Original Research Article

Demulsification of Crude Oil Emulsion Using Xylene, Polyhydric Alcohol (Glycerol), and Tri-ethanol Amine (TEA)

Ebikapaye Jeffery Peretomode

Department of Petroleum and Gas Engineering
Delta State University, Abraka,
P.M.B. 22, Oleh Campus, Oleh, Nigeria

E-mail: peretomodejeffery7@gmail.com;

Tel: +2348035831365, +234809243661

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Abstract

Water in oil emulsions occur at many stages in the production and treatment of crude oil. The breaking down of these emulsions is a very important aspect in the petroleum industry as the formation of emulsion can cause serious problems in the production and transportation of crude oil. This study examined the efficacy of using three chemical agents, xylene, polyhydric alcohol (glycerol), and triethanol amine (TEA) in the demulsification of crude oil emulsions. Results from this study show that glycerol and TEA were able to remove as much as 72.00% (from Well B) and 70.25% (from Well B) of water from crude oil/water emulsions in 72 hours respectively as against a maximum average of 65.70% water removed by xylene from three oil wells. Glycerol was the most active demulsifier and specifically in well B with 72.00% water removed in 720 minutes. Glycerol and TEA were therefore better demulsifiers than Xylene. The amount of water separated from crude oil increased with time.

Keywords: Oil emulsion; xylene, tri-ethanol amine, glycerol, demulsification

Introduction

The breaking of emulsion is very important in many areas such as painting, environment, waste-water treatment and in the petroleum industry. Methods available can be grouped as mechanical, electrical and chemical methods, and are commonly used in demulsification. (Abdulraman *et al*., 2007)

The formation of water-in-crude oil can be encountered at different stages of oil production and processing (Rasha *et al*., 2014). This case may predominantly be present in the production of heavy crude oils where steam is used to enhance recovery, or in cases where submersible pumps are used to artificially lift the produced fluids.

Emulsification of oil in water is generally complicated due to the immiscibility between these two liquid phases. Nevertheless, the result of shear mixing on the fluids during production and the existence of natural surfactants in the petroleum's composition contribute to formation of emulsions. (Hajivand and Vaziri, 2015)

Each time two immiscible liquids such as oil and water come in contact, one liquid has a tendency to disperse but not dissolve in the other. This dispersion of liquid characteristically in the aqueous medium is an emulsion. The presence of water in crude oil can be a source of undesirable consequences such as: corrosion, raised conductivity and leaching of additives (Sjoglom, 2001).

Common emulsions in the oil field are water-in-crude-oil emulsions. Their formation is mainly caused by high shear rates and zones of turbulent encountered at different points of production facilities, especially in the choke valve at the Christmas tree. (Van Der Zande, 2000).

Formation of an emulsion in the production path of the gathering system is therefore a major challenge in the oil industry which must be resolved. To efficiently design and operate heavy oil production systems, knowledge about properties that will influence the formation of emulsions and destabilization mechanisms of emulsions systems is necessary (Anne Silset, 2008). If the water is not removed from the crude oil, it will lead to emulsion related problems and economical loss.

This work was therefore motivated by the need to solve or treat emulsions and then select the best demulsifier against a particular well at a relatively lower cost. This study sought to look at the chemical kinetics using various demulsifiers for the breaking down of crude oil emulsions from various wells, and recommending the best demulsifier for each well with the limitation to studying the kinetics of breaking crude oil emulsions collected from one field (three wells) using Triethanol amine (TEA), Xylene and Glycerol.

In order to achieve the aim of this work which is to report on the demulsification of crude oil emulsion using xylene, polyhydric alcohol (glycerol), and triethanol amine (tea), it is also important to understand the concepts (collection of crude samples and selection of appropriate bottle test methods) for the separation or breaking of crude oil emulsions using various demulsifiers.

Materials and Methods

Crude oil used in this study was obtained from three different oil wells in Delta State, Nigeria. The samples were stable emulsions gotten from the wellheads. It contained lots of water, brine, mud and other unwanted particles.

a. Chemical Demulsifiers

Three chemical demulsifiers were purchased from Pyrex Scientific Company, Benin City, Edo State, Nigeria. and used for this work.

These were:

- Glycerol (Analytical grade of 98% purity, produced by Loba Chemie, Mumbai, India).
- Triethanolamine (Analytical grade of 99% purity, produced by Guangzhou Jinhuada Chemical Reagent Company Limited, Guangzhou China)
- Xylene (Analytical grade reagent of 99% purity, produced by JHD Chemicals, Guangdong China).

b. Equipment and Apparatus

Equipment and apparatuses used were a homogenizer, which is a motorized mechanical stirrer used to stabilize untreated crude oil emulsion, a thermometer, to monitor temperature of crude oil while stirring, beakers for holding and storing the samples, density bottle for the determination of density and specific gravity, and a stop watch for determining demulsification time.

c. Demulsification Experiment

A 1000ml beaker containing an emulsion sample with oil/water ratio of 50:50 (v/v) and 5ml of an emulsifier which is able to bind oil/water together was also added and thoroughly mixed with a motorized mechanical stirrer (homogenizer) for 10 minutes at 2000rpm.

Four sets of 250ml of the emulsion sample were then transferred to measuring cylinders, and one of the chemical demulsifiers (Glycerol, TEA and Xylene) added at 2ml to the emulsion in each of the measuring cylindesr. The fourth sample was left to stand on its own without the addition of a demulsifier as a control for the experiment.

The rate of water and other particulate matter separation was then carefully monitored in each of the cylinders to determine the effectiveness of the chemical demulsifying agents.

The percent of water removed was calculated as:

$$\%\text{water removed} = \frac{Volume\ of\ water\ seperated}{Total\ volume\ of\ crude\ oil\ emulsion} x\ 100 \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The steps discussed above were repeated for the other two samples and the results recorded.

Results and Discussion

The results of the demulsification experiment are presented in Tables 1, 2 and 3. The results show the effects of the various chemical demulsifiers used in the methodology of this work. The percentage of water recovered in each case was tabulated against time. Water recovered from the

Table 1: Percentage of water removal from Well A sample

Time of Observation (Min)	Volume of Water Removal (Percent) in Well A for 2ml of demulsifiers used			
	No Emulsion (ml)	TEA (%)	Glycerol (%)	Xylene (%)
1	8-33	8-11	9-50	8-00
5	20-50	21-65	17-70	16-47
10	44-17	58-88	35-00	33-33
15	50-00	61-98	52-00	47-50
20	51-25	62-44	56-50	49-17
25	52-08	62-94	58-00	50-80
30	52-50	63-96	59-00	51-67
40	52-92	64-26	60-50	53-33
50	52-98	64-46	60-92	54-10
60	53-08	64-65	61-70	55-80
90	53-33	64-81	64-00	56-25
120	53-33	65-2	64-20	57-00
180	53-33	65-71	64-50	57-50
240	53-33	65-89	64-90	58-33
360	53-33	65-89	65-20	58-33
480	53-33	65-89	66-00	58-33
540	53-33	65-89	66-14	58-33
600	53-33	65-89	66-15	58-33
660	53-33	65-89	66-15	58-33
720	53-33	65-89	66-15	58-33

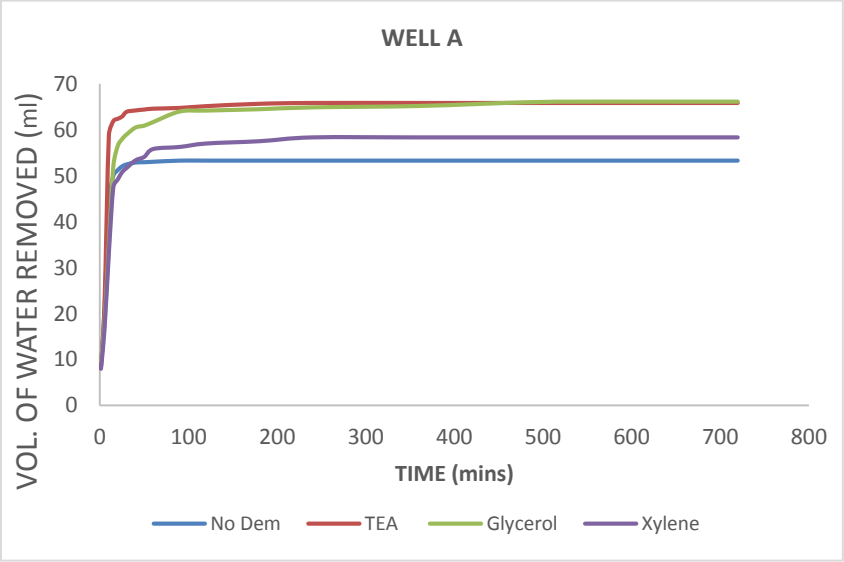

Figure 1. Plot of various demulsifiers against time for Well A sample

Table 2: Percentage Water Removal from Well B sample

Time of Observation (Min)	Volume of Water Removal (Percent) in Well B for 2ml of demulsifiers used			
	No Emulsion (ml)	TEA (%)	Glycerol (%)	Xylene (%)
1	6-75	3-10	6-84	5-87
5	24-27	6-67	8-77	6-19
10	29-13	10-00	14-04	7-08
15	48-54	26-67	15-79	14-16
20	49-51	40-00	17-54	33-63
25	50-49	40-00	17-54	33-63
30	56-31	40-00	61-40	61-95
40	56-41	46-55	64-85	61-95
50	57-00	50-00	66-67	61-95
60	57-28	50-00	66-67	61-95
90	57-44	50-00	67-10	62-40
120	57-77	50-00	67-54	63-72
180	58-25	53-33	70-18	65-04
240	61-17	55-00	70-18	65-49
360	64-76	58-93	71-05	66-37
480	65-05	66-67	71-05	66-26
540	65-05	70-00	71-93	69-03
600	65-05	70-24	71-99	70-42
660	65-05	70-25	72-00	70-50
720	65-05	70-25	72-00	70-52

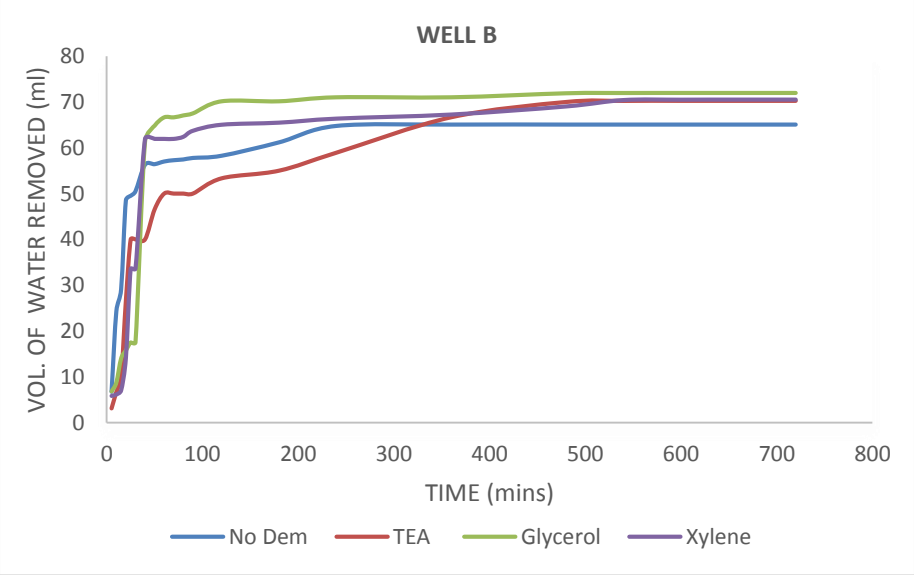

Figure 2. Plot of various demulsifiers against time for Well B sample

Table 3: Water removal percent in well C

Time of Observation (Min)	Volume of Water Removal (Percent) in Well C for 2ml of demulsifiers used			
	No Emulsion (ml)	TEA (%)	Glycerol (%)	Xylene (%)
5	47-52	45-10	57-63	58-90
10	50-99	48-64	64-14	62-75
15	51-92	55-45	65-66	64-71
20	51-66	59-09	66-16	65-69
25	52-32	61-73	66-67	66-27
30	52-65	61-82	67-17	66-47
40	52-98	62-64	67-78	66-86
50	53-40	62-90	67-96	66-99
60	56-29	63-15	68-32	67-20
70	56-29	63-36	68-59	67-45
80	56-29	63-56	68-63	67-54
90	56-29	63-64	68-69	67-65
120	56-62	63-64	68-69	67-84
180	56-62	63-82	68-89	68-24
240	56-95	63-82	68-89	68-24
360	57-28	64-09	68-89	68-24
480	57-28	64-36	68-99	68-24
540	57-28	64-39	68-99	68-24
600	57-28	64-40	68-89	68-24
660	57-28	64-40	68-89	68-24
720	57-28	64-40	68-89	68-24

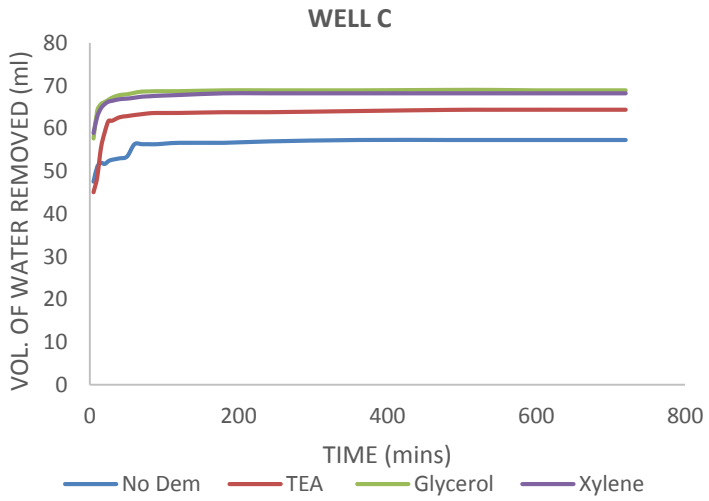

Figure 3 Plot of various demulsifiers against time for Well C sample

emulsion samples collected from the various wells were studied for 720 minutes (12 hours). This was to ensure that the volume of water collected was constant which is as a result of complete demulsification.

Figures 1, 2 and 3 show the percentage of water separation by using oil-soluble demulsifiers in Wells A, B and C respectively. Xylene was non-water soluble while Triethanolamine (TEA) and Glycerol were both water and oil soluble. Glycerol with 66.15%, 72.00% and 68.89% for wells A, B and C respectively and TEA with 65.89%, 70.25% and 64.40% for wells A, B and C respectively gave the best results in the three wells when compared to Xylene with 58.33%, 70.52% and 68.24% for wells A, B and C. Glycerol was the most active demulsifier in all the wells and specifically in well B (with 72.00% water removed) as can be seen in the result presented. Glycerol's effectiveness in this well was related to its ability to dissolve efficiently.

The activity of these demulsifiers was most noticeable in well C when compared with the performance of the control (no demulsifier) where only 57.28% of the water in the oil was removed compared to 68.89% water removed by glycerol.

Although these demulsifiers are expensive chemicals, their ability in resolving the emulsion problem is very excellent. Figure1 shows the inefficiency of Xylene which did not performed well in breaking emulsion basically due to its inability to dissolute in water. This is because the proportion of water contained in the wells was very high.

Conclusion

Specific gravity of crude oil is not dependent on the amount of brine in emulsion with the crude oil, but on the amount of water in the crude oil emulsion. It is evident from this study that some of the oil wells in Delta State produce, naturally, crude oil emulsions. It also shows that at a constant temperature, the performances of all three demulsifiers increased with time and also generally increased with separation time considered. Arising from the results of this study, Glycerol can be selected as demulsifying agents for these wells.

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