*SHORT PAPER*

# EFFECTIVNESS OF DEMLUSIFIERS IN BREAKING OFF EMULSION IN CRUDE OIL PRODUCTION

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**Abstract**: This work is aimed to evaluate four chemical demulsifiers (DE1, DE2, DE3, and XY) to break-off emulsion formed in oil wellA54. The active ingredient of demulsifiers (DE1, DE2, and DE3) is alkoxylated resins and high molecular weight polyols in an aromatic solvent. Static jar test is carried out at ambient and production separator temperatures (25°C and 85°C). Emulsion is prepared at mixing ratio of oil (70%) and produced water (30%).

The salinity of produced water is changing considerably; chemical demulsifiers are evaluated at low and high salinities. Results showed that temperature plays a significant role in breaking off emulsion. As temperature increases, the rate of oil/water separation rate increases. DE2 showed an optimum effectiveness in breaking off emulsion at 200mg/L. At high saline water (188,727mg/L), emulsion showed less stability comparing with low saline water (33,088mg/L).

**Keywords**: Demulsifiers, Emulsion, Xylene, alkoxylated resins, polyols

## INTRODUCTION

Stable water-in-oil emulsions can occur at many stages during the production and processing of crude oils. The formation of these emulsions is generally caused by the presence of resins and asphaltenes which play the role of "natural emulsifiers", and by wax and solids. All these components can organize and form rigid films at the oil/water interface. Effective separation of oil and water is essential in ensuring the crude oil quality and low cost of the oil production. (Dalmazzone & Noik, 2001). Methods currently employed in demusification of crude oil are: heat, electrical, chemical and polymer methods. Emulsion breaking or de-emusification is separation of a dispersed liquid from the liquid in which it is suspended. The objective of demusifiction is to destroy the interface and drive the surfactant to either the oil side or the water side, allowing the oil particles and sediments to coalesce and rise to the surface as in creaming. Decreasing water phase viscosity or increasing the diameter of oil droplets and lowering the density of oil to water also works. There are several strategies for counteracting emulsion:

(i) Decompose the emulsion, modifying or using dissolved air floatation, oxidation or other oxidation process.

(ii) Chemically react the emulsion, modifying the surfactants change so that it no longer acts as an emulsifier. Ionic surfactant neutralization is often the simplest method using an acid base or ionizer if calcium or magnesium salt, such as $CaCl_2$ or $MgSO_4$ is added to emulsion stability by sodium soap, which is less soluble in water because the interfacial film has changed.

(iii) Increase the solubility of the surfactant in either bulk phase. Alcohol or other polar solvents such as acetone can be used to increase solubility in the water phase and pull the emulsifier out of the oil phase. If the aqueous phase is brine, dilution with water may be all that is needed to achieve separation.

(iv) Disrupt the oriented structure of emulsifier interfacial phase with de-emulsifier. Because these materials are not very soluble in either phase they concentrate at the interface (Hajivand and Vaziri, 2015).

## THEORY

An emulsion is a dispersion of droplets of one liquid (water) in another liquid (oil) with which it is incompletely immiscible. Emulsion normally does not exist in the producing formation but are formed when oil and water are produced together with a great amount of agitation when water and oil in a reservoir enter the well bore, a comparatively large

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pressure differences are created which violently mix the produced oil and water together so that emulsion forms.

Emulsion consists of three phases: The internal or discontinuous phase of finely divided droplets; The external or continuous phase (i.e. oil) is the matrix that keeps droplets in suspension; The interphase consists of an emulsifier or stabilizer, which keeps the emulsion stable, binding the internal and external phases together and preventing droplets form approaching each other and coalescing. Usually, emulsifiers are surfactants and soaps present either by themselves or as part of the makeup of a detergent formation. An emulsifier consists of a molecule with hydrophilic and hydrophobic ends. In the presence of immiscible liquids, the emulsifier migrates to the interface of the internal and external phases, forming a protective sheath round droplets of dispersed phase. While the hydrophobic ends of the molecule migrates or partitions into droplets, the hydrophilic ends stays in the water (Hajivand and Vaziri, 2015).

## EXPERIMENTAL METHOD

### Materials

***Crude oil***: Crude oil sample (Image 1) from oil well A54, was used in this study (Table 1).

***Brine:*** Synthetic brine was used with different salinities (188,727mg/L and 33,088mg/L). The status of oil well before and after stimulation is described in (Table 2).

### Method

Water in oil emulsion is prepared by mixing crude oil and water (7:3 V/V) to obtain 30% (V/V) water content. All tests were performed at (25°C and 85°C) as follows (Udonne, 2012):

Image 1. Crude oil sample

(i) Precise volume of the quantity of emulsion poured in graduated test tube.
(ii) Injection of the desired quantity of demulsifier (100, 200, and 400mg/L with pipette).
(iii) First mixing by vigorous hand-shaking.
(iv) Vibration mixer for 10 minutes to ensure homogenous distribution of demulsifier.
(v) Reading the quantity and clarity of separated water after 30 minutes of rest. The residual interface was noticed for stability.

$$\left(\% \frac{V}{V}\right) = \frac{V_1}{V_2} \times 100$$

*Where,*

$V_1$: is the separated water
$V_2$: is the original volume of water contained

Table 1. Crude oil (well A54), characteristics.

| Technical Specification | Value | |
|---|---|---|
| Specific Gravity | 0.8232 | |
| API | 40.4 | |
| Water Cut | Max. 30% | |
| Salinity | 237.91 g/l | |
| Viscosity | 5.62 | 75 |
| | 1.80 | 175°F |

Table 2. Oil well A54 status before and after stimulation

| OIL WELL | Before Stimulation | After Stimulation and/or lifting | | | |
|---|---|---|---|---|---|
| | Well Status | Well Status | Choke Size (1/64”) | FWHP (Psig) | Oil Rate (BOPD) |
| A54 | SHUT-Due to Low WHP | PTN | 64 | 159 | 1154 |

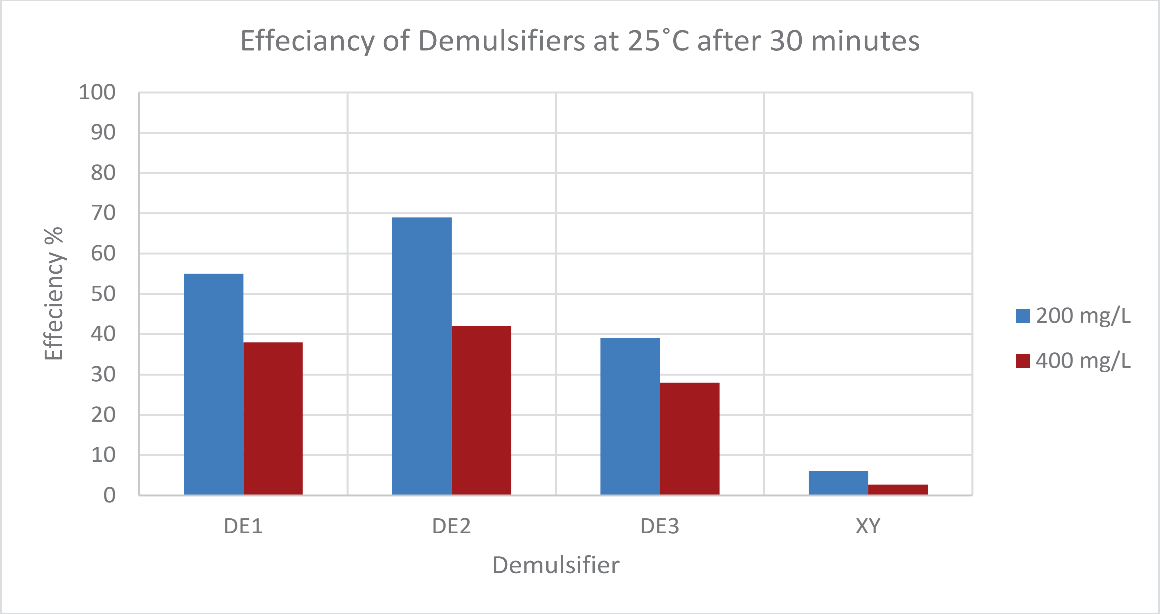

Fig. 1. Efficiency of demulsifiers at 25°C and 30 minutes

Table 3. Results of Static efficiency test for demulsifiers at 25 °C and 200 mg/L

| Chemical | Concentration (mg/L) | Time (minutes) | separated Water (ml) |
|---|---|---|---|
| DE 1 | 400 | 30 | 5.5 |
| | | 60 | 11.5 |
| DE 2 | 400 | 30 | 6.6 |
| | | 60 | 13 |
| DE 3 | 400 | 30 | 4 |
| | | 60 | 13 |
| XY | 400 | 30 | 0.4 |
| | | 60 | 1 |

Table 4. Results of Static efficiency test for demulsifiers at 25 °C and 400 mg/L

| Chemical | Concentration (mg/L) | Time (minutes) | Separated Water (ml) |
|---|---|---|---|
| DE 1 | 200 | 30 | 8 |
| | | 60 | 14.8 |
| DE 2 | 200 | 30 | 10.5 |
| | | 60 | 14.9 |
| DE 3 | 200 | 30 | 5.7 |
| | | 60 | 11.2 |
| XY | 200 | 30 | 0.4 |
| | | 60 | 1 |

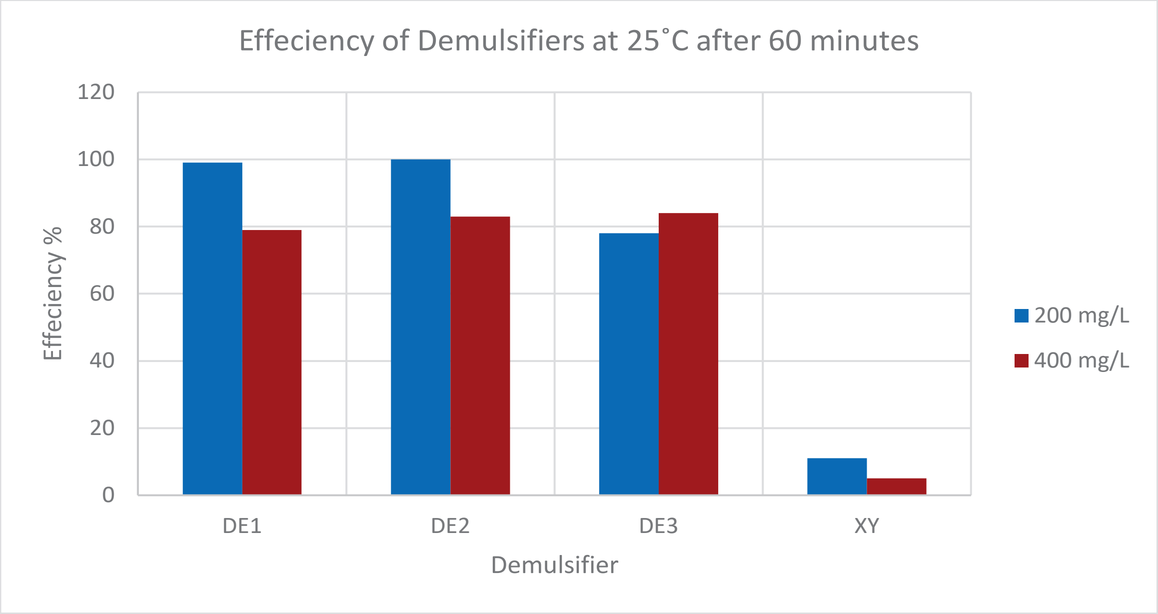

Fig. 2. Efficiency of demulsifiers at 25°C and 60 minutes

Image 2. Static efficiency test for demulsifiers at 200mg/L and 25˚C

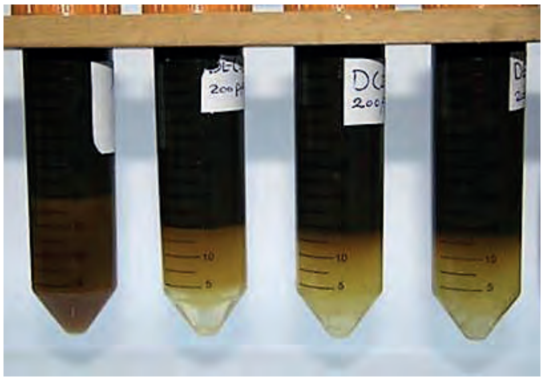

Image 3. Static efficiency test for demulsifiers at 200mg/L and 25˚C

Image 4. Static efficiency test for demulsifiers at 200mg/L and 25˚C

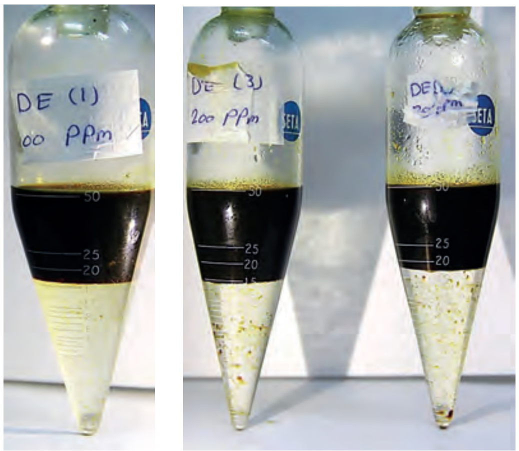

Image 5. Static efficiency test for demulsifiers at 200mg/L and 85˚C

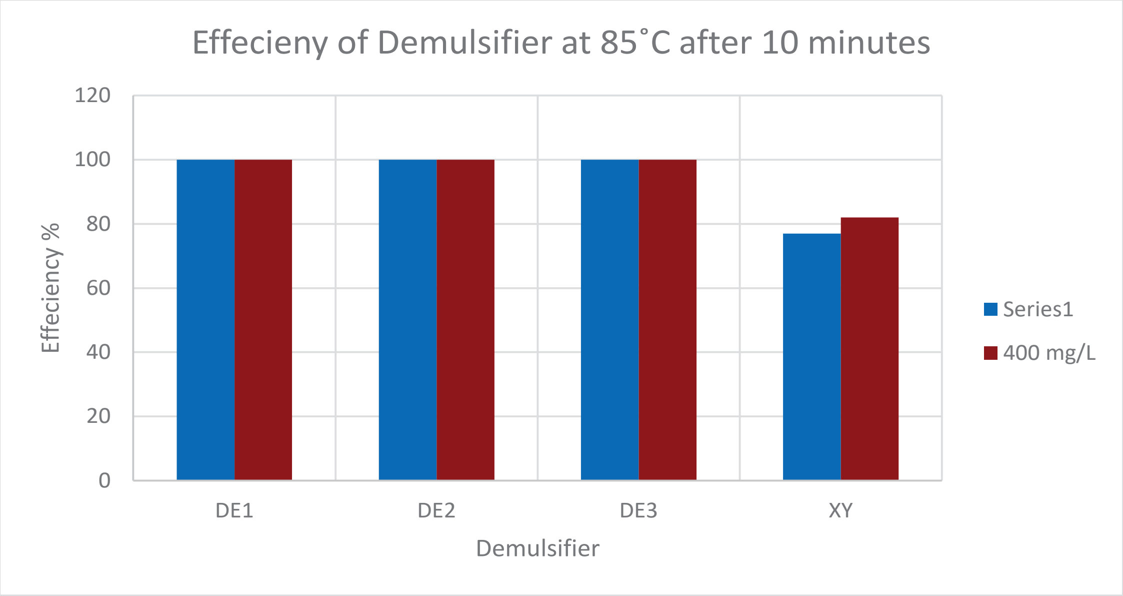

Fig. 3. Efficiency of demulsifiers at 85°C and one minute

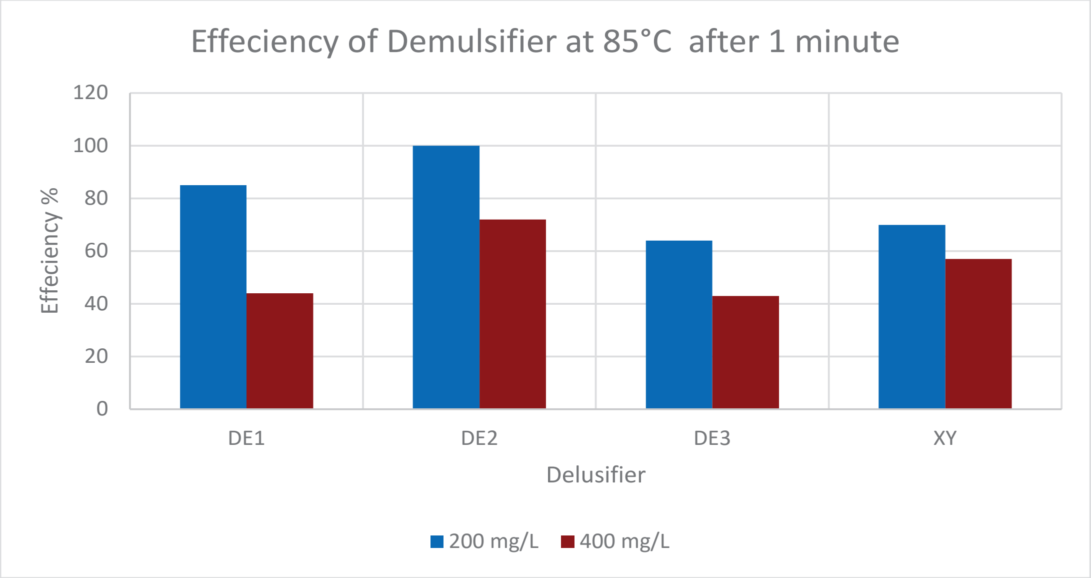

Fig. 4. Efficiency of demulsifiers at 85°C and 10 minutes

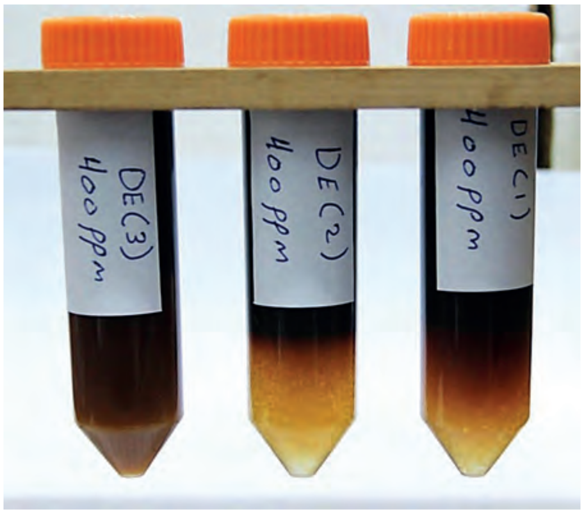

Image 6. Static efficiency test for demulsifiers at 400mg/L and 25˚C (low saline water)

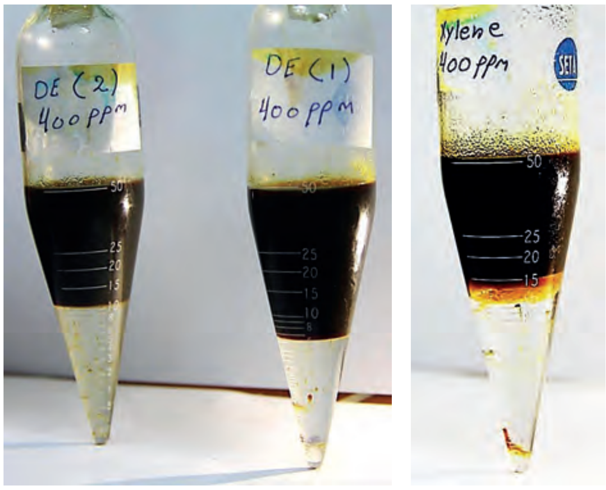

Image 7. Static efficiency test for demulsifiers at 400mg/L and 85˚C

Table 5. Results of Static efficiency test for demulsifiers at 85 °C and 200 mg/L

| Chemical | Concentration (mg/L) | Time (minutes) | separated Water (ml) |
|---|---|---|---|
| DE 1 | 200 | 1 | 13 |
| | | 10 | 15 |
| DE 2 | 200 | 1 | 15 |
| | | 10 | 15 |
| DE 3 | 200 | 1 | 10 |
| | | 10 | 15 |
| XY | 200 | 1 | 11 |
| | | 10 | 12.5 |

Table 6. Results of Static efficiency test for demulsifiers at 85 °C and 400 mg/L

| Chemical | Concentration (mg/L) | Time (minutes) | separated Water (ml) |
|---|---|---|---|
| DE 1 | 400 | 1 | 7 |
| | | 10 | 15 |
| DE 2 | 400 | 1 | 11 |
| | | 10 | 15 |
| DE 3 | 400 | 1 | 7 |
| | | 10 | 15 |
| XY | 400 | 1 | 8 |
| | | 10 | 11 |

## RESULTS AND DISCUSSION

Demulsifier are evaluated at different concentration to find out the optimum effective concentration. A low concentration (50 and 100mg/L) the amount and rate of separation of water is low. This screening test reduced the range of demulsifiers concentration for evaluation at operational temperature.

After 30 minutes, and at 25°C, the maximum efficiency was 69% for DE2 (Fig. 1). At 25°C the separated water from static test was measured after 30 and 60 minutes (Tables 3 and 4). Also, results at 25°C indicate that DE1 and DE2 show the maximum separation of water (99.9% V/V) was achieved after 60 minutes (Fig. 2), while DE3 and xylene showed 75% V/V and 7%V/V of separated water respectively.

Image 2 showed a comparison between DE1, DE2, DE3 and XY with blank sample after 5 minutes and at 25°C. After 10 minutes DE2 showed a clear solution in the bottom of test tube, Image 3. After 15 minutes, about 50% of total water was separated, (Image 3). All demulsifiers used in this work showed low separation of water at concentration of 400mg/L comparing with concentration at 200mg/L at the same temperature (Table 5, Images 4 and 5).

Figure 3 shows that at 85°C, DE2 achieved maximum effectiveness in one minute. The temperature 85°C has improved the rate of breaking off emulsion within one minute. Demulsifiers DE 1, 2, and 3, have achieved the maximum efficiency at 85°C after 10 minutes (Fig. 4).

The effect of water salinity on emulsion stability can be clearly observed from results (Table 4), images 6 and 7 (Table 6). Low saline water, the emulsion is more stable. This indicates that a reduction in the effectiveness of the performance of demulsifier in breaking off emulsion in short time.

## CONCLUSION

Experimental study was conducted to evaluate the effectiveness of four demulsifiers (DE1, DE2, DE3 and XY) for breaking off emulsion at different temperatures (25°C and 85°C). Temperature plays a significant role in improving the performance of demulsifiers (DE1, 2, and 3) in breaking of formed emulsion. Also, salinity of produced water plays a role in emulsion stability. DE2 showed the maximum efficiency at 200mg/L concentration.

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