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Research Article

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Investigation of Almond 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 almond (*Terminalia catappa*) was used to demulsify crude oil emulsion. The crude oil emulsion of 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 almond oil and triethanlamine (TEA) as demulsifiers. The yield and density of the almond oil were also determined using standard methods. The density of the almond oil extracted was found to be 0.95g/cm^3 with the yield of 39.7%. It could be concluded from the results obtained that the almond oil have the ability to break the interfacial forces between the water and oil in the emulsion at the concentration of 10% appreciably close to the ability of the synthetic chemical, TEA. It is therefore recommended that further study should be done on the blend of the almond oil with other suitable natural product to obtain a novel effective demulsiier for treating emulsion problems in oil and gas industry.

Keywords almond oil, demulsifier, crude oil emulsions, triethanolamine

1. Introduction

When 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 [1-2]. 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 [3-4]. Many oilfield researchers are concerned about the stability of crude oil emulsions, inventing various efficient and relevant techniques to cut it off. Some 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 [5]. The various methods of demulsification are generally classified into three categories, namely physical, chemical and biological treatments [6]. The chemical method, which involved use of chemical demulsifiers is widely accepted procedure in the oil and gas industry for treatment of crude oil emulsion [7]. In Nigeria oil and gas industry, demulsifiers used in treatment of crude oil emulsions are imported [7].

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 of the emulsion 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 [8]. The chemical additives migrate to the oil-water interface to destabilize the emulsifying agents. The chemical additives are generally classified into polymeric, anionic, amphoterics, nonionic, cationic, biosurfactant and surfactant mixtures [9]. 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 [9].

Many of the chemicals available in the oil industry are not environmentally friendly 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. Almond oil obtained from almond seed could be a natural source as demulsifier in oil and gas industry. *Terminalia catappa*, commonly known as tropical almond which has been an underutilized crop which belongs to a group of nuts with hard shelled seeds enclosing a single edible kernel [10] is now growing more attention of researchers in recent times. The tree is highly prevalent in tropical regions of Asia, Africa, and Australia [11], [12]. The seeds of the fruit are often of small sizes and difficult to extract from the nuts. These factors may have contributed to its lack of use in many areas [10]. Thus, this study is investigating of the utilization of almond oil, a natural and environmental friendly chemical as green based demulsifier to break crude oil emulsion.

2. Materials and Method

2.1 Materials

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

2.2 Method

2.2.1 Extraction of locally source demulsifier from agricultural product

The almond fruits were decorticated and sun-dried for a couple of days. After removing the flesh (succulent portion), the seeds were obtained by cracking the hard core nut. The almond fruit seeds were sun-dried for five days. The dried seed was further heated in an oven at 60^{o}C for 2 hrs to obtain very low moisture content dried seeds. After the seed has been allowed to cool from the heating, 500g of the dried seeds were weighed and milled using milling machine. Little drops of distilled water was added to the milled almond seeds and stirred together. A muslin cloth was used to press out the oil from the water + milled almond seed. The extracted oil was weighed and stored in a clean container. The volume of the extracted oil was also determined using measuring cylinder. The yield of the oil produced from the seed was determined using equation (1):

$$Yield\ (\%) = \frac{m_1 - m_2}{m_1}\ x\ 100 \qquad (1)$$

Where

m_1 = mass of dried seed before oil extraction

m_2 = mass of dried seed after oil extraction

The density of extracted oil was also determined using equation (2)

$$density\ of extracted oil\ \left({}^{g}/_{cm^3}\right) = \frac{m_3}{v} \qquad (2)$$

Where

m_3 = mass of extracted oil (g)

v = Volume of extracted oil (cm^3)

2.2.2 Procedures for Crude oil Characterization

The crude oil used in this study was characterized to determine its American Petroleum Institute gravity (APIg), hydrocarbon composition, wax content, asphalthene content, viscosity, among others using standard ASTM methods as described by [13], [14].

2.2.3 Preparation of Crude Oil Emulsion

Crude oil emulsion was 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 200ml of sodium chloride solution of 3g/L to 300ml of crude oil. Polysorbate 8 of 1.0ml was added to the 500ml emulsion mixture as emulsifying agent and the final mixture was thoroughly mixed using an homogenizer for 15minutes.

2.4 Demulsification Test using the Extracted Demulsifier Oils

The almond 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. Also, the procedures were used for triethanolamine, which is the available chemical demulsifiers for comparison. A blank sample containing none of the demulsifiers was also tested. Crude oil emulsion sample of 10 ml was pre-heated in the water bath for 10 minutes at 60^{o}C. Demulsifier of 2.5%v/v was added to the crude oil emulsion sample in a centrifuge tube and placed in a water

bath at 60ºC for 10minutes. At the end of the10minutes, the tubes were placed in the centrifuge for 2 minutes at 1000rpm. The sample was then removed and placed in a water bath at 60ºC. The readings of water separation were 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 almond oil and triethanolamine.

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3. Experimental Results

3.1 Properties of crude oil sample

From Table 1, the characteristics API gravity value of the crude oil is approximately 27.40 which indicate that the crude oil sample is a medium crude oil with 16.32 wax content. Figure 1 revealed that from the paraffinic composition analysis as of the crude oil sample, dotriacontane was the highest alkane in the crude oil sample followed by octacosane, octadecane and docossane in decreasing order respectively. Hydrocarbons from octane and below appeared in trace quantities in the crude oil sample (Figure 1). From Figure 2, the highest polyaromatic component of the crude oil sample is Fluorene followed by Chrysene. Acenaphthene has the smallest compositional value among the polyaromatics components of the crude oil (Figure 2).

Table 1: Characteristics properties of the crude oil

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

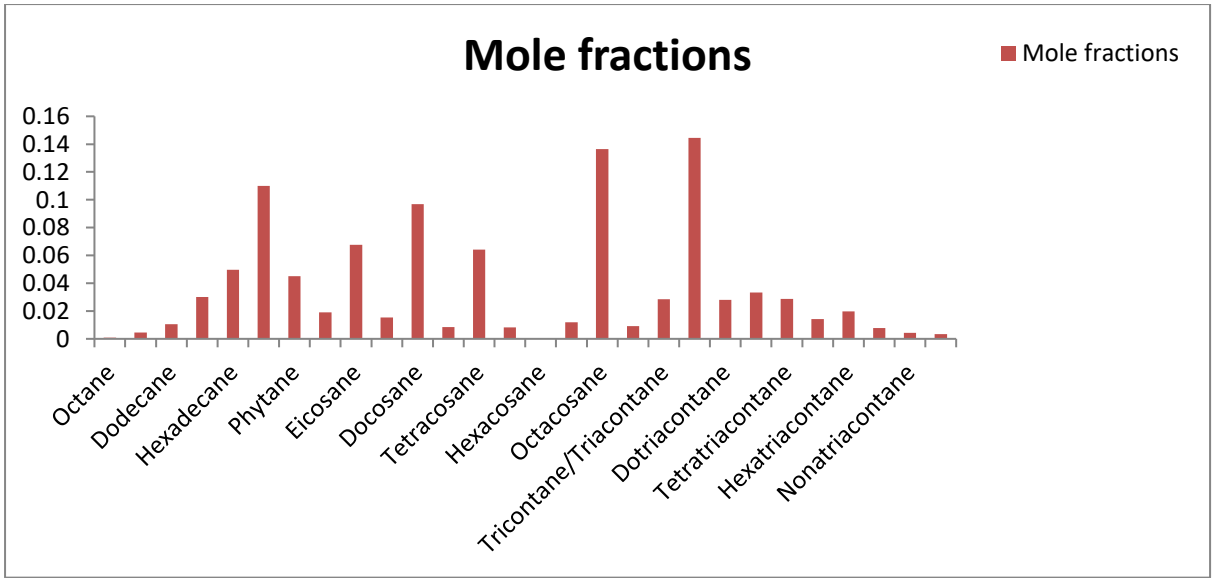

Figure 1: Paraffin hydrocarbon composition of crude oil sample

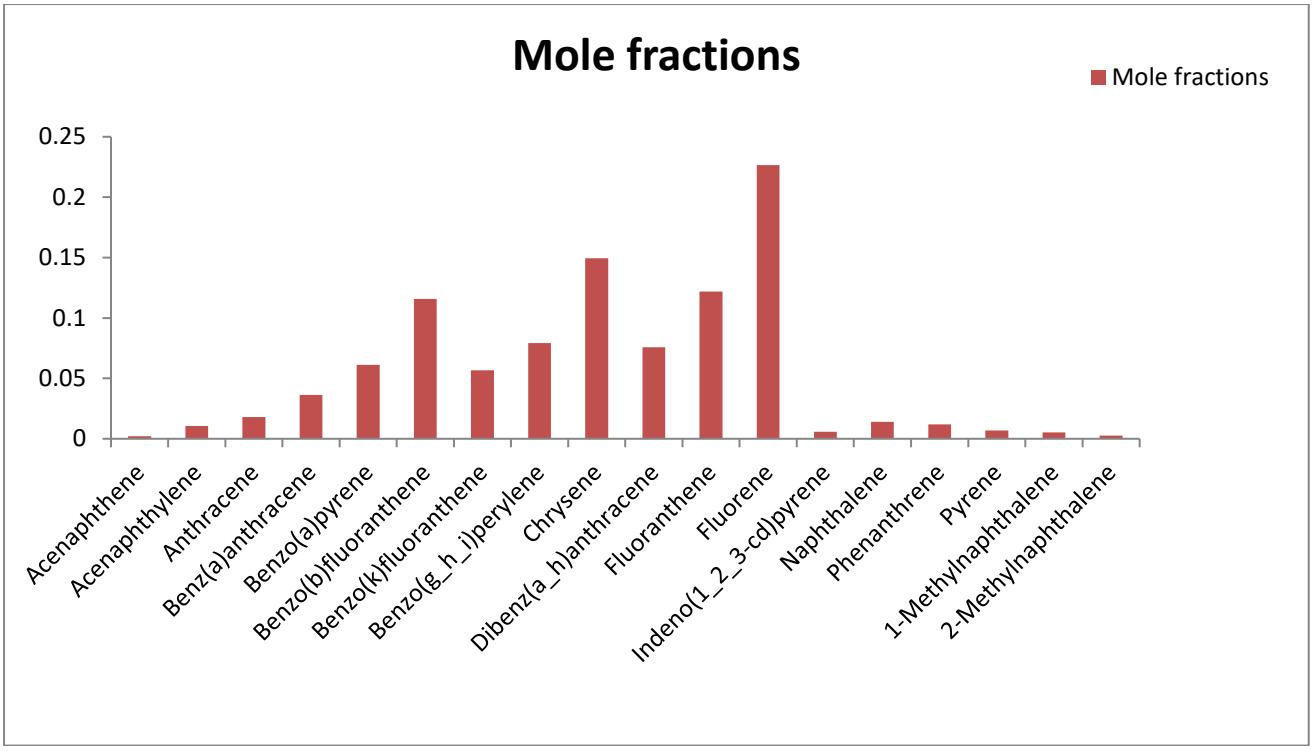

Figure 2: Polyaromatic composition of crude oil sample

3.2 Performance of the Demulsifiers on the Crude oil emulsion sample

The density of the almond oil extracted was found to be 0.95g/cm^3 with the yield of 39.7%. It was observed that almond oil barely break the crude oil emulsion when doped with 2.5% of the almond oil as demulsifier while the triethanolamine (TEA) break the emulsion appreciably (Figure 3). As time increased the ability of the almond oil to break the emulsion at 2.5% doping increased steadily while that of TEA increased slightly. This implied that both the almond oil and TEA have the capacity to break the interfacial forces in the crude oil emulsion at low concentration. This is in agreement with the findings of previous researchers [1], [2]. Increased in the concentration of the almond oil in the crude emulsion to 5.0% increased the breaking of the emulsion slightly (Figure 4). The increase in breaking capacity of the almond oil with increase in time duration followed the same trend as for 2.5% concentration. The TEA and almond oil exhibited similar trend of increase in emulsions breaking capacities for concentrations of 7.5% and 10% as they did with 2.5% concentration (Figures 5 and 6). It was observed that the rate of increase in breaking capacity with increase in concentration is higher for almond oil than it was for TEA even though the TEA had higher breaking capacity than the almond oil (Figures 7 and 8). The differences in increment in breaking capacity of the TEA at the various concentrations were so close (Figure 7). It was observed that the almond could break the emulsion up to removal of 2.61ml base sediment and water from the 10ml crude oil emulsion sample tested using 10% concentration of almond oil (Figure 8). Thus the almond oil could be blended with other suitable natural chemical for use as good demulsifier in treating crude oil emulsion problem.

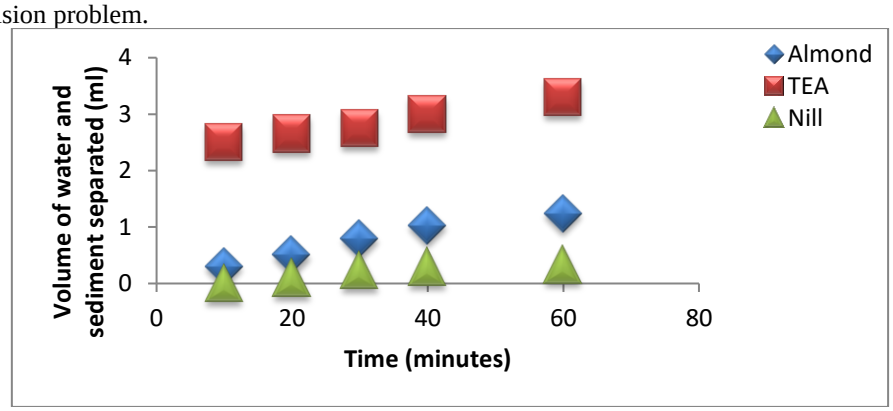

Figure 3: Water and sediment separation for demulsifier doped at 2.5%

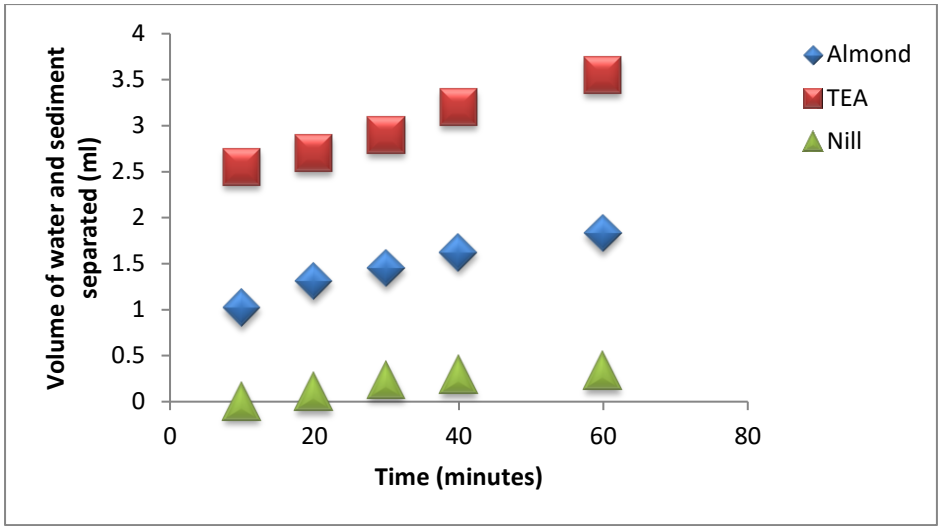

Figure 4: Water and sediment separation for demulsifier doped at 5%

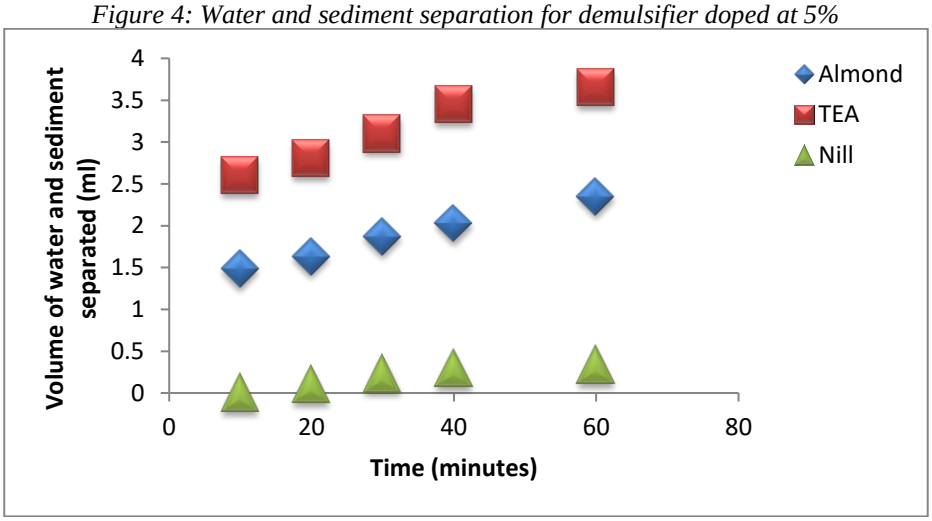

Figure 5: Water and sediment separation for demulsifier doped at 7.5%

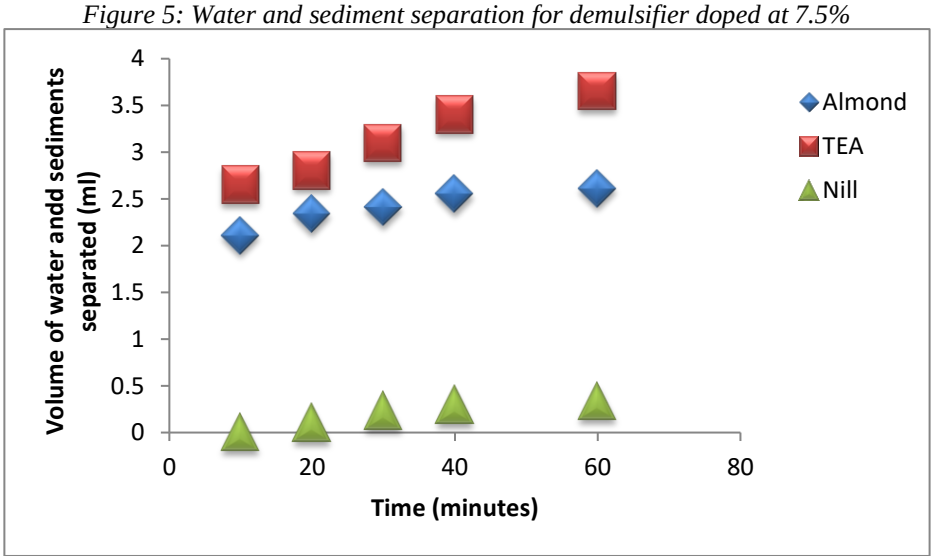

Figure 6: Water and sediment separation for demulsifier doped at 10%

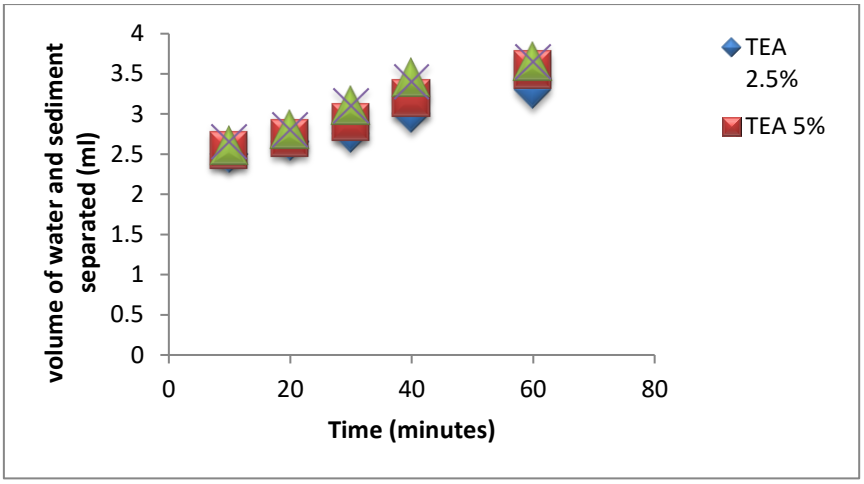

Figure 7: Water and sediment separation for TEA at different concentrations

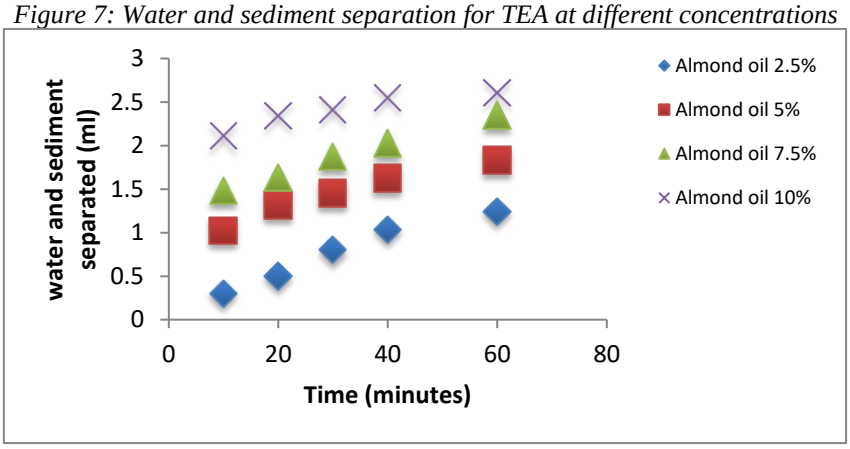

Figure 8: Water and sediment separation for Almond oil at different concentrations

4. Conclusion

Almond oil extract was considered as demulsifier of crude oil emulsion and its performance was compared with triethanolamine, a synthetic compound which has demulsifying tendencies. Crude oil which was used for the preparation of the emulsion was obtained from Niger Delta region of Nigeria was characterized using standard ASTM methods. The analyses of demulsifying abilities of the almond oil and TEA were carried out using bottle test method. Although the almond oil could perform as the TEA at low concentration, at higher concentration it could perform close to the TEA at high concentration of 10% in crude oil emulsion. It could be concluded that the almond oil have the ability to break the interfacial forces between the water and oil in the emulsion at the concentration of 10% appreciably close to the ability of the synthetic chemical, TEA. It is therefore recommended that further study should be done on the blend of the almond oil with other suitable natural product to obtain a novel effective demulsiier for treating emulsion problems in oil and gas industry.

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