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Investigation of Coconut Oil as Green Demulsifier in Crude Oil Emulsions

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ABSTRACT: Presence of water in crude oil is typically undesirable and can result into high pumping costs and pipeline corrosion as well as cost of transportation. In this study, extracted oil from coconut was used to demulsify crude oil emulsion. The crude oil emulsion which contained 40% v/v water was prepared using crude oil collected from Niger delta region of Nigeria. The water used was made of 3g/L sodium chloride solution. The crude oil was characterized using standard ASTM methods while the demulsifying analyses were carried out using bottle test method with coconut oil and triethanlamine (TEA) as demulsifiers. The result obtained showed that the coconut oil break the emulsion in the crude oil emulsion more effectively than TEA at moderate doping of 10%. Thus coconut oil could be considered as green demulsifier in the treatment of Nigeria crude oil emulsions.

KEY WORDS: demulsifier, coconut oil, crude oil emulsions, triethanolamine

I. INTRODUCTION

As the crude oil rises through the well and passes through the valves and pumps, water and oil can blend into relatively stable dispersions of water droplets in crude oil, which is usually referred to as emulsions from oil fields (Hajivand and Vaziri, 2015; Akinyemi et al., 2015). Shear mixing imposed on the crude oil and water during crude oil production and the existence of natural surfactants in the petroleum's composition contribute to formation of such emulsions (Sjoblom et al., 2007; Ramalho et al., 2010). Several oilfield researchers are concerned about the stability of crude oil emulsions, inventing various efficient and relevant techniques to cut it off. Previous researchers have observed that it is possible to remove or reduce the water in crude oil to level of < 0.1% by de-emulsification or dehydration (Wang et al., 2012). Methods of demulsification are generally classified into three categories, namely physical, chemical and biological treatments (Saad et al., 2019).

II LITERATURE REVIEW

Of the three methods, chemical method, which involved use of chemical demulsifiers is widely accepted procedure in the oil and gas industry for treatment of crude oil emulsion (Mepaiyeda et al., 2020). However, in Nigeria oil and gas industry, demulsifiers used in treatment of crude oil emulsions are imported (Mepaiyeda et al., 2020). The demulsification involve the process of breaking emulsions by weakening the viscoelastic films techniques surrounding the dispersed water droplets, thus enhancing coalescence. The emulsifier at the interface is replaced with the demulsifier destroying the stable film surrounding the water droplets. Removal of impurities, salt and water is important in demulsification processes. Demulsifiers are surface active compounds which upon addition to emulsion, migrate to the oil-water interface and breaks the rigid film thereby resulting in coalescence of water droplets (Alwadani , 2000). The chemical additives migrate to the oil-water interface to destabilize the emulsifying agents. The additives are generally classified into polymeric, anionic, amphoterics, nonionic, cationic, biosurfactant and surfactant mixtures (Zainab 2015; Murtada, 2019). The fraction and concentration of surfactants such as asphaltenes and resins have been observed to undergo interplay of diffusion at the oil water interface thus contributing immensely to the mechanism of interfacial adsorption, emulsion formation, and stability (Zainab 2015). Most of the chemicals available in the oil industry are not environmentally friendly

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when compared with green based demulsifiers. An effective demulsfier will enhance the release of safe and clean separated water into the environment thus reducing potential poisoning concerns of the marine environment especially. From the foregoing, this study is investigating of the utilization of coconut oil, a natural and environmental friendly chemical as green based demulsifier to break crude oil emulsion.

III. METHODOLOGY

A. Materials

The crude oil sample used in this study was obtained from the Niger delta region of Nigeria. The major pieces of equipment used in this study were Weighing scale, Density Bottle, Test tubes, Dispensers (1ml and 1.5ml), Water bath, Centrifuge, Homogeniser, Oven, Vernier caliper, hot plate, Wet and Dry Mill, Muslin cloth. The major reagents used were distilled water, Polysorbate 80, Sodium chloride, Triethanolamine which are analytical grade of BDH products. The plant oil was extracted from coconut purchased in local market in Epe, Lagos, Nigeria.

B. Method

B.1 Extraction of locally source demulsifiers from agricultural product

Eight medium size of fresh coconuts were dewatered by breaking the coconut with a hammer. The coconuts were de-shelled by heating the shell for some minutes and using a knife to separate the coconut meat from the shell. The coconut meat was washed and cut into smaller bits for easy milling. Wet milling was carried out using a blender. The milled coconut meat was filtered using a muslin cloth after boiling for 10 minutes, the filtrate was allowed a settling time of approximately 18 hours, after which the oil, creamy layer and water were separated by decantation. The creamy layer was filtered using a muslin cloth, to get out as much coconut milk as possible. The residue and the filtrate were heated to extract coconut oil. Two colour shades of coconut oils were produced. The residue gave a lighter coloured coconut oil, The oil was heated for about 4 minutes to dry off water that was still in it. The extracted oils were stored in clean labeled containers.

B.2 Procedures for Crude oil Characterization

T1he crude oil to be used in the study is to be characterized to determine its, hydrocarbon, composition, wax content, asphalthene content, viscosity, American Petroleum Institute gravity (APIg) among others using standard ASTM methods as described by (Akinyemi et al., 2016; Akinyemi et al., 2018).

B.3 Preparation of Crude Oil Emulsion

Crude oil Emulsion shall be prepared using sodium chloride (NaCl) solution, distilled water, crude oil and polysorbate 8 as emulsifier in appropriate proportion. The prepared emulsions was 40.0% v/v water compositions by adding 300ml of crude oil to 200ml of sodium chloride solution of 3g/L. Polysorbate 8 of 1.0ml was added to the 500ml mixture as emulsifying agent and the final mixture was thoroughly mixed for 15minutes using an homogenizer

B.4 Demulsification Test using the Extracted Demulsifier Oils

The coconut oil was tested as demulsifier in standard bottle test analysis using 2.5%, 5%, 7.5%, and 10 % doping of demulsifier in the crude oil emulsion. The procedures were also used for triethanolamine, available chemical demulsifiers for comparison. Also, a blank sample containing none of the demulsifiers was tested.

Ten milliliter of crude oil emulsion sample was pre-heated in the water bath for 10 minutes at 60^{o}C. 2.5% v/v of demulsifier was added to the crude oil emulsion sample was poured into centrifuge tube and placed in a water bath at 60^{o}C for 10minutes. Thereafter, the tubes were placed in the centrifuge for 2 minutes at 1000rpm. The sample was then removed and placed in a water bath at 60^{o}C. Readings of water separation was taken after 0, 10, 20, 30, 40 and 60 minutes by measuring the height of the water. The procedure was repeated for 5%, 7.5%, and 10 % doping of the demulsifer. The process was carried out for both the coconut oil and Triethanolamine.

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IV. EXPERIMENTAL RESULTS

A.Properties of crude oil

The characteristics properties of the crude oil used are given by Table 1. From the API gravity value of the crude oil it is a medium crude oil with 16.32 wax content. From the paraffinic composition analysis as shown by Figure 1, Dotriacontane was the highest alkane in the crude oil sample followed by octacosane, octadecane and docossane respectively in decreasing order. Octane and hydrocarbons below appeared in trace quantities in the crude oil sample (Figure 1). The highest polyaromatic component of the crude oil sample is Fluorene followed by Chrysene.

Table 1 Characteristics properties of the crude oil

Properties	Value
Wax content (%)	16.32
Asphalten content (%)	0.901
Resin content (%)	7.32
Kinematic viscosity @ 25ºC (cSt)	75.84
Specific gravity @15ºC	0.8905
APIg	27.399

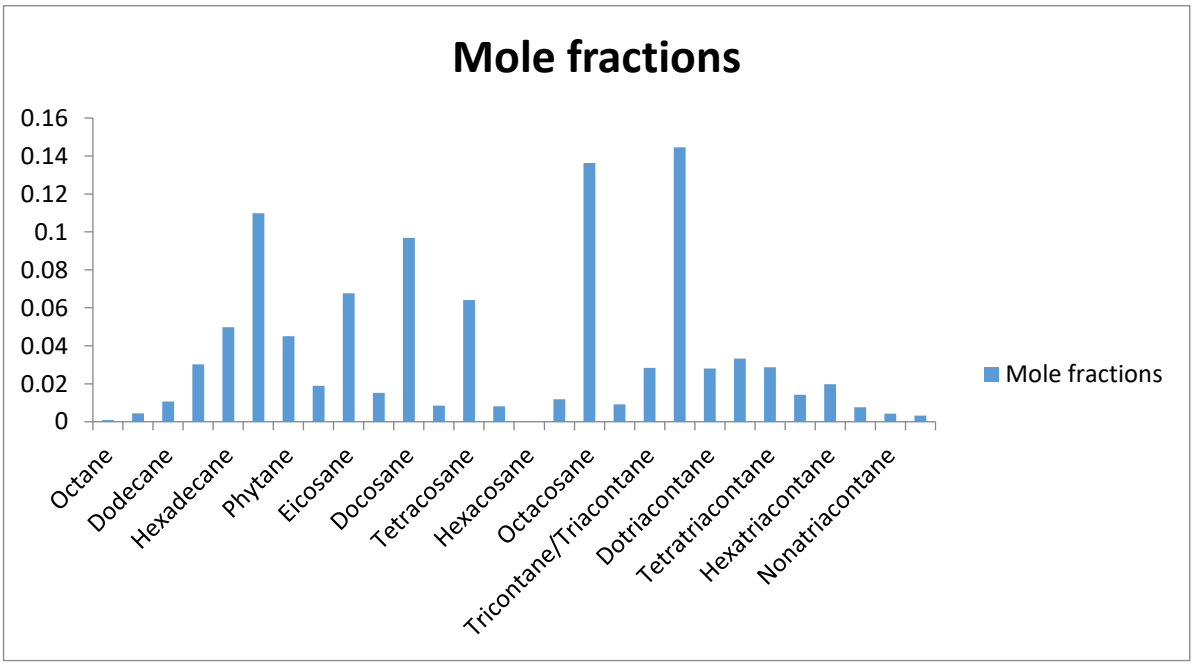

Figure 1 Paraffin hydrocarbon composition of crude oil sample

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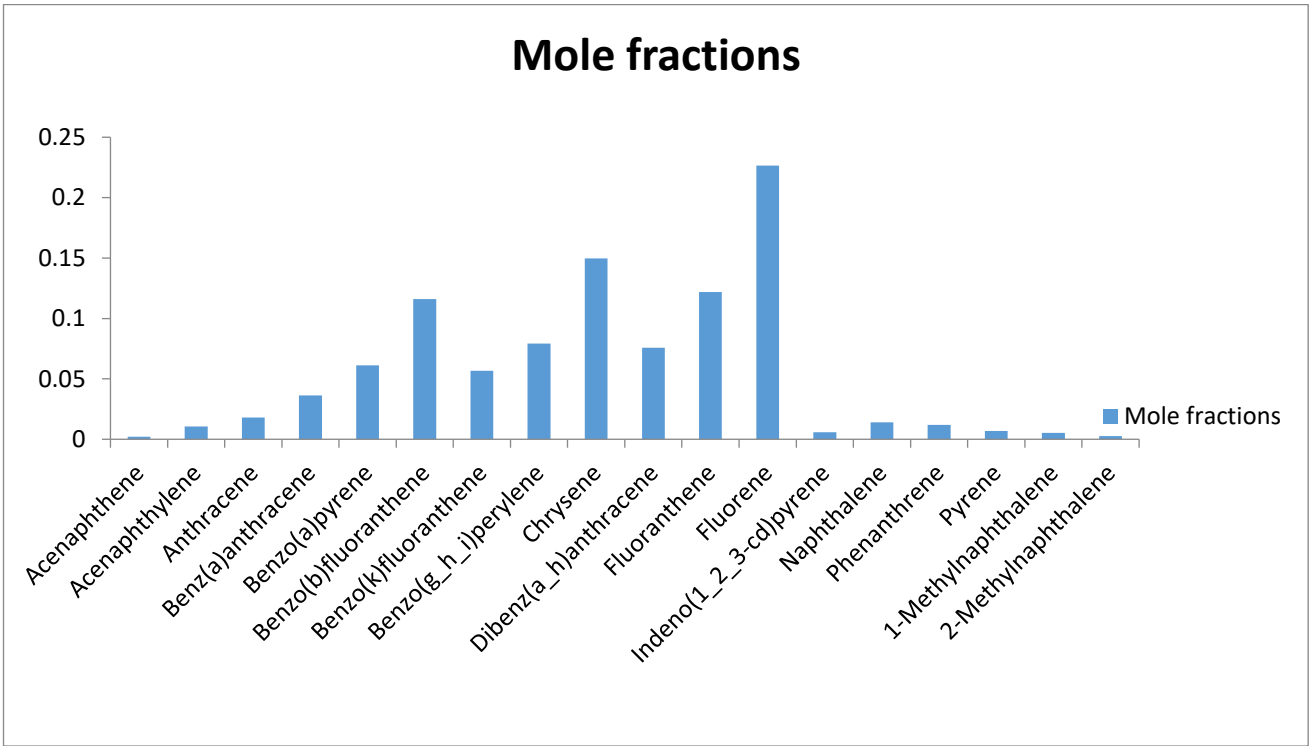

Figure 2 Polyaromatic composition of crude oil sample

B.Performance of the Demulsifiers on the Crude oil emulsion sample

From Figure 3, it was observed that coconut oil was able to separate water and sediment from the crude oil emulsion when doped with 2.5% of the coconut oil as demulsifier. The triethanolamine (TEA) also separated the water and sediment but slightly better than coconut oil within the time frame considered (Figure 3). Thus the TEA has the ability to break the interfacial forces in the crude oil emulsion of at low concentration. This is in agreement with the findings of previous researchers ((Hajivand and Vaziri, 2015; Akinyemi et al., 2015). At higher doping of 5.0% and above, the coconut oil improved in its ability to break the crude oil emulsion (Figures 4 to 6). It was observed that ability of the coconut oil to break the crude oil emulsion increased with increased in its concentration in the emulsion (Figure 7). It was also observed that the coconut oil began to perform at pal with the TEA in breaking the emulsion at the concentration of 7.5% (Figure 5) and even performed better than the TEA at the doping of 10% (Figure 6). The components in the coconut oil may have interacted with the interfacial surface between the crude oil and the water droplets therein to reduce the forced holding then together, thereby separating the water from the oil. This is in agreement with the findings of previous researchers (Venkatesham et al., 2018) Thus, the coconut oil has the capability of breaking crude oil emulsion better than the TEA at the moderate doping of 10%v/v. From Figure 8, it was observed that TEA performance on breaking the emulsion stop improving as the concentration goes above 7.5%.

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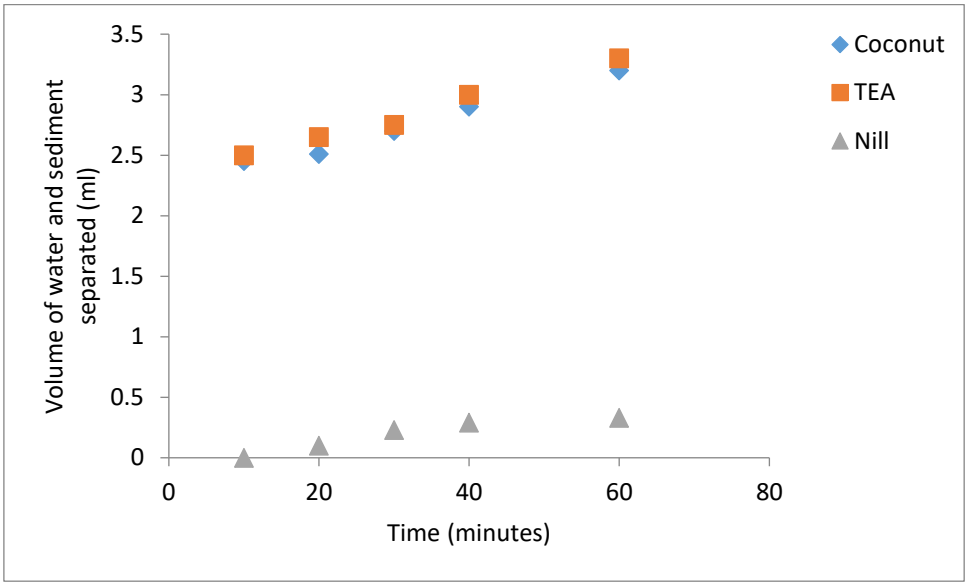
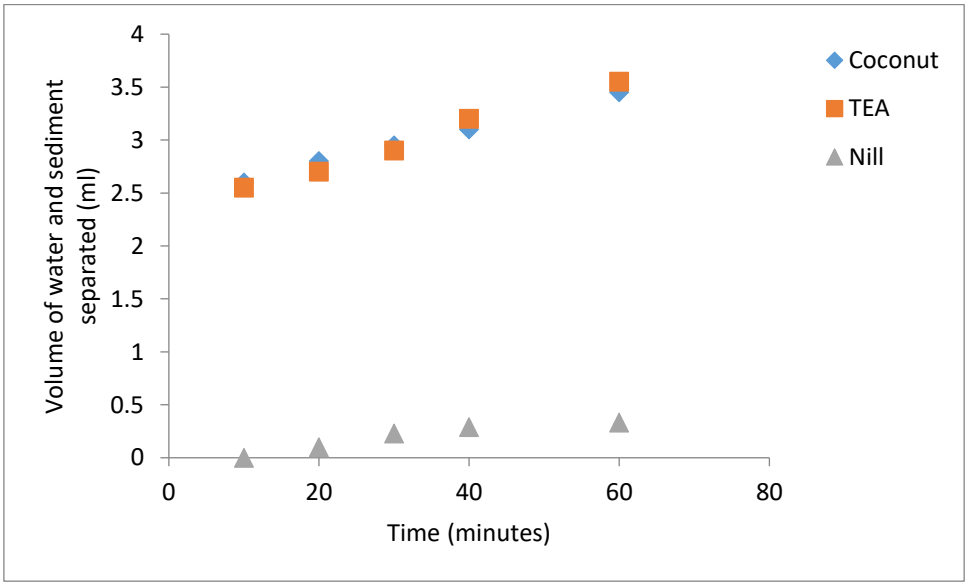


Figure 3 Water and sediment separation against time for 2.5% demulsifier



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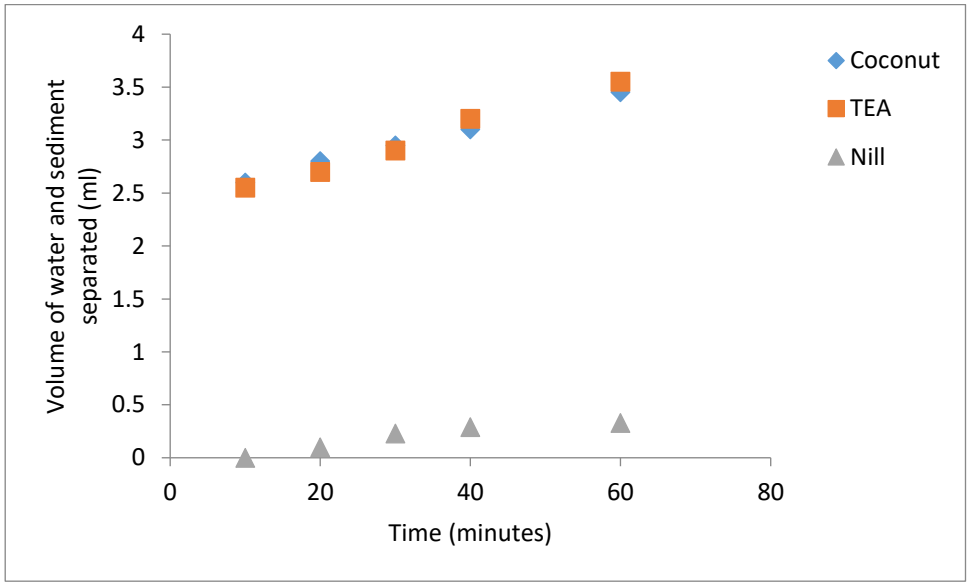

Figure 4 Water and sediment separation against time for 5% demulsifier

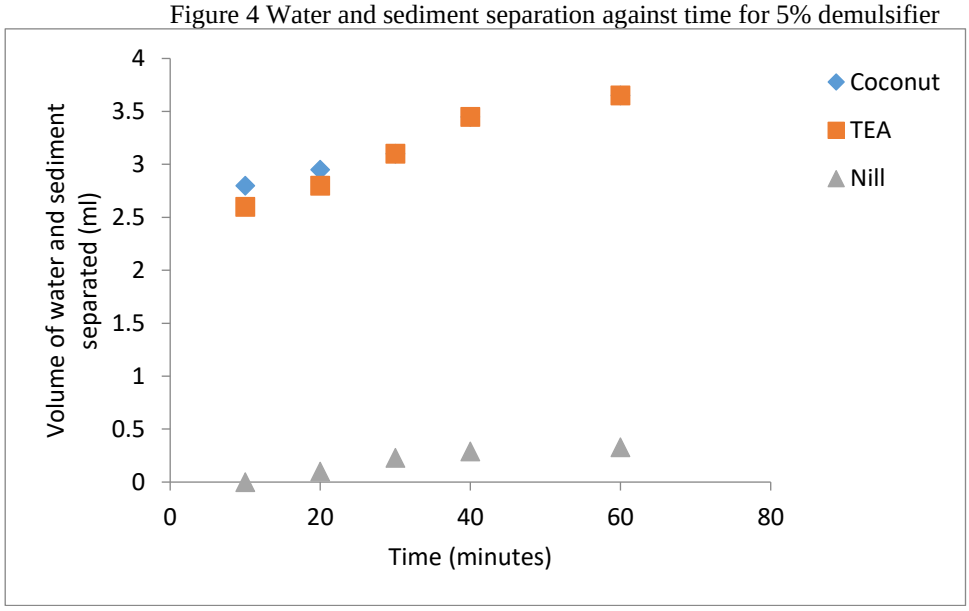

Figure 5 Water and sediment separation against time for 7.5% demulsifier

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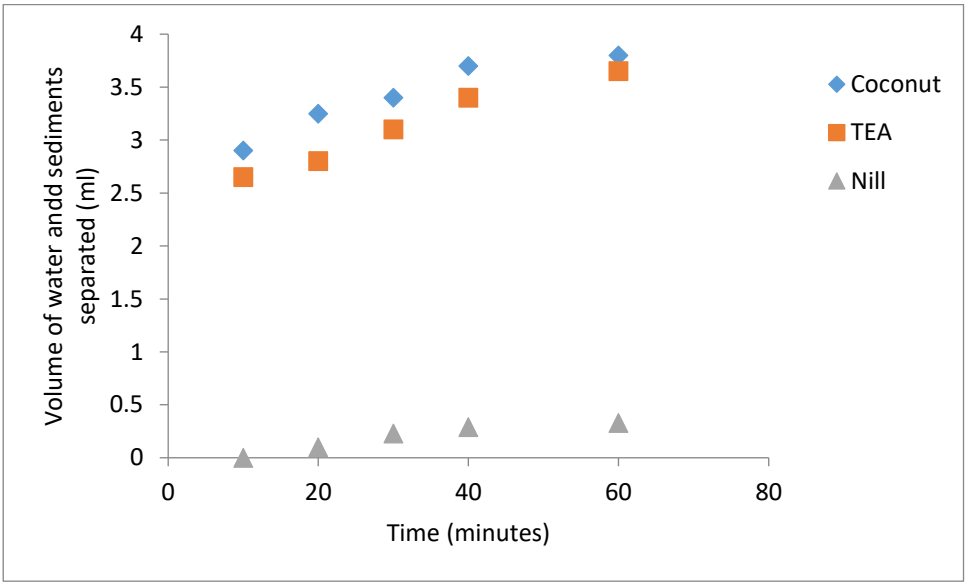

Figure 6 Water and sediment separation against time for 10% demulsifier

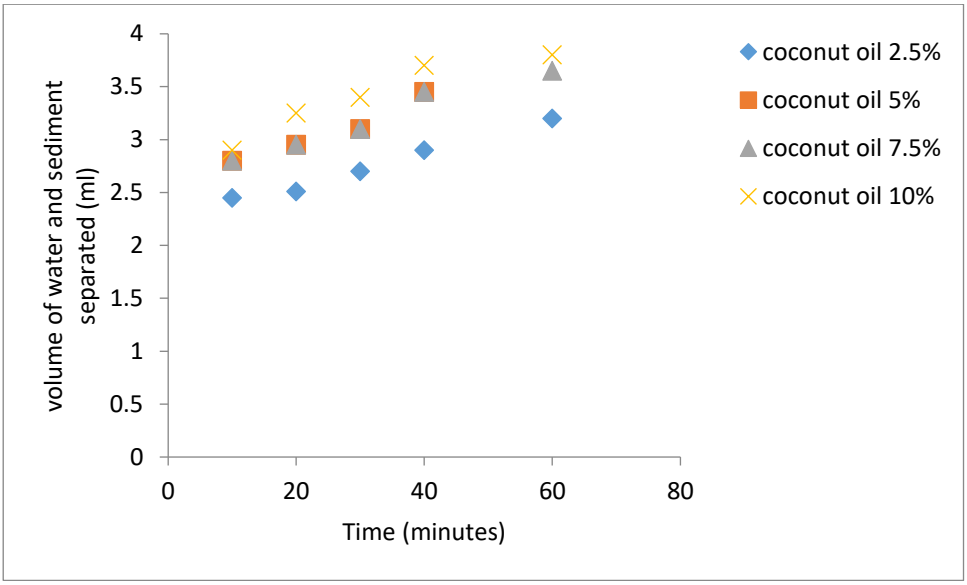

Figure 7 Water and sediment separation against time for coconut oil at different concentrations

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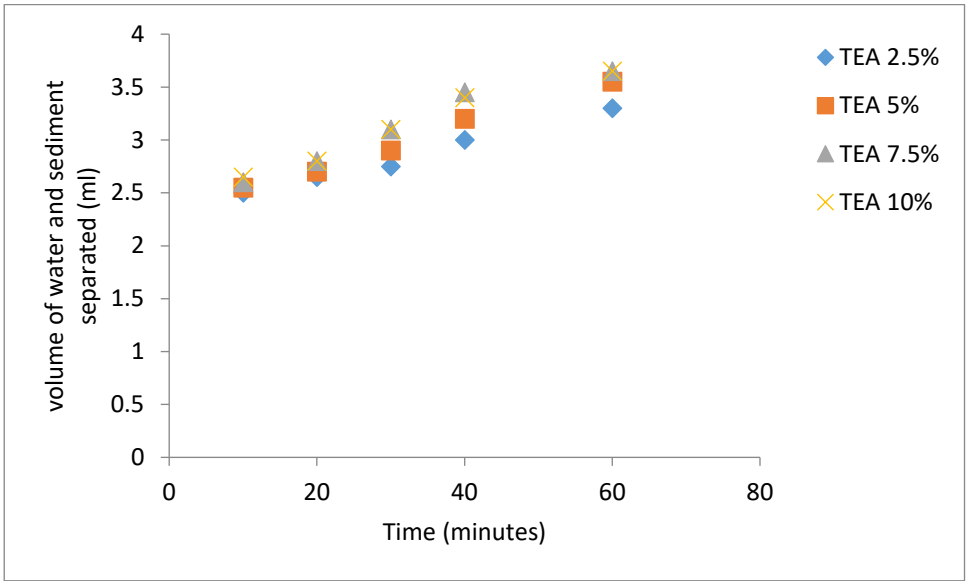

Figure 8 Water and sediment separation against time for TEA oil at different concentrations

V. CONCLUSION AND FUTURE WORK

In this study, coconut oil extract was considered as demulsifier of crude oil emulsion and its performance was compared with triethanolamine, a synthetic compound with demulsifying tendencies. The crude oil obtained from Niger Delta region of Nigeria was characterized using standard ASTM methods and utilized in preparation of the emulsion. Bottle test methods was used in the analyses of demulsifying abilities of the coconut oil and TEA. The coconut oil could be concluded to have the ability to break the interfacial forces between the water and oil in the emulsion at moderate concentration and even perform better than the TEA at concentration of 10% doping.

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