B. The Fuel Properties

The Properties such as viscosity, density, ash content, sediment, cetane index, PH, color ASTM and acid number were measured. The properties of CMNaOH5, CMNaOH10, CMZ5 and CMZ10 were measured in Petrolab Services Laboratory in Jakarta, Indonesia. However, The pure *cerbera manghas* oil (CMME) properties were collected from Ong H. C *et al* in 2014 [13].

C. Density

In order to have a good combustion in the engine. The density is important to determine because it is calculated the exact fuel volume [7] and it is also impact to the fuel atomization and combustion in the engine [8].

Fig. 1 shows that the density from CMNaOH5, CMNaOH10, CMZ5, and CMZ10 have meet the requirement of ASTMD1298. Nevertheless, CMME has above the maximum limit (869.7 kg/m3). The density of CMME is the highest from others because it is pure oil. CMME has not been processing to Trans esterification.

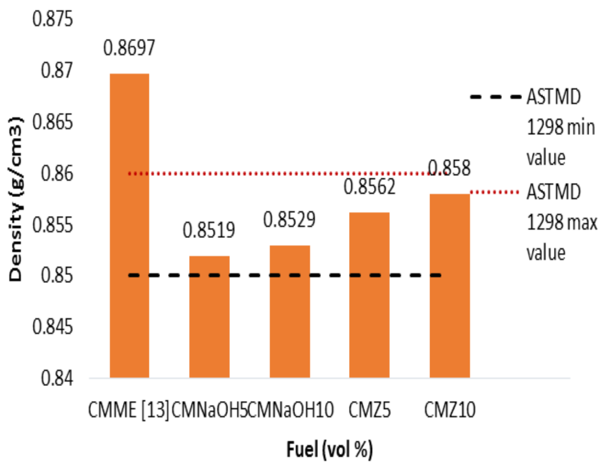

Fig. 1. Density from various biodiesel.

D. Viscosity

The analysis in viscosity is very important in the fuel especially in biodiesel. The viscosity has huge influence in producing the deposits and can effect in the spray atomization [8]. Higher viscosity in the fuel can make harder of the fuel to pump and make a poor spray droplets in atomization [10].

From Fig. 2, the viscosity of CMNaOH5, CMNaOH10, CMZ5 and CMZ10 have meet the requirements for min and max value of ASTMD 1298. The viscosity of CMZ5 has 10% lower than CMNaOH10. Nevertheless the CMZ10 has 1.64% higher than CMNaOH10. CMME has not meet the requirement for ASTMD445 min and max value due do has highest viscosity from among the fuel.

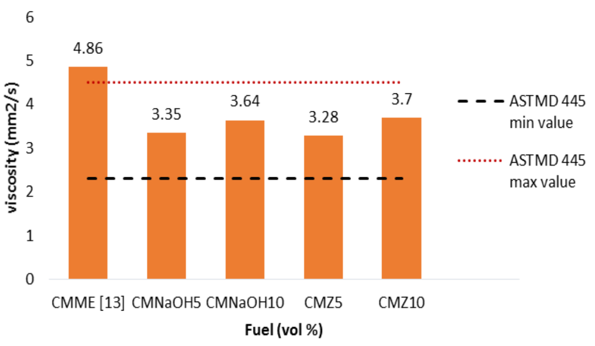

Fig. 2. Viscosity from various biodiesel.

E. *Cetane Index*

The cetane index was calculated based on ASTM D 976. The standard limitation of cetane index is 45. Cetane index is always lower than cetane number about 2 to 3 [19]. From Fig. 3 shown that all samples have met the requirement of ASTMD 976 (up to 45). Lower cetane number causes poor engine performance, but higher cetane number helps to start the machine easily in cold conditions and minimize the formation of white smoke [20].

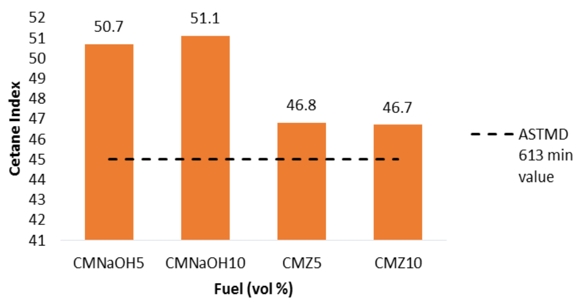

Fig. 3. Cetane Index from various biodiesel.

F. *Flash Point*

Flash point is the temperature in which the fuels will be automatically ignited in the storage. The lower temperature of the flash point, the easier self-ignition will be [10]. CMME has high in the flash point (up to 52) however, CMZ5 and CMZ10 have meet the ASTMD93 standard (minimum 52).

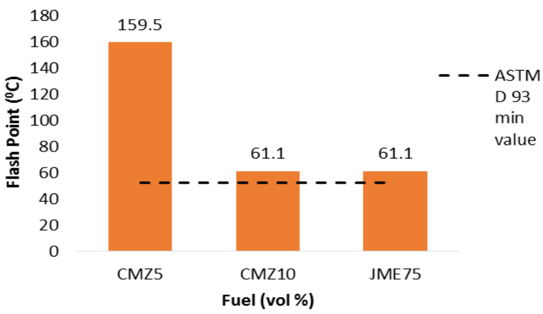

Fig. 4. Flash Point from various biodiesel.

G. *Acid Number*

The concentration of acid in the oil called acid number. Acid number too high or too low can affect the oil oxidation. The oil oxidation can cause the formed of acid product. High acid levels indicates that the excessive oil oxidation or deficiency from the additives of oils can cause the corrosion [21]. Fig. 5 shows the acid number from various biodiesel. It shows that all the biodiesels have meet the requirements of ASTMD 974 standardization.

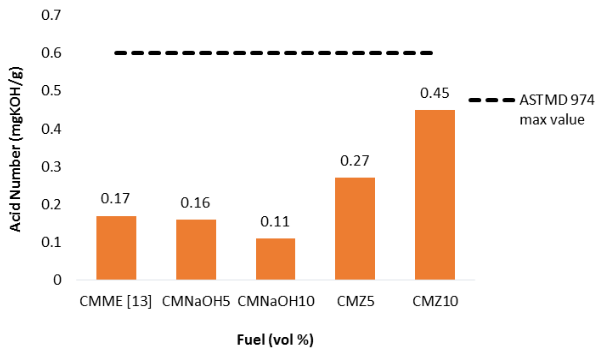

Fig. 5. Acid Number from various biodiesel.

H. *Sediment*

It is important to analyze the sediment in biodiesel. The higher sediment in biodiesel can reduce the flow of fuel from tank to the combustion chamber [22]. From Fig. 6, it shows CMZ10 is the only meet the requirement of ASTMD 473 max value standard. This happened due to the characteristics from zeolite can be able to stabilize the effect of metal stabilization in the sediment [23].

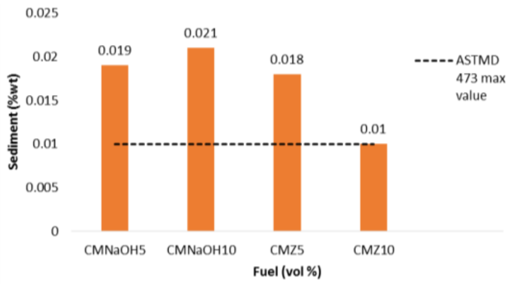

Fig. 6. Sediment from various biodiesel.

IV. Conclusion

In this study biodiesel production from *cerbera manghas* using different catalyst was reported and investigated. It is shown that using different catalyst NaOH and zeolite will have different physicochemical properties from biodiesel *cerbera manghas*. It is also shown that different percentage of blending diesel fuel will have different properties from biodiesel and that would affect the engine combustion and emissions. In this study, although most all the biodiesel have meet the requirements for biodiesel standard. Nevertheless, only CMZ10 has met all the requirements for biodiesel properties standard. This can be proved that zeolite can be considered to be a catalyst to produce the biodiesel and the non-edible oil from *cerbera manghas* can also be considered as a future biodiesel feedstock.

Acknowledgment

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References

[1] Y. L. Meng, S. J. Tian, S. F. Li, B. T. Wang, and M. H. Zhang, "Transesterification of rapeseed oil for biodiesel production in trickle-bed reactors packed with heterogeneous Ca/Al composite–

based alkaline catalyst," *Bioresource Technology*, vol. 136, pp. 730-773, 2012.
[2] T. Saba, J. Estephane, B. El Khoury, and M. El Khoury, "Biodiesel production from refined sunflower vegetable oil over KOH/ZSMS catalyst," *Renewable Energy*, vol. 90, pp. 301-306, 2016.
[3] S. C. Tupufia, Y. J. Jeon, C. Marquis, A. A. Adesina, and P. L. Rogers, "Enzymatic conversion of coconut oil for biodiesel production," *Fuel ProcessingTechnology*, vol. 106, pp. 721-726, 2013.
[4] N. A. M. Azam, Y. Uemura, K. Kusakabe, and M. A. Bustam, "Biodiesel production from palm oil using micro tube reactors: Effects of catalyst concentration and residence time," *Procedia Engineering*, vol. 148, pp. 354-360, 2016.
[5] M. F. Milazzo, F. Spina, P. Primerano, and J. C. J. Bart, "Soy biodiesel pathways: Global prospects," *Renewable and Sustainable Energy Reviews*, vol. 26, pp. 579-624, 2013.
[6] S. Fernando, P. Karra, R. Hernandez, S. K. Jha, "Effect of incompletely converted soybean oil on Biodiesel quality," *Energy*, vol. 32, pp. 844-851, 2007.
[7] J. V. Gerpen, "Biodiesel processing production," *Fuel Processing and Production*, vol. 86, pp. 1097-1107, 2005.
[8] F. Ma and M. A. Hanna "Biodiesel production: A review," *Bioresource Technology*, vol. 70, pp. 1-15, 1999.
[9] U. Schuchardt, R. Sercheli, and R. M. Vargas, "Transesterification of vegetable oils: A review," *J. Braz. Chem. Soc.*, vol. 9, pp. 199-210, 1998.
[10] N. Al-Jamal, Z. Al-hamamre, and M. Alnaief, "Manufacturing of Zeolite based catalyst from Zeolite tuft for biodiesel production from waste sunflower oil," *Renewable Energy*, vol. 93, pp. 449-459, 2016.
[11] M. J. Ramos, A. Casas, L. Rodriguez, R. Romero, and A. Perez, "Transesterification of sunflower oil over zeolites using different metal loading: A case of leaching and agglomeration studies," *Appl. Catal. A. General.*, vol. 346, pp. 79-85, 2008.
[12] Y. Gailard, A. Krisnamoorthy, and F. Bevalot, "Cerbera Odollam: A 'suicide tree' and cause of death in the state of Kerala, India," *Ethnopharmacol*, vol. 95, pp. 123-126, 2004.
[13] H. C. Ong, A. S. Silitonga, T. M. I. Mahlia, H. H. Masjuki, W. T. Chong, "Investigation of biodiesel production from Cerbera Manghas biofuel sources," *Energy Procedia*, vol. 61, pp. 436-439, 2014.
[14] A. S. Silitonga, H. H. Masjuki, T. M. I. Mahlia, H. C. Ong, W. T. Chong, M. H. Boosroh, "Overview properties of biodiesel blends from edible and non-edible feedstock," *Renewable and Sustainable Energy Reviews*, vol. 22, pp. 346-360, 2013.
[15] Indonesia Diesel Fuel Specification. *Dirjen Migas*. [Online]. Available: http://transportpolicy.net/index.php?title=Indonesia:_Fuels:_Diese l_and_Gasoline
[16] D. Hendra, S. Wibowo, N. Hastuti, and H. S. Wibisono, "Characteristics of biodiesel of bintaro seeds (cerbera manghas L) by modification process," *Jurnal Penelitian Hasil Hutan*, vol. 34, no. 1, pp. 11-21, 2016.
[17] S. Kateran, *Pengantar Teknologi Minyak dan Lemak Panga*n, Jakarta, UI Press, 2008.
[18] R. Sudrajat, D. Hendra, and D. Setiawan, *Teknologi Pengolahan Biodiesel dari Biji Bintaro*, The Research report, Bogor, pusat litbang keteknikan kehutanan dan pengolahan hasil hutan, Bogor, 2012.
[19] J. V. Gerpen, B. Shanks, and R. Pruszko, "Biodiesel production technology," *National Renewable Energy Laboratory*, *Colorado*, 2004.
[20] I. W. Susila, Rachimoellah, and I. N. Sutantra, "The performance of diesel engine using biodiesel fuel from rubber seed oil production by catalytic method," *International Journal of Technology*, vol. 1, pp. 24-34, 2012.
[21] Test oil for biodiesel. [Online]. Available: https://testoil.com/services/oil-analysis/acid-number/
[22] G. Knothe, "Analyzing biodiesel: Standards and other methods," *Journal of the American Oil Chemists's Society*, vol. 83, no. 10, 2006.
[23] J. Wen, Y. Yi, and G. Zeng, "Effects of mmodified zeolite on the removal and stabilization of heavy metals in contaminated lake sediment using BCR sequential extraction," *Journal of Environmental Management*, vol. 178, pp. 63-69, 2016.

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M. Hafnan was graduated from Trisakti University for bachelor degree in Mechanical Engineering Department in 1983. He continued to study master of engineering and doctor of engineering at Ritsumeikan University Kyoto Japan. He is currently a lecturer in Mechanical Engineering Department Trisakti University concentrate in energy conversion.

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In order to have a good combustion in the engine. The density is important to determine because it is calculated the exact fuel volume [7] and it is also impact to the fuel atomization and combustion in the engine [8].

Fig. 1 shows that the density from CMNaOH5, CMNaOH10, CMZ5, and CMZ10 have meet the requirement of ASTMD1298. Nevertheless, CMME has above the maximum limit (869.7 kg/m3). The density of CMME is the highest from others because it is pure oil. CMME has not been processing to Trans esterification.

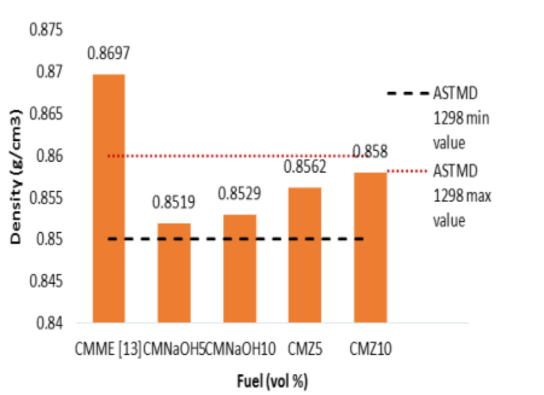

Fig. 1. Density from various biodiesel.

D. Viscosity

The analysis in viscosity is very important in the fuel especially in biodiesel. The viscosity has huge influence in producing the deposits and can effect in the spray atomization [8]. Higher viscosity in the fuel can make harder of the fuel to pump and make a poor spray droplets in atomization [10].

From Fig. 2, the viscosity of CMNaOH5, CMNaOH10, CMZ5 and CMZ10 have meet the requirements for min and max value of ASTMD 1298. The viscosity of CMZ5 has 10% lower than CMNaOH10. Nevertheless the CMZ10 has 1.64% higher than CMNaOH10. CMME has not meet the requirement for ASTMD445 min and max value due do has highest viscosity from among the fuel.

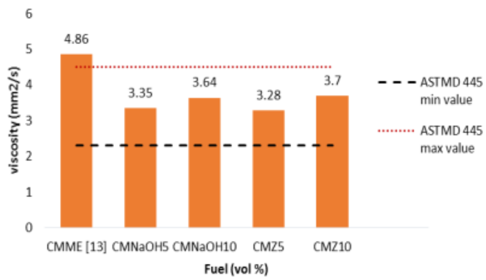

Fig. 2. Viscosity from various biodiesel.

E. Cetane Index

The cetane index was calculated based on ASTM D 976. The standard limitation of cetane index is 45. Cetane index is always lower than cetane number about 2 to 3 [19]. From Fig. 3 shown that all samples have met the requirement of ASTMD 976 (up to 45). Lower cetane number causes poor engine performance, but higher cetane number helps to start the machine easily in cold conditions and minimize the formation of white smoke [20].

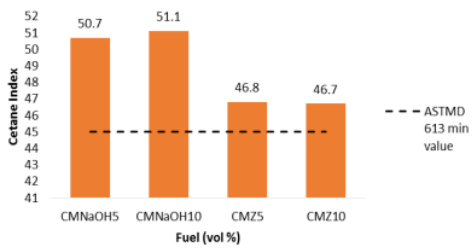

Fig. 3. Cetane Index from various biodiesel.

F. Flash Point

Flash point is the temperature in which the fuels will be automatically ignited in the storage. The lower temperature of the flash point, the easier self-ignition will be [10]. CMME has high in the flash point (up to 52) however, CMZ5 and CMZ10 have meet the ASTMD93 standard (minimum 52).

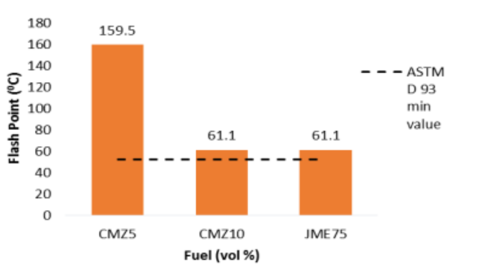

Fig. 4. Flash Point from various biodiesel.

G. Acid Number

The concentration of acid in the oil called acid number. Acid number too high or too low can affect the oil oxidation. The oil oxidation can cause the formed of acid product. High acid levels indicates that the excessive oil oxidation or deficiency from the additives of oils can cause the corrosion [21]. Fig. 5 shows the acid number from various biodiesel. It shows that all the biodiesels have meet the requirements of ASTMD 974 standardization.

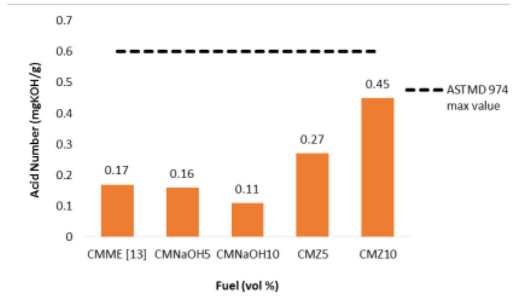

Fig. 5. Acid Number from various biodiesel.

H. Sediment

It is important to analyze the sediment in biodiesel. The higher sediment in biodiesel can reduce the flow of fuel from tank to the combustion chamber [22]. From Fig. 6, it shows CMZ10 is the only meet the requirement of ASTMD 473 max value standard. This happened due to the characteristics from zeolite can be able to stabilize the effect of metal stabilization in the sediment [23].

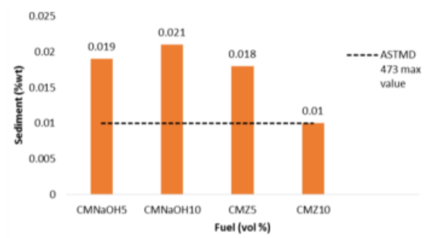

Fig. 6. Sediment from various biodiesel.

IV. Conclusion

In this study biodiesel production from *cerbera manghas* using different catalyst was reported and investigated. It is shown that using different catalyst NaOH and zeolite will have different physicochemical properties from biodiesel *cerbera manghas*. It is also shown that different percentage of blending diesel fuel will have different properties from biodiesel and that would affect the engine combustion and emissions. In this study, although most all the biodiesel have meet the requirements for biodiesel standard. Nevertheless, only CMZ10 has met all the requirements for biodiesel properties standard. This can be proved that zeolite can be considered to be a catalyst to produce the biodiesel and the non-edible oil from *cerbera manghas* can also be considered as a future biodiesel feedstock.

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References

[1] Y. L. Meng, S. J. Tian, S. F. Li, B. T. Wang, and M. H. Zhang, "Transesterification of rapeseed oil for biodiesel production in trickle-bed reactors packed with heterogeneous Ca/Al composite–

based alkaline catalyst," *Bioresource Technology*, vol. 136, pp. 730-773, 2012.

[2] T. Saba, J. Estephane, B. El Khoury, and M. El Khoury, "Biodiesel production from refined sunflower vegetable oil over KOH/ZSMS catalyst," *Renewable Energy*, vol. 90, pp. 301-306, 2016.

[3] S. C. Tupufia, Y. J. Jeon, C. Marquis, A. A. Adesina, and P. L. Rogers, "Enzymatic conversion of coconut oil for biodiesel production," *Fuel ProcessingTechnology*, vol. 106, pp. 721-726, 2013.

[4] N. A. M. Azam, Y. Uemura, K. Kusakabe, and M. A. Bustam, "Biodiesel production from palm oil using micro tube reactors: Effects of catalyst concentration and residence time," *Procedia Engineering*, vol. 148, pp. 354-360, 2016.

[5] M. F. Milazzo, F. Spina, P. Primerano, and J. C. J. Bart, "Soy biodiesel pathways: Global prospects," *Renewable and Sustainable Energy Reviews*, vol. 26, pp. 579-624, 2013.

[6] S. Fernando, P. Karra, R. Hernandez, S. K. Jha, "Effect of incompletely converted soybean oil on Biodiesel quality," *Energy*, vol. 32, pp. 844-851, 2007.

[7] J. V. Gerpen, "Biodiesel processing production," *Fuel Processing and Production*, vol. 86, pp. 1097-1107, 2005.

[8] F. Ma and M. A. Hanna "Biodiesel production: A review," *Bioresource Technology*, vol. 70, pp. 1-15, 1999.

[9] U. Schuchardt, R. Sercheli, and R. M. Vargas, "Transesterification of vegetable oils: A review," *J. Braz. Chem. Soc.*, vol. 9, pp. 199-210, 1998.

[10] N. Al-Jamal, Z. Al-hamamre, and M. Alnaief, "Manufacturing of Zeolite based catalyst from Zeolite tuft for biodiesel production from waste sunflower oil," *Renewable Energy*, vol. 93, pp. 449-459, 2016.

[11] M. J. Ramos, A. Casas, L. Rodriguez, R. Romero, and A. Perez, "Transesterification of sunflower oil over zeolites using different metal loading: A case of leaching and agglomeration studies," *Appl. Catal. A. General.*, vol. 346, pp. 79-85, 2008.

[12] Y. Gailard, A. Krisnamoorthy, and F. Bevalot, "Cerbera Odollam: A 'suicide tree' and cause of death in the state of Kerala, India," *Ethnopharmacol*, vol. 95, pp. 123-126, 2004.

[13] H. C. Ong, A. S. Silitonga, T. M. I. Mahlia, H. H. Masjuki, W. T. Chong, "Investigation of biodiesel production from Cerbera Manghas biofuel sources," *Energy Procedia*, vol. 61, pp. 436-439, 2014.

[14] A. S. Silitonga, H. H. Masjuki, T. M. I. Mahlia, H. C. Ong, W. T. Chong, M. H. Boosroh, "Overview properties of biodiesel blends from edible and non-edible feedstock," *Renewable and Sustainable Energy Reviews*, vol. 22, pp. 346-360, 2013.

[15] Indonesia Diesel Fuel Specification. *Dirjen Migas*. [Online]. Available: http://transportpolicy.net/index.php?title=Indonesia:_Fuels:_Diesel_and_Gasoline

[16] D. Hendra, S. Wibowo, N. Hastuti, and H. S. Wibisono, "Characteristics of biodiesel of bintaro seeds (cerbera manghas L) by modification process," *Jurnal Penelitian Hasil Hutan*, vol. 34, no. 1, pp. 11-21, 2016.

[17] S. Kateran, *Pengantar Teknologi Minyak dan Lemak Pangan*, Jakarta, UI Press, 2008.

[18] R. Sudrajat, D. Hendra, and D. Setiawan, *Teknologi Pengolahan Biodiesel dari Biji Bintaro*, The Research report, Bogor, pusat litbang keteknikan kehutanan dan pengolahan hasil hutan, Bogor, 2012.

[19] J. V. Gerpen, B. Shanks, and R. Pruszko, "Biodiesel production technology," *National Renewable Energy Laboratory, Colorado*, 2004.

[20] I. W. Susila, Rachimoellah, and I. N. Sutantra, "The performance of diesel engine using biodiesel fuel from rubber seed oil production by catalytic method," *International Journal of Technology*, vol. 1, pp. 24-34, 2012.

[21] Test oil for biodiesel. [Online]. Available: https://testoil.com/services/oil-analysis/acid-number/

[22] G. Knothe, "Analyzing biodiesel: Standards and other methods," *Journal of the American Oil Chemists's Society*, vol. 83, no. 10, 2006.

[23] J. Wen, Y. Yi, and G. Zeng, "Effects of mmodified zeolite on the removal and stabilization of heavy metals in contaminated lake sediment using BCR sequential extraction," *Journal of Environmental Management*, vol. 178, pp. 63-69, 2016.

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