Effect of Emulsion in Sudanese Crude Oil PalougeField ,Melute Basin

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ABSTRACT

The study was conducted in Palouge Field in Malute Basin Block 3&7 located in the Republic of South Sudan This paper discusses problems related to oil emulsions that have been encountered in Palouge Field. Oil samples collected from 17 Oil Gathering Manifold (OGM), viscosities ranges from 106cP to over 8159cP (@ 50°C and API gravities ranged from 13 to 25. Emulsion from 2 up to 33 and water cut from (7% water cut to over 77%), Pour Point 30 to 42⁰. These properties provide an interesting case of operational problems in oil water separation. The main causes of emulsion formation in the investigated fields were water cut, temperature, shear, Pour Point, demulsifier dosage and mixing different crudes. The results show a strong correlation of Pour Point (Paraffinic content which lead to stabilized emulsion) in the crude oil with the water-oil separation index or emulsion tightness. Recommendations are made for reducing and optimizing demulsifier dosage by adding chemical additives, and further comprehensive study should be done to determine the compounds which lead to stabilized emulsion for example Naphthenic compound and Asphaltenic.

Keywords: demulsifier, Palouge Oilfield, formation water, Environmental concerns

1- INTRODUCTION

Water-in-oil emulsions are formed during the production of crude oil. The stability of the emulsion is ranging from a few minutes to years depending on the nature of the

crude oil and to some extent the nature of water (Daaou, M., Bendedouch, D, 2012). A recent report has suggested that an equivalent volume of water accompanied the daily production of some 60 million barrels

of crude oil. Under the production conditions, a proportion of this water can become intimately dispersed throughout the crude oil as small droplets. Emulsions (Fortuny, Met al 2007) are undesirable because the volume of dispersed water occupies space in the processing equipment and pipelines, increased operating and capital costs. Moreover, the characteristics and physical properties of oil change significantly upon emulsification. The density of emulsion can increase from 800 kg/m³ for the original oil to 1030 kg/m³ for the emulsion. The most significant change is observed in viscosity, which typically increases from a few mPa·s or less to about 1000 mPa·s.

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 their formation or to break them. In some cases when the formation of emulsions is a result of poor operation practices, it is possible to prevent emulsion formation. Nevertheless, in many instances emulsion formation is predictable. The exclusion of water during recovery from the oil wells and

prevention of agitation is difficult to realize, and emulsions must be treated.

The treatment of water-in-crude oil emulsions involves the application of thermal, electrical, chemical process or their combinations. Thermal method or heat treatment in emulsion breaking is usually based on the overall economic picture of a treating facility. Excess heat is not supplementary when it is more commercial to add chemical or set up electrostatic heat. Temperatures are not high enough to significantly rise up water solubility in a particular crude oil, and high temperatures do not cause large amounts of asphaltenes (Daaou, M. *et al* 2009) (Gafonova, O. V. *et al*. 2000), (Groezin, H. *et al*. 2007) to become insoluble in the crude oil and form an interface pad (Honse, S. O. *et al*. 2012).

Polymeric demulsifiers (Kelland, M. A. 2009) are also the most common demulsifiers (Ramalho, J. B. V. S., *et al*. 2010) used to break water in oil emulsion. The polymeric demulsifiers (Lucas, E. F., *et al* 2009) are capable of adsorbing at the oil or water interface by displacing the interfacial film. Interfacial active fraction presence in the oil possesses a sufficient numbers of functional groups that can penetrate into the oil or water interface, and form an interfacial layer which can be

broken by demulsifiers (Mat, H. B., 2006).(Wang, X. Y., Alvarado, V. J 2009)(Al-Yaari, M. *et al.* 2015).

In order to devise optimum treatment for water-in-oil emulsions by using chemical treatment method, it is vital to understand how they are stabilized and destabilized the emulsion. Therefore, screenings of demulsifiers are very important in deciding the most effective demulsifiers in breaking the emulsion system. This result will lead to demulsifiers formulation for treating crude oil emulsion. The objective of this study is to evaluate the emulsion by using different types of Demulsifiers and Reverse Demulsifier using Bottle test method in the Laboratory and Field trial techniques. The bottle test is used to assist in the selection of a demulsifier which will most effectively resolve the emulsion produced by a given well or production system..

2-METHODOLOGY

Materials and Methods

Samples of crude oil were collected from 17 Oil gathering manifolds OGMs flow lines in (Test-1) 17 samples of 500ml clean plastic bottle were analyzed for water cut and emulsion (ASTM, D 96-88 1998). Another samples for bottle test to determine the optimum volume of chemicals to be injected

through the line of crude oil for emulsion treatment (Test-2), 17 samples using a stainless steel bomb permits sampling at produced fluid pressure thus minimizing loss of light ends and gas. A representative sample without any chemicals added such as demulsifiers, corrosion inhibitors, paraffins, and finally fresh to prevent emulsion stabilization was tested.

Reagents:-

Demulsifiers reagents collected from three companies:-

1-PWP 916

2-PWP 718

3-Champion X-80-29-A

Reverse Demulsifiers reagents collected from three companies

1-Dwell

2-Clariant

3-Champion

3-RESULT AND DISCUSSIONS

Crude oils are mainly consist of asphaltenes, resins and waxes. The presence of these agents results in the formation of stable emulsion. Stability is the persistence of an emulsion (Kumar, S.; Mahto, V. 2016) and presence of an interfacial film on the droplets to coalesce due to the present of interfacial active agents. As a result, the

suspended droplets do not settle out, float and coalesce quickly.

Crude oil in the reservoir is found together with formation water. The stable emulsion (Akbari, S., *et al.* 2015) resulted from the stress caused from the flow of crude oil and formation water. Emulsions create a lot of problems such as corrosion. For these reasons, crude oils must be treated by using demulsification process. There are four types of emulsions; W/O, O/W, W/O/W and O/W/O. Demulsifier which is injected to the OGMs must be calculated according to the OGMs production to avoid demulsifier over dose and the cost wise, the dose to be injected should be in liter per hour L/H. (Figure-1) represents OGMs water cuts % the volume of water cut ranged in between 7% in Ogm 11 to 77% in Ogm 6, (Figure-2) Shows the Ogm emulsion % the emulsion volume ranged in between 2% in Ogm 4 up to 33% in Ogm 3, (Figure-3) Demonstrate the emulsion volume%, water cut % and Demulsifier dose to be injected according to the Ogm production

The most widely used method in this treatment process is by using chemical demulsification. This process involves the use of chemical additives (demulsifiers) in order to accelerate the emulsion breaking

process. The demulsifier adsorbs at the interfacial film, weakens the interfacial barrier and separates the water droplets. Bottle test method or jar test method is commonly used in developing a new formulation of demulsifiers composition and the results are read from the water separation level. To choose the most effective demulsifiers, screening process is used without considering the price of the demulsifiers. Basically, oil-soluble demulsifiers are more expensive compared to water-soluble demulsifiers. Table (2), shows the efficiency of the three products used in the field with the different separation performance % which ranged between 55%, 59%, and 60%.

Table (3) represents the visual test regarding the interface, water quality and water drop speed which ranged from sharp, clear to fast. Table (4) shows the difference in separation performance % for reverse demulsifier of the chemical products companies, which ranged from 80% to 92%.

Regarding the study of Demulsifiers which has four main actions: a) Strong attraction to the oil-water interface. They must displace and/or neutralize the emulsifying agents (Nesterenko, A., *et al.* 2014) already on the droplet interface, b) Flocculation. They must neutralize any

repulsive electrical charges between the dispersed drops and so allow the drops to touch, c) Coalescence. They must permit small droplets to combine into drops large enough to settle; this requires that the film surrounding and stabilizing the droplets be ruptured) solids wetting. They must prevent fines at the droplet interface from physically blocking coalescence. Clays,

drilling mud, and iron sulfide fines can be water wet so that they leave the film interface and migrate into the water droplet. Asphaltenes and waxes can be dissolved or oil wet to disperse them into the continuous crude phase. The composition is different from company to another which composed of polymers the monomer are shown in (table- 1).

(Table-1) The major types of demulsifier chemicals can be characterized as follows

Type	Characterization
Esters	<ul style="list-style-type: none"> • good dehydrators, drop water out slowly, • subject to overdosing, • Glycol esters reduce o/w interface pad
Di-epoxides:	<ul style="list-style-type: none"> • excellent dehydrator, • Little effect on water drop
Urethanes:	<ul style="list-style-type: none"> • good dehydrator, do not effect water drop
Resins:	<ul style="list-style-type: none"> • speed water drop, will water-wet solids, • fair to good dehydrators, • oxyalkylated-acid-catalyzed resins give good quality, clean separated water, • base-catalyzed resins give drier oil
Polyalkylene Glycols	<ul style="list-style-type: none"> • poor dehydrator, do not drop water quickly require

Demulsifier chemicals should be injected as early as possible *e.g.*, at the wellhead or down hole. This allows more time for the chemicals to work, can also prevent possible downstream emulsion

	blending for most applications
Sulfonates:	<ul style="list-style-type: none"> • can resolve virtually any emulsion, • good wetting and water drop abilities, • overdosing does not cause o/w emulsion, but can cause FeS particles to drop out
Polyester amines	<ul style="list-style-type: none"> • extremely surface active, dehydrate at low dosages, produce sharp o/w interface
Oxyalkylated	<ul style="list-style-type: none"> • good wetting agents, used in blends,
phenols	<ul style="list-style-type: none"> • reduce interface pad build-up, • fair to poor demulsifiers
Oxyalkylated	<ul style="list-style-type: none"> • excellent emulsion breakers
polyamines	<ul style="list-style-type: none"> • retard water drop
Alkanolamines	<ul style="list-style-type: none"> • speed water drop, fair total performance

formation, and allows different chemicals to be used for problem wells. Injecting demulsifiers ahead of a pump ensures adequate mixing and minimizes emulsion formation by the pump. Mild mixing,

such as in pipe flow at design velocities, can accelerate chemical dispersion and flocculation of water drops. However,

intense agitation *e.g.*, centrifugal pumps promotes emulsion formation.

Figure (1) Water cut% Volume from 17 OGMs

Figure (2)Ogm Emulsion% Volume

Ogm : Oil gathering Manifold

FPF : Field process Facility

Figure (3) Emulsion % Volume, Water Cut% Volume and Demulsifier Dose inject

Table(2) 3ree Companies to show difference Separation Performance%

Company Product	PWP	PWP	Champion	Blank
Results	916	718	X-80-29-A	
Separated Water % after 15 min @ 75°C	0.2	0.2	0.2	0.0
Separated Water % after 30 min @ 85°C	3.0	0.4	0.6	0.2
Separated Water % after 60 min @ 80°C	11.0	3.0	4.0	1.8
Separated Water % after 90 min @ 80°C	12.0	7.0	9.0	4.0
Separated Water % after 120 min @80°C	13.0	11.0	12.0	6.0
Top Cut BS&W after 120 min	9 %	9 %	8 %	17 %
Total Water Cut in the Bottle %	22	20	20	23
Separation Performance %	59.0 %	55.0 %	60 %	26 %

Table(3) 3ree Companies to show Comparison in interface,water quality and water drop speed

Company Product	PWP	PWP	Champion	Blank
Results	916	718	X-80-29-A	
Visual Test				
Interface	Sharp	sharp	Sharp	
Water quality	Clear	Clear	Clear	
Water drop speed	Very Fast	Not Fast	Fast	

Table (4) 3ree Companies to show difference Separation Performance% for Reverse Demulsifere

Company Product	Reverse Demulsifier	Reverse Demulsifier #1	Reverse Demulsifier #2	Blank
Results	Champion	Dwell	Clariant	***
5 min	0.0	0.0	0.0	0.2
10 min	0.2	0.0	0.0	0.4
15 min	1.4	0.0	0.0	2.0
20 min	2.0	0.0	0.0	3.0
30 min	6.0	0.0	0.0	6.0
60 min	25	0.0	10	30
120 min	42	40	40	40
180 min	46	40	40	40
Top Cut BS&W after 180 min	4	10	10	10
Total Water Cut in the Bottle %	50	50	50	50
Separation Performance %	92	80	80	80

4-CONCLUSIONS

Crude oils are mainly consists of asphaltenes, resins and waxes. The presence of these agents results the formation of stable emulsion. Stability is the persistence of an emulsion and presence of an interfacial film on the droplets to coalesce due to the present of interfacial active agents.

Emulsions are characterized by the type of emulsion (W/O, O/W, or multiple), nature of emulsifying agents present, BS&W, droplet size and droplet-size distribution, bulk viscosity, and interfacial viscosity.

Emulsions are destabilized by increasing temperature, moderate agitation followed by gentle settling (i.e. residence time), removing solids, and controlling emulsifiers

The mechanisms involved in demulsification are flocculation, aggregation, and coalescence

The methods involved in emulsion breaking or demulsification are thermal, mechanical, electrical, and chemical. Experience and economics determine which methods are used, and to what degree, for emulsion treatment.

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