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On

BRIDGING THE GAP BETWEEN ACADEMIA AND INDUSTRY IN NIGERIA – REFOCUSING THE ENGINEERING DISCIPLINE

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WELCOME ADDRESS FROM THE CHAIRMAN, CONFERENCE PLANNING COMMITTEE (ACICon 2014)

It gives me great pleasure to welcome you to the ancient city of Kano, the cross road of the ancient trans-Saharan trade, the current Centre of Commerce, and the venue of the Academia-Industry Conference 2014, tagged ACICon 2014. You are arriving Kano when the hamattan winds, the North-East Trade Winds, are taking over the landmass of the city. Although the weather might be a bit chilly in the early morning, it gradually heats up in the afternoon and mostly cools down towards evening. So please try to enjoy the little bit of each.

Nigeria has developed many visions and missions for development but the desired result is still only trickling in, if at all being achieved. The rising economies of the world such as the BRICS and the 'ASIAN Tigers' are miraculously making headways, even though we seem to have started together with most of them. Why? Many have since realized that it is their successful marriage of their Academia with their Industries. Both the Academia and the Industry in Nigeria have also realized this and are calling for linkage. The other question is 'How?'

Engineering and Technology has always been the causative agent of spectacular upsurge in development effort of any nation. Thus the development of engineering and technology must start from the academia and must be translated in to useful infrastructures/products/services in the industry so as to move the society forward. The participants assembled here are no doubt representative of both groups and would surely find a way of making this happen.

The Conference Organizing Committee has taken special care to ensure that the conference is stress free and enjoyable to all. Because of a number of constructions currently going on around Kano city, you may find some inconveniences to visit some areas, but the serene atmosphere of the conference venue could be a substitute.

I would like to thank our sponsors, donors, and collaborators in organizing this conference. I would like to particularly thank the National Office for Technology Acquisition and Promotion (NOTAP), the National Board for Technology Incubation (NBTI) and the National Agency for Science and Engineering Infrastructure (NASENI) for their support.

Finally, on behalf of the LOC, I warmly welcome you all, and wish you a wonderful and stress-free conference.

Prof. Mustapha Hassan Bichi, FNSE
Chairman, Conference Organizing Committee.

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EFFECT OF PROCESS VARIABLES ON BIODIESEL PRODUCTION FROM NEEM SEED OIL

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ABSTRACT

This work studied the effect of process variables on the production of biodiesel from Neem oil. Two-step transesterification was employed using potassium hydroxide as a homogeneous catalyst and methanol as alcohol. The effect of temperature (40 to 60 ^{O}C), reaction time (45 to 60 minutes), oil/methanol ratio (1:5 to 1:7) and catalyst concentrations (0.5 to 1.0 wt. %) was investigated. An optimum yield of 90 wt % of Neem oil methyl ester was obtained at a reaction time of 45 minutes, catalyst concentration of 1.0 wt %, temperature at 60 ^{O}C, and oil/methanol ratio of 1:7. The properties of the biodiesel produced were characterized and compare favourably with the ASTM standards for biodiesel signifying that the neem oil methyl ester could be used as an alternative to diesel.

KEYWORDS: Biodiesel, fossil fuel, transesterification, neem oil

1 INTRODUCTION

World energy needs are primarily fossil derived fuel (Mohammad *et al.,* 2010). Due to the current world energy usage, experts have reported that the fossil fuel reserve will be exhausted in few decades to come (Zadeh *et al*., 2011). More so, increase in emission of greenhouse gases, cost of processing crude oil, non-renewability and energy demand during the process which is arguably high is among the challenges of the continuous usage of this non-renewable source of energy. The challenges prompted a number of government, researchers and stakeholders in industries to develop alternative energy sources to consolidate the non-renewable fuels (Highina *et al.,* 2011). This alternative fuel must be technically feasible, economically competitive, environmentally friendly and readily available (Makama *et al.,* 2011).

Vegetable oils are perceived as a possible alternative to petroleum diesel. Generally, biodiesel is prepared from vegetable oils, animal fats, and waste greases such as yellow and brown greases (Lotero *et al.,* 2005). Various oils have been domesticated by different countries as raw materials for biodiesel production owing to its availability. Example includes soybean oil in United States, rapeseed oil in many European countries, coconut oil and palm oils in Malaysia and Indonesia. In India and Southeast Asia, Jatropha oil, Karanja oil and Mahua oil are used as a significant oil source for biodiesel production (Demirbas, 2009).

In nearly all part of Africa and Asia, edible vegetable oils are limited in supply and substantial quantities are been imported from developed nation to satisfy consumption demand. The author added the production of biodiesel in commercial quantity in Nigeria using common vegetable oil like palm oil and palm kernel oil is technically not feasible, since the Nigerian as nation at present cannot satisfy the food supplies of these oilsThe uses of non-edible oils are perceived as a possible feedstock for commercial biodiesel production in Nigeria. Non edible oils like rubber seed oil, Jatropha oil, castor oil, neem oil and waste cooking oil are therefore being considered as potential feed stocks (Musa *et al.,* 2014).
One of the promising sources oil seed for biodiesel production is the neem tree (*Azadirachta indica*). These trees produce the neem seeds which contained about 39.7 to 60 % (Aransiola *et al.,* 2012). A number of works have been reported on the biodiesel production from neem oil (Anya *et al.,* 2012; Aransiola *et al.,* 2012; Mohammed *et al.,* 2012). But as far as the author knowledge is concerned no attempt has been made to study the effect of process variable using factorial design. This work focused on optimizing the production of biodiesel by varying the factors that affect the production.

2.0 METHODOLOGY

The major material in this work is crude neem oil (CNO) purchased in NARICT, Zaria, Kaduna State, Nigeria. The chemicals used include analytical grade methanol and potassium hydroxide manufactured by Aldrich Chemicals Co. ltd, England.

2.1 Characterization of Crude Neem Oil

Characterization of the feedstock (CNO) was analysis for its chemical composition and physicochemical properties to ease comparison with standard level of purity of the material relative to using it for biodiesel production. Some of such properties include specific gravity (or density), flash point, kinematic viscosity, acid value, iodine value sulphur content, moisture or water content and were determined as reported by Musa *et al.,* 2014; Mohammed *et al.,* 2012; Tesfaye, 2009.

2.2 Production of Biodiesel from Crude Neem Oil using acid esterification and based transesterification

The crude neem oil was heated at 60 ^oC for about 10 mins and mixed with methanol (60 % w/w of oil). 0.75 % w/w of concentrated H_2SO_4 was added to the mixture and the mixture was stirred on a magnetic hot plate for 1hr at 60 ^oC, after which it was allowed to settle for 2 hrs. The pre-treated oil was separated from the methanol-water phase at the top (Aransiola *et al.,* 2012; Anya *et al.,* 2012). Production of biodiesel from neem oil was carried out in accordance with the experimental procedure reported by Musa *et al.,* 2014 and Berchmans and Hirata, 2008. A 2^4 Factorial design was employed. Methoxide was first prepared in a conical flask by dissolving potassium hydroxide in methanol; the mass of the catalyst dissolved and the ratio of the oil to methanol in each experiment is shown in Table 1. The reactor was filled with 50 grams of neem oil sample at 60 ^oC; the methoxide solution was then poured into the reactor containing the oil. The mixture was agitated vigorously for the giving reaction time and at a particular temperature as shown in Table 2. At the end of the reaction, the resulting mixture was cooled to room temperature and transferred into a separating funnel, allowed to settle (overnight) into a lighter coloured biodiesel on top of a layer of darker glycerine. Then separated, washed and dried as reported by Tesfaye, 2009. The methyl ester produced was then characterized as reported by Musa *et al.,* 2014

Plate 1: A water bath shaker

Plate 2: Biodiesel settling stage before glycerol removal

Plate 3: Washed biodiesel

3.0 *RESULTS AND DISCUSSIONS*

3.1 optimization of biodiesel production

Table 1: Variables and levels used for Neem oil Methyl ester (NOME) Synthesis

Variables	Symbols	Levels	
		Low level	High level
Temperature	A	40	60
Oïl/Méthanol ratio	B	1 : 5	1 : 7
Catalyst concentration	C	0.5	1.0
Reaction time	D	45	60

Table 2.0: Experimental Design for Alkali Transesterification

Run	**A**	**B**	**C**	**D**	**NOME Yield**
1	40	1.5	0.5	45	75.00
2	60	1,5	0.5	45	82.00
3	40	1:7	0.5	45	83.00
4	60	1:7	0.5	45	86.00
5	40	1:5	1.0	45	57.00
6	60	1:5	1.0	45	78.00
7	40	1:7	1.0	45	77.00
8	60	1:7	1.0	45	90.00
9	40	1:5	0.5	60	60.00
10	60	1:5	0.5	60	84.00
11	40	1:7	0.5	60	82.00
12	60	1:7	0.5	60	91.00
13	40	1:5	1.0	60	47.00
14	60	1:5	1.0	60	74.00
15	40	1:7	1.0	60	69.00
16	60	1:7	1.0	60	91.00

3.2 Effect of temperature

The effect of temperature on transesterification plays a vital role in both the quantity and quality of the methyl ester to be produced. As shown in Figure 1 the increase in temperature clearly influences the reaction rate and biodiesel yield in a positive manner. This is evident from the fact that from all experimental runs shown in Table 2, increase in temperature result into an increase in the biodiesel yield irrespective of other process conditions. The result obtained is in agreement with the report of Musa et al., 2014, and Patil and Deng (2009). The increase in the yield of NOME at higher reaction temperature is due to higher rate of reaction. According to Musa et al., 2014 Transesterification reaction is best performed at a temperature close to the boiling point of the alcohol used for alkaline transesterification. The high yield obtained in this study for all experimental run can be clearly attributed to appropriate choice of temperature.

3.3 Effect of Methanol-to-Oil Molar Ratio

The methanol-to-oil molar ratio is one of the important factors that affect the conversion of triglyceride to biodiesel. Stoichiometrically, three moles of methanol are required for each mole of triglyceride, but in practice, a higher molar ratio is required in order to drive the reaction towards completion (Patil and Deng, 2009). The presence of slight excess amount of alcohol during the transesterification reaction is essential to break the glycerine - fatty acid linkages. But excess of methanol should be avoided

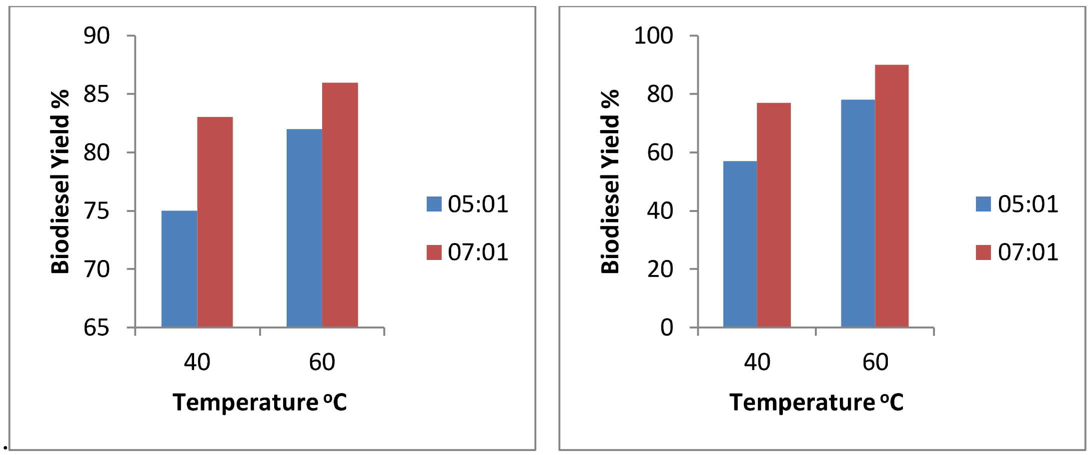

Figure 1: Effect of temperature and oil/methanol ratio on biodiesel yield at constant reaction time and catalyst concentration

As shown in Figure 1, the methanol to oil ratio of 7:1 from this work shows higher yield than methanol to oil ratio of 5:1. The result obtained shows close agreement with the work of Sulistyo *et al.* (2008) who stated a mole ratio of 7.5:1 to be optimum. It is important to add that increasing the alcohol content beyond this point (7:1) would lead to an increase the cost of alcohol recovery and complicate ester recovery.

3.4 Effect of Catalyst Concentration

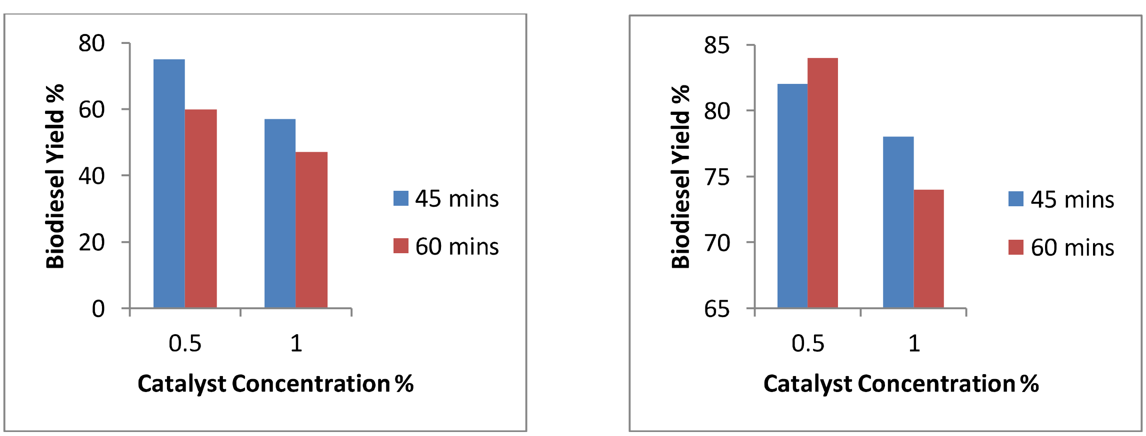

Figure 2: Effect of catalyst concentration and time on biodiesel yield at constant temperature and mole ratio

From Figure 2, it was rightly observed that the increase in catalyst concentration influenced the biodiesel yield in a negative way. This is in agreement with the report of Sulistyo *et al.* (2008); Lalita *et al.* (2004); and Refaat *et al.* (2008) who state the yield of methyl ester yield decreases with an increase catalyst concentration beyond 1 %. This is as result of soap formation by the side reaction between the vegetable oil and the excess catalyst concentration making separation difficult Effect of Reaction Time

Figure 2, shows that increase in reaction time had a negative impact on the NOME yield. This can be attributed to the high percentage of catalyst concentration but at same reaction time and catalyst concentration the percentage conversion have no significant impact. This report is in accordance with the work of Refaat *et al.* (2008) and Lalita *et al.* (2004).

4.0 CONCLUSIONS

The effect of process variable on biodiesel synthesis from neem seed oil was successfully carried out. Optimum condition for the synthesis was deduced to be a reaction time of 45 minutes, catalyst concentration of 1.0 wt %, temperature at 60 ^{O}C, and oil/methanol ratio of 1:7. The optimum yield at these conditions was 90 wt %.

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