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DE-EMULSIFICATION EFFICIENCY OF THE NIGER DELTA CRUDE OIL USING DIFFERENT DE-EMULSIFIERS

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ABSTRACT

This technical paper evaluates the separation efficiency of water from Niger Delta crude oil using five different de-emulsifiers: two commercial ones, that is, RP6000, and Chimec 2439, PPA prepared by polymerization, LAS and HAS both prepared by sulfonation. Chemical de-emulsification was then carried out at the temperature of 65^{O}C, using different concentrations for the period of 120 minutes. Alcohol were added as a modifier agent to enhance the performance of de-emulsifications at different concentrations. And the results depicts that water separation increases with increase in de-emulsifier concentration. Also, HAS and LAS prepared by sulfonation gave 90% and 88.3% of water separation respectively. PPA prepared by polymerization gave 75%, while commercial LP6000 and Chem2439 produced the same value of 87.5%. This shows that HAS is the best while PPA is the least in terms of water separation efficiency.

Key words: De-emulsifiers, Polymerization, Sulfonation, Chemical de-emulsification, Alcohol, Separation Efficiency.

INTRODUCTION

Emulsion is a heterogeneous system, containing at least immiscible liquid intimately dispersed in another in the form of droplets with a diameter ranging between (0.1-20) microns, and it is stabilized by an emulsifying agent, asphaltenes, resins and finely divided solids. The dispersed droplets are known as the internal phase. The liquid surrounding the dispersed droplets is the external or continuous phase. The emulsifying agent separates the dispersed droplets from the continuous phase **(Kenneth, 1998)**. Water-in-oil emulsion is formed during the production of oil, which is often accompanied with water. The stability of the emulsion is ranging from a few minutes to years depending on the nature of the crude oil **(Bhardwaj et al, 1998)**. Crude oils consist of, in any case, a series of hydrocarbons such as alkenes, naphtenes, and aromatic compounds as well as phenols, carboxylic acids, and metals. A major fraction of sulfur and nitrogen compounds may be present as well. The carbon numbers of all these components range from 1 (methane) through 50 or more (asphaltenes). Some of these components (asphaltenes, resins, wax, and naphtenic acids) can form films at oil surfaces. So, the tendency to form stable or unstable emulsions of different kinds varies greatly among different oils **(Schramm, 1992)**.

The natural petroleum emulsion resulting from the secondary production consists of crude oil as dispersion medium and brine as dispersed phase, normally stabilized by natural chemicals such as asphaltenes, resins, and solids such as clays and waxes (**Bhardwaj**,**1998)**. Emulsion stability is the ability of the dispersed phase of the emulsion to resist coalescence or sticking together of droplets. Emulsions are stabilized by the presence of a film between dispersed droplets and the continuous phase. According to **MacBain, 1950** this film is of many molecules thick, on the other hand **Fischer** and **Harkins, 1966** showed that this film is only mono-molecular. Emulsion resolution is therefore an important element in handling the petroleum, from the time it is produced until it enters the refining process. In order to minimize the production problems related with crude oil emulsions and environmental concerns, petroleum operators need to prevent emulsion formation or to break it (**Gafonova, 2000)**. The treatment of water-in-crude oil emulsions involves the application of mechanical, thermal, electrical, and chemical processes **(Grace, 1992)**. Chemical method of resolving crude oil emulsions are based on the addition of reagents (de-emulsifiers) which destroy the protective action of hydrophobic emulsifying agents and allow the water droplets to coalesce. There are anionic, cationic and nonionic surfactants that have been used as de-emulsifiers **(Selvarajan et al., 2001)**. Success of chemical demulsifying method is dependent upon the adequate quantity of a properly selected chemical that must be added into the emulsion, through mixing of the chemical with the emulsion, adequately heat may be required to facilitate or fully resolve an emulsion. Demulsifiers permit agglomeration, coalescence and gravity settling of the water droplets **(Staiss et al., 1991)**.

MATERIALS/METHODOLOGY

The crude oil obtained from the Niger Delta with its physical properties is shown in table 1 below:

Table 1: Physical Properties of the Niger Delta crude oil

Property	Basrah Crude Oil
Sp.Gr. at 15.6°C	0.8849
API	28.4
Salt content (%wt.)	0.0006
Water and Sediment content (%vol.)	0.05
Asphaltene (%wt.)	2.22
Ash content (%wt.)	0.0151
Sulfur content (%wt.)	2.1
Viscosity (cp) at 20°C	50
Conductivity (mS)	0

Five types of de-emulsifiers were used in the laboratory measurements and their explanations and compositions were shown in tables 3 and 4 and they are:

1. RP6000 (commercial) and the chemical composition of this de-emulsifier is not known .The PERTROLITE Company adopted this de-emulsifier in desalting process in East Baghdad oil field.
2. Chimec2439 (commercial), which is a blend of non-ionic oil soluble surfactants and the physical properties given from (CHIMEC S.P.A, Italy) Company, are shown in Table 2:

Table 2: Physical Properties of Chimec2439 **(CHIMEC S.P. Company, Italy)**.

Appearance	**Brown liquid**
Sp.Gr.at 20 °C	0.94±0.02
Viscosity at 20 °C (cp)	<50
Pour point °C	<-30 °C
Flash Point °C	>62 °C

3. PAA (prepared by polymerization method).

4. LAS and HAS (prepared by sulfonation LAB and HAB were brought from ARADET Company, Iraq), are given in Table 3:

Table 3: Properties of LAB and HAB **(ARADET Company, Iraq)**.

Substance	**Molecular Weight**	**Density at 20^{o}C**	**Viscosity at 20 ^{o}C**	**Flash point ^{o}C**
Linear Alkyl benzene LAB	242	0.8573	7.7	145
Heavy Alkyl benzene HAB	—	0.8825	95	188

Emulsion Preparation

In this research, the brine solution was used in preparing the emulsion system. The brine solution was prepared by dissolving 3gm NaCl in 100 ml water in order to obtain the required salinity similar to crude oil field. The emulsion was prepared by adding water 30% vol. (3% wt. NaCl) to the crude oil at room temperature. The de-emulsification was carried out by using a mixer at a speed of 5000 rpm for 60 minutes to until a stable emulsion was obtained.

Chemical De-emulsification Method (Bottle test)

The de-emulsification tests were performed on emulsion and the de-emulsifiers were then tested by using bottle test method (**Lissant, 1983)**.The purpose of this testing process is to test the effectiveness of de-emulsifiers in breaking the Niger Delta crude oil as per the procedures stated below:

- Four beakers of capacity 100ml each, was filled with the (W/O) emulsion samples, de-emulsifier or chemical compound was added in different concentrations (10-80)ppm to the contents of the beakers.
- A series of four condensers were joined with water bath. The water was

pumped from the reservoir tank at 65 ^{o}C into condensers, at the same time the contents of the beakers were added to the condensers to separate water from crude oil emulsion for 120minutes.

RESULTS AND DISCUSSION

The following data were obtained from the experimental runs as shown in tables 4 and 5 using different de-emulsifiers.

Table 4 : De-emulsifier concentration on water separation Efficiency at 120 minutes for both RP6000 and Chimec2439.Temperature(65^{o}*P*C) *P*and water content(30% volume), 3%wt. NaCl.

Concentration	Water Separation (%)	
(ppm)	RP6000	Chimec2439
10	45.6	17.6
20	57.4	18
30	63.5	28.6
40	66.7	36
50	77.8	44.7
60	83.5	58.3
70	86.4	64.1
80	87.5	72.2

Table 5: De-emulsifier dose on water Separation Efficiency at time 120 minutes for PAA, LAS and HAS. Temperature(65^{O}C), water content(30% volume),3%wt. NaCl.

Concentration (ppm)	Water Separation (%)		
	PAA	LAS	HAS
10	32.7	35.6	35.7
20	46.9	48.2	64.1
30	56.5	57.3	64.5
40	61.8	63.3	65.3
50	65.7	65.9	68
60	70.1	73.5	78
70	73.8	77.1	87.1
80	75	88.3	90

Result Discussion

Tables 4 and 5 above show the effect of de-emulsifiers concentrations on water separation efficiency at 120 minutes for RP6000, Chimec2439, PAA, LAS and HAS. From figure1 below, It can be observed that water separation increases with increasing de-emulsifiers concentrations. The maximum removal of 87.5% water was obtained at 80 ppm of RP6000, which gave higher separation than Chimec2439 at the same concentration and time. Three types of de-emulsifiers had been prepared PAA by polymerization, both LAS and HAS by sulfonation, used in water separation tests were all compared together with maximum value of 90% separation obtained from HAS. That means HAS has a good ability to promote separation of water than other types due to its chemical and physical properties especially its structural formula. This behavior is similar to the trend obtained by **(Nimat, 1998** and **Hanapi, 2006)**.

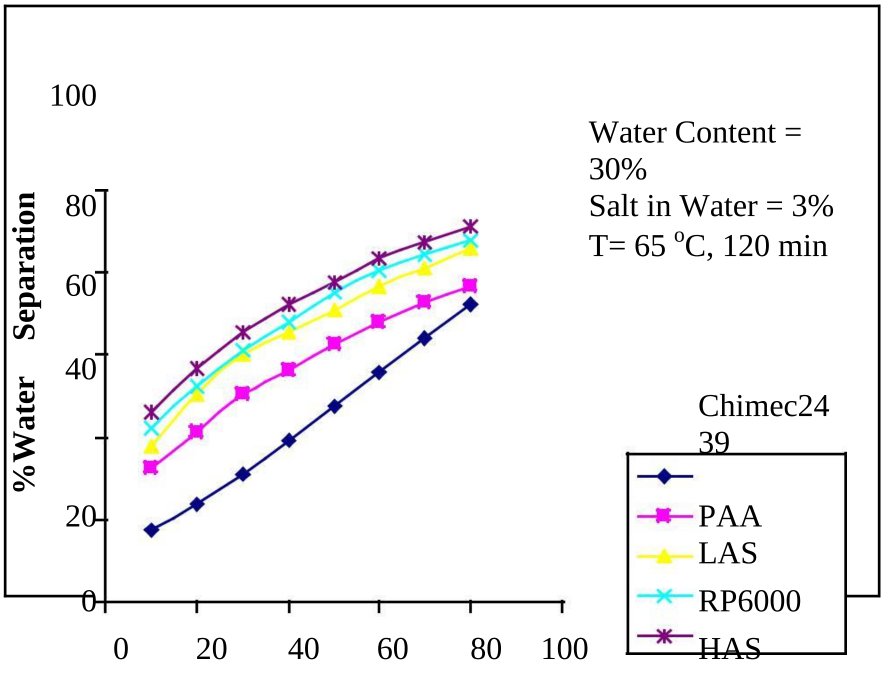

Figure 1: Effect of Concentrations on Water Separation for RP6000, Chimec2439, PAA, LAS and HAS at 120 minutes

CONCLUSION:

The following conclusions could be obtained:

1. Water separation efficiency increases with increasing concentration of de-emulsifiers where maximum separation for water obtained was at (80ppm) for all types of de-emulsifiers.

2. Two types of commercial de-emulsifiers has been used (RP6000 and Chimec2439), where they gave (87.5%) and (72.2%) water separation efficiency, respectively. Three types of prepared de-emulsifiers has been used (PAA, LAS and HAS). HAS gave higher removal efficiency of (90%), and (88.3%, 75%) for LAS and PAA respectively.

Recommendations

The followings to be recommended for future research:

1. Study the effect of changing temperature on water separation process.
2. Work needs to be carried out using natural crude oil emulsion.

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