International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 3 March 2023, pp: 257-261 www.ijaem.net ISSN: 2395-5252

Production of Biodiesel Using the Esterification Method

Umunnakwe ChristianEmeka[1], Njoku Scholastica Chika[1], Achilike Joseph Johnbosco [1],Udeh Kennedy [1]

[1]*Chemistry/Biochemistry Department, Federal Polytechnic Nekede, Owerri.*

Date of Submission: 25-02-2023 Date of Acceptance: 05-03-2023

ABSTRACT

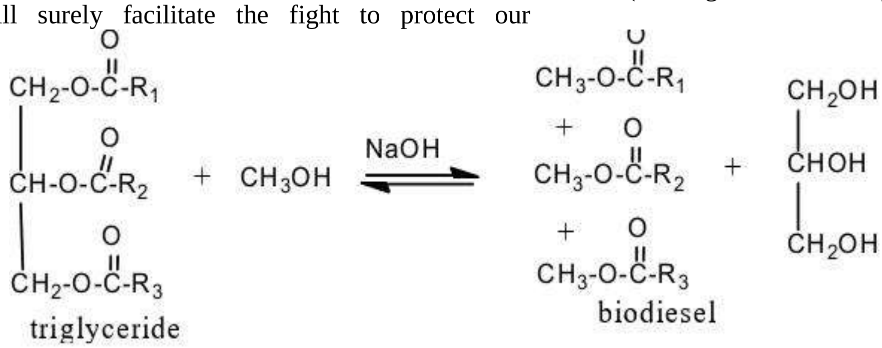
Fatty acid methyl esters were synthesized from fatty acid distillates obtained from a palm kernel oil refinery using methanol and tetraoxosulphate (vi) acid, as catalyst. Fatty acid distillates, methanol (99%), and sulphuric acid (98%), were mixed at various mole ratios and refluxed with a reflux condenser at various temperatures (40^oC to 80^oC) and contact times (10 minutes to 80 minutes). The optimum mole ratio of methanol to fatty acid was 8:1, the optimum mole ratio of H_2SO_4 to fatty acid was 0.2:1, the optimum reaction time was 60 minutes, while the optimum reaction temperature was 65^oC, which altogether gave an optimum yield of 98% biodiesel. This research has proved that biodiesel should be sourced not only from triglyceride oils but also from fatty acid distillates. Using more biodiesel than fossil diesel will help to reduce the greenhouse effect and the degradation of the earth's eco system. The results of this paper has shown that transesterification of oils is not the only source of getting biodiesel but that the esterification of fatty acid distillates obtained from vegetable oil refineries can also give high quality biodiesel. Such a breakthrough in green chemistry will surely facilitate the fight to protect our environment by cutting down on the use of fossil fuels.

Keywords: esterification, optimization, green chemistry,

I. INTRODUCTION

For centuries man has depended mostly on petroleum and coal as main sources of energy generation, leading to the release of so much greenhouse gases into the atmosphere. The major consequences of such overdependence on fossil fuels are environmental pollution, and global warming (Alamuet al., 2007; Varma and Madras, 2006). Green chemistry research has led to the production of biodiesel, as alternatives to fossil-based diesel. However, the raw materials for most of the biodiesels produced on earth are triglyceride oils such as palm oil, palm kernel oil, linseed oil, soybean oil, castor oil and sunflower oils(Silva et al., 2007; Velez et al., 2012).

Such production of biodiesel using triglycerides is called transesterification and the chemical reaction involved in the transesterification of triglyceride oils into biodiesel is illustrated in equation-1 (Cheong et al., 2011;Bayonleet al., 2017).



... equation 1

In contrast, this paper investigated the production of biodiesel using the process of esterification (instead of transesterification) as shown in equation-2 (Chongkhonget al., 2007; Thoet al ., 2016)

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 3 March 2023, pp: 257-261 www.ijaem.net ISSN: 2395-5252

$$\underset{\text{fatty acid}}{R\text{-}C(=O)\text{-}OH} + \underset{\text{methanol}}{CH_3OH} \underset{}{\overset{H^+}{\rightleftharpoons}} \underset{\text{biodiesel}}{R\text{-}C(=O)\text{-}O\text{-}CH_3} + H_2O \quad \text{... equation 2}$$

II. EXPERIMENTATION

Fresh1liter sample of fatty acid distillates was obtainedfrom Camela Vegetable Oil Limited, Owerri. They were filtered with Whatman filter paper and stored in an air-tight container. Using the procedure of Chongkhonget al., (2007), 50.0 grams of fatty acid distillate was mixed with 8.0 grams of methanol (99%) and 9.8 grams of H_2SO_4 (98%) in a round bottom flask and refluxed with a reflux condenser for 80 minutes at 70^oC, after which they are poured into a separating funnel and allowed to stand overnight. The bottom layer of biodiesel was later run off, washed with distilled water and dried for 30 minutes at 105^0C. The synthesis was repeated for various mole ratios of methanol to the fatty acid distillates ranging from 1:1 to 1:10. The various masses of the biodiesels produced were weighed and recorded. Next,the synthesis was repeated several times with 50.0 grams of fatty acid distillate at 70^oC for 80 minutes with various mole ratios of H_2SO_4 per mole of fatty acid(0:1 to 0.36:1). The masses of biodiesel produced in each case were recorded. Also the synthesis was repeated several times with 50.0 grams of fatty acid distillate, 64.0 grams of methanol, and 5.88grams of H_2SO_4 at 70^oC for various reaction times ranging from 10 minutes to 80 minutes. The masses of biodiesel produced in each case were also recorded. Lastly, the synthesis was repeated several times with 50.0 grams of fatty acid distillate, 64.0 grams of methanol, and 5.88grams of H_2SO_4 for 60 minutes at various temperatures (40^oC to 70^oC). The masses of biodiesel produced in each synthesis were recorded. The various percentage yields for each synthesis werecalculated and recorded.

III. RESULTS AND DISCUSSION

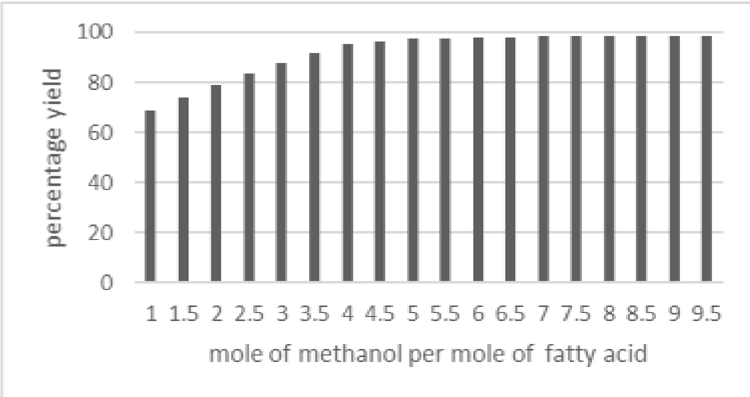


Figure 1: variation of percentage yield with mole ratio of methanol

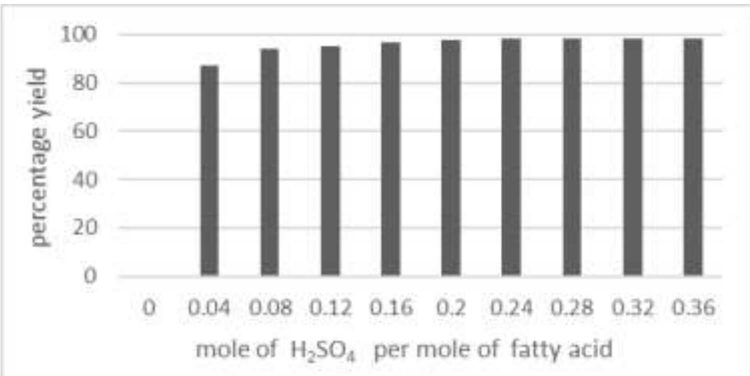


Figure 2: variation of percentage yield with mole ratio of Catalyst (H_2SO_4)

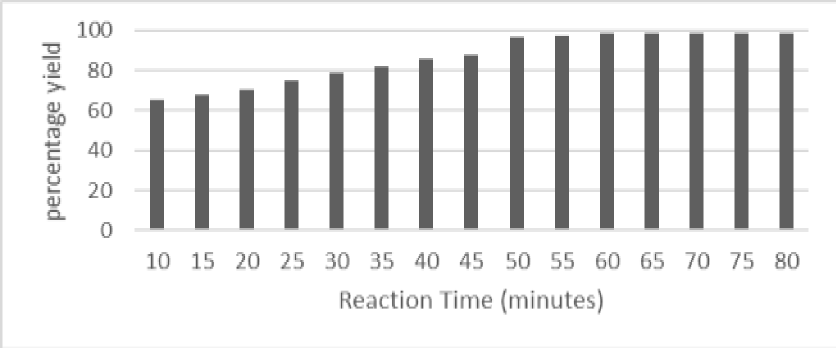


Figure 3: variation of percentage yield with reaction time

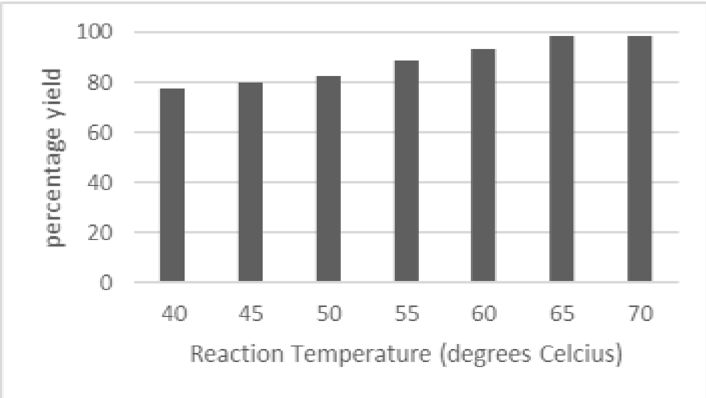


Figure 4: variation of percentage yield with reaction temperature

Figure 5 : Fatty acid distillate

Figure 6: Biodiesel produced from fatty acid distillate

Figure 1showed that the optimization of mole ratio of methanol to fatty acid gave a value of 8:1. The optimum mole ratio of H_2SO_4 to fatty acid was 0.2:1 as shown in Figure 2 (variation of percentage yield with mole ratio of Catalyst). Figure 3 (variation of percentage yield with reaction time) showed that the optimized reaction time for the esterification was 60 minutes, while the optimum reaction temperature was 65^OC (Figure 4: variation of percentage yield with reaction temperature). All these altogether gave an optimum yield of 98% biodiesel. This research has proved that biodiesel should be sourced not only from triglyceride oils but also from fatty acid distillates. Such a breakthrough in green chemistry will surely facilitate the fight to protect our environment by cutting down on the use of fossil fuels.

IV. CONCLUSION

Production of biodiesel by the transesterification of triglycerides (palm oil, soybean oil, cotton seed oil, palm kernel oil) has received more attention from researchers than the esterification of fatty acid distillates to produce fatty acid methyl or ethyl esters. The vegetable oil refining industry is growing at a fast rate in Nigeria, which will ensure a steady supply of its major by product (fatty acid distillates).At present many countries have approved the use of various percentage blends of biodiesel (with petroleum diesel) for use in diesel engines(Changhwanet al., 2015). Our federal legislators are thus encouraged to enact such environmentally friendly laws in order to protect our planet from the destructive effects of fossil fuels. These will go a long way to reduce the greenhouse effect and the degradation of the earth's eco system. The results of this paper has shown that transesterification of oils is not the only source of getting biodiesel but that the esterification of fatty acid distillates obtained from vegetable oil refineries can also give high quality biodiesel.

COMPETING INTEREST

Authors have declared no competing interest exist.

REFERENCES

[1]. Alamu, O.J., Waheed, M.A. and Jekayinfa, S.O. (2007). Biodiesel production from Nigerian palm kernel oil: effect of KOH concentration on yield. Energy for Sustainable Development, 6(3):77-82.

[2]. Bayonle, K., and Abarasi, H. (2017) An overview of transesterification methods for producing biodiesel from waste vegetable oils. Biofuels, 43: 1-19.

[3]. Changhwan, W., Sanghoon K., Peter, R., Christopher, M., Evatt, H., and Samani, T. (2015) A Comparative Analysis on Engine Performance of a Conventional Diesel Fuel and 10% Biodiesel Blends Produced from Coconut Oils. International Journal of Fuels and Lubricants, 8(3): 24.

[4]. Cheong, S. C., Jin, W. K., Cheol, J. J., Huiyong, K., and Ki, P. Y. (2011) Transesterification kinetics of palm olein oil using supercritical methanol. The Journal of Supercritical Fluids, 10: 1016.

[5]. Chongkhong, S., Tongurai, C., Chetpattananondh, P., and Bunyakan, C. (2007) Biodiesel production by

esterification of palm fatty acid distillate. Biomass and Bioenergy, 31(8): 563-568.

[6]. Silva, C., Weschenfelder, T. A., Rovani, S., Corazza, F. C., Corazza, M. L., Dariva, C., and, and Vladimir, J. O. (2007) Continuous Production of Fatty Acid Ethyl Esters from Soybean Oil in Compressed Ethanol. Industrial & Engineering Chemistry Research, 46(16): 5304-5309.

[7]. Tho, D. S. V., Nghia, P. T., Vu, N. A., Huong, N. L., and Anh, T. K.. (2016) Optimization of esterification of fatty acid rubber seed oil for methyl ester synthesis in a plug flow reactor. International Journal of Green Energy, 13(7): 720-729.

[8]. Varma, M. N. and, Madras, G. (2007)Synthesis of Biodiesel from Castor Oil and Linseed Oil in Supercritical Fluids. Industrial & Engineering Chemistry Research, 46 (1): 1-6.

[9]. Velez, A., Soto, G., Hegel, P., Mabe, G., and Pereda, S. (2012) Continuous production of fatty acid ethyl esters from sunflower oil using supercritical ethanol. Fuel, 97: 703-709.