Ultimate analysis and acid value of biodiesel from waste oil and ethanol

IOP Conf. Series: Materials Science and Engineering **508** (2019) 012097 doi:10.1088/1757-899X/508/1/012097

Ultimate analysis and acid value of biodiesel from waste oil and ethanol

I Wayan Bandem Adnyana[1*] and Ni Made Suaniti[2]

[1]Mechanical Engineering Department, Faculty of Engineering
[2]Chemistry Department, Faculty of Mathematic and Natural Sciences
Universitas Udayana

*bandem.adnyana@unud.ac.id

Abstract. Waste cooking oil is a renewable energy source that is easily obtainable in a domestic environment. This energy source can be used as a substitute for diesel fuel known as biodiesel. Biodiesel can be produced from the process of esterification and transesterification reagent used cooking oil with ethanol. The content of fossil fuels as an energy source in general can be seen from the content of the main elements of which are carbon and hydrogen. The purpose of this study to determine the content of carbon, hydrogen, and acid in biodiesel produced from waste cooking oil and ethanol reagent using phosphoric acid catalyst in the process of esterification and sodium hydroxide in the transesterification process. Ultimate analysis was conducted by using ASTM method D7582 Biomass and acid number is determined by titration. The results Showed that the content of biodiesel from waste cooking oil with ethanol reagent pro analysis or ethanol from wine and distillate results are carbon and hydrogen as the main element contained as fuel in general. Percentage of Free Fatty Acids (FFA) and Acid Value in biodiesel highest in ethanol reagent pro analysis.

1. Introduction

Energy needs continue to increase along with the development of human needs for life that is practical and efficient. Facilities human needs can work if there is a source of energy such as fuel. someday, fuel availability is limited, as the preparation effort required for new energy sources. Waste cooking oil is one of the new renewable energy sources where continuous availability is expected to remain in line with the needs of cooking oil as a staple. Waste cooking oil is used oil frying results are unfit used to process food back because it is not good for health. Waste cooking oil is a saturated fat due to oxidation and hydrolysis process so that chemistry changes. Waste cooking oil in the form of used cooking oil can be used as raw material for biodiesel [1]. Biodiesel from waste cooking oil as an energy source can only be done through a process of esterification and transesterification.

Oil-based biodiesel production requires a reagent, reagent commonly used are methanol but in this study use of ethanol obtained from the distillation of wine. The result of the process of esterification and transesterification with ethanol reagent will produce fatty acid ethyl ester (FAEE) [2,3]. Triglycerides react with alcohols into esters with glycerol as a byproduct. The molecules are branched and long triglycerides turn into esters which are small and have the characteristics such as diesel oil. In addition to oil and ethanol required either acidic or basic catalysts in the form of inorganic compounds and in mixtures with organic compounds. The sulfuric acid as a catalyst used in the esterification

process biodiesel from various types of vegetable oils with an acid value varies as jatropa and cotton seed oil each gained 3.8 and 0.11 mg KOH / g of oil [4].

One effort to overcome the limitations of available energy in the future do study the manufacture of biodiesel by utilizing used cooking oil and wine as reagents using phosphoric acid as a catalyst. Seen from the performance of the fuel constituent elements were analyzed in comparison to ethanol ultimate standard of degree pro analysis.

results of the food frying oil several times can make the fried taste less tasty known as used cooking oil to form new compounds so that it is not suitable for consumption. Non-consumable oil needs to be treated to function according to its designation, due to oil decomposition of fatty acids. The fat content in this oil will affect the results obtained. To understand this used cooking oil is chemically refined before the process of making biodiesel is developed at this time. The accumulation of inorganic material such as phosphoric acid in a long time will change the environment to be not according to its designation, the more toxic toxic substances and the composition of air, water, and soil change to become unhealthy.

2. Method and materials

2.1 Biodiesel preparation

Biodiesel were prepared from waste oil after frying chicken via two routes, as follows: (1) acid catalyzed esterfication and (2) alkaline catalyzed transesterification. The first was Esterification set-up: waste oil 100mL added 20ml of ethanol and 0,5ml of phosphate acid were poured into the reactor which was a two necks and provide round-bottomed flask with a magnetic stirrer, a condenser, thermometer with continuous stirring, heated for 1 hour and conducted 60^{o}C. After the reaction, the mixture until cool down, then it was trasferred into a separating funnel and left overnight to obtain two layers. The higher layer was ethyl ester, then it was washed by heated water. The second transesterification set-up: weighting result of the esterification reactor was poured into added 1.38 g NaOH and 18.4 ml of ethanol, then heated for 1 hour with continuous stirring, it was conducted 60^{o}C. The higher layer was ethyl ester, added $CaCl_2$. It was filtered to obtain biodiesel. The percent yield was Formulated:

$$\text{Yield (\%)} = (\text{Weigh of the refined ethyl ester} \div \text{weigh of waste oil used}) \times 100\%$$

2.2 Biodiesel Measurement

Biodiesel were Analyzed by evaluating the content of the carbon, hydrogen, oxygen, and nitrogen through the ultimate analysis by using ASTM D7582 Biomass and acid value by the titration method.

3. Results and discussion

3.1 Ultimate Analysis

The percent yield of biodiesel (ethyl ester) was 93 according to the above formula, the result obtained biodiesel is higher than [5], which uses 20% volume mixture of methanol and waste cooking oil KFC Bandung and sulfuric acid catalyst 0.2% weight. To improve operating conditions yng biodiesel yield obtained in the esterification reaction of rubber seed oil and 60^{o}C methanol and sulphuric acid catalyst weight of 0.5% by weight [6].

Furthermore, biodiesel is analyzed by the ultimate analysis, it was Showed as Figure 1. The highest carbon content of about 60-70 percent, followed by about 11,02-11.99 percent hydrogen, and oxygen varied from 14.12 to 26.92 percent, and sulfur about 0.25 percent.

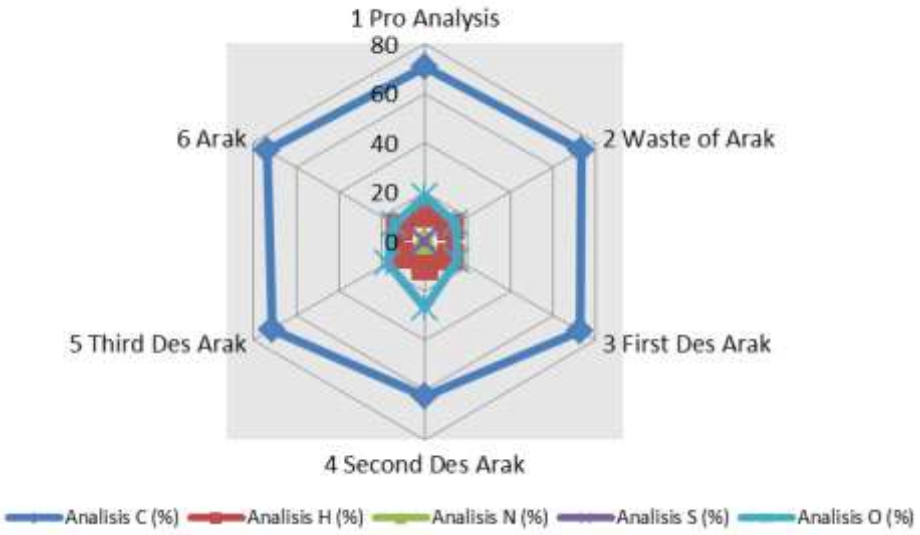

Figure 1. Results Ultimate analysis of waste cooking oil with ethanol reagent pro analysis, ethanol in wine and distillate results

The percentage of carbon and hydrogen are shown in Figure 1 in accordance with the results obtained by Anand et al., 2009 that analyzes the carbon in biodiesel Cotton seed oil amounted to 81.42 percent and 11.28 percent hydrogen is using methanol and sulfuric acid catalyst.

3.2 Acid Analysis

Acid value was Analyzed by titration, it was showed in Figure 2. The percentage of Free Fatty Acid and acid value were higher when used ethanol as reagent pro analysis Followed the ethanol from wine and finely disttiled ethanol from wine.

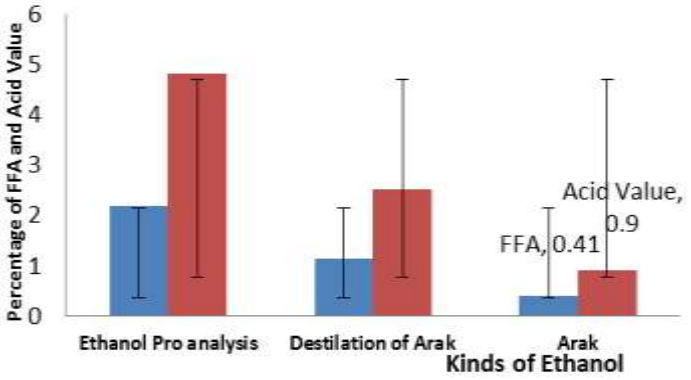

Figure 2. Percentage of Free Fatty Acid (FFA) and Acid Value in Biodiesel from Waste Oil and Kinds of Ethanol

This is in accordance with the concentration, that ethanol pro analysis is highest purity in order to obtain the acid number best level and the highest free fatty acid. Although ethanol is used from the wine and distillate results with a lower concentration of ethanol pro similarity analysis occurs ultimate result yet and the acid number lower FFA. These results are supported by [4] that biodiesel using cotton seed oil and methanol with sulphuric acid reagent obtained by the acid number is 0.11. Similarities biodiesel acid number was also obtained using methanol and hydrochloric acid catalyst in the ratio of palm cooking oil and methanol (10: 1) in the esterification process [7]. High acid number

that likely caused the oxidation reaction occurs in unsaturated fatty acids left in biodiesel forming an aldehyde functional group, easily forming a carboxylic acid ($RCHO \rightarrow RCO_2H$) is different from the ketone functional group [8], so we need more research by comparison oil and ethanol to obtain the corresponding acid number and other characteristics in order to qualify biodiesel.

4. Conclusion

The main element contained in biodiesel from waste cooking oil with ethanol pro analysis reagents, wine and distillate results using phosphoric acid catalyst (esterification) and sodium hydroxide (tranesterification process) are the elements carbon and hydrogen as fuel in general. Percentage of Free Fatty Acids (FFA) and Acid Value in the highest biodiesel after using ethanol reagent pro analysis.

5. Aknowledgment

The authors thanks the Ministry of Research, Tech., and Higher Education of the Republic of Indonesia and LPPM University of Udayana for supporting this research and paper through The Grant 2015-2016, through Contract No. 641-63/UN 14.2/PNL.01.03.00/2016.

6. References

[1] Adhiatma, A., Ansshory,C.P., Purwanto, A., & Ciptonugroho, W., 2012, The Enhancement of waste Cooking Oil Esterification Catalyzed by Sulfated Zirconia and Assisted by The Addition of Silica Gel, *Proceeding of 19th Regional Symposium on Chemical Engineering*, Bali.

[2] Zajac, G., Pickarski, W., Kizaczek, P., 2008, Comparison of an Effect of FAME and FAEE Addition to Diesel Fuel on Energetic Parameters of an Engine, *TEKA Kom. Mot. Energ. Roln – OL. PAN*, pp. 217-223.

[3] Adnyana, I W.B., Suaniti, N.M., 2015, Analysis Ethyl Ester in Biodiesel of Raw Material Waste Coconut Oil and Arak, *Proceedings2nd International Conference on Engineering of Tarumanagara "Urban Engineering for Future Generation*", 22-23 October, pp. ME-17/1-17/4.

[4] Anand, R., Kannan, G.R., Reddy, K. R., and Velmathi, S., 2009, The Performance and Emissions of A Variable Compression Ratio Diesel Engine Fuelled with Bio-Diesel from Cotton Seed Oil, *ARPN Journal of Engineering and Applied Sciences*, **4**-9-72-87.

[5] Haryono, Fairus, S., Sari, Y., Rakhmawati, I., 2010, Pengolahan Minyak Goreng Kelapa Sawit bekas menjadi Biodiesel Studi Kasus: Minyak Goreng Bekas dari KFC Dago Bandung, Prosiding Seminar Nasional Teknik Kimia, pp.1-5, ISSN 1693-4393

[6] Yuliana, F., Primasari, M., Rachmaniah, O., and Rachimoellah, M., WY. Pengaruh Katalis Asam (H_2SO_4) dan Suhu Reaksi pada Reaksi Esterifikasi Minyak Biji Karet (Hevea brasillensis) menjadi Biodiesel. Laboratproim Biomassa dan Energi, Jurusan Teknik Kimia, Fakultas Teknologi Industri Institut Teknologi Sepuluh November Surabaya.

[7] Sanjiwani, N. M. S., Suaniti, N. M., and Rustini, N. L., Bilangan Peroksida, Bilangan Asam, dan Kadar FFA Biodiesel dengan Penambahan Antioksidan dari Kulit Buah Pisang Kepok (Musa paradisiaca Linn.). *Jurnal Kimia*, **9**-2-259-266., ISSN 1907-9850.

[8] McMurry, J., and Simanek, E., 2007, Fundamental of Organic Chemistry, Sixth Edition, Thomson, pp. 268.