Treating Wet Oil in Amara Oil Field Using Nanomaterial (SiO$_2$) With Different Types of De emulsifiers

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Abstract

One of the most important problems in the oil production process and when its continuous flow, is emulsified oil (w/o emulsion), which in turn causes many problems, from the production line to the extended pipelines that are then transported to the oil refining process. It was observed that the nanomaterial (SiO$_2$) supported the separation process by adding it to the emulsion sample and showed a high separation rate with the demulsifiers (RB6000) and (sebamax) where the percentage of separation was greater than (90 and 80)% respectively, and less than that when dealing with (Sodium dodecyl sulfate and Diethylene glycol), the percentage of separation was (60% and 50%) respectively.

The high proportion of (NaCl + distilled water) raises the probability of the separation efficiency as the separation was (88.5,79)% and (65.5, 55) % for (RB6000, SebaMax)respectively with (SiO$_2$) at 70 °C, while the results of separation were (77,85)% and (65,40) for (RB6000, Seba Max) respectively with (SiO$_2$) at 50 °C after 120 minutes, where the (w/o ratio) was (9:1) for the high separation results and (7:3) for the lower separation results, at a speed of (12000rpm), and with a salt concentration of (1500) ppm, and less of these results at lower volumetric and temporal conditions. The (NaCl) salt deals with the wall films separating the droplets and reduces their viscosity [1].

As for the pH factor, it is at the value (2 and 3) represent a stable emulsion that is difficult to separate easily, but with the passage of raising the pH away from the acidic medium and near to the basic direction, a significant increase in the separation process was observed compared with the acidic medium at lower values, after 120 minutes the separation seemed to be good efficient, reaching (60 and 70) % respectively, while at the same time the emulsion reached a more efficient separation level with a pH of (8 and 7) equal to (80 and 87.3) %, at 50 °C with SebaMax demulsifier in presence of (SiO$_2$), and with the same pH values, an increase was observed in the separation with the increase in temperature to (70 °C), then it returns to be a reverse emulsifier when the value exceeds (10) to (11, 12, 13).

Keywords: emulsion, demulsifiers, crude oil, saltwater, w/o emulsion, nanomaterial

1-   Introduction

In the oil production process, the formation of emulsions such as water in oil (W / O) is common due to the simultaneous continuous flow of the produced oil and water and high shear rates [2], which are mainly associated with the throttle valves, which leads to an increase in the area of the oil and water phases. In this case, inorganic colloids are accompanied by organic molecules and molecules with active interfaces (for example, asphalt and naphthenic acids) that increase the viscosity of the emulsion mechanically, resulting in a stable emulsion.

This stability leads to a noticeable increase in the viscosity of the emulsion formed that can become greater than that of the oil itself, which leads to loss of system head, and thus reduces the productivity of wells and the capacity of the production system, mainly in deep waters, with a significant increase in production costs[3].

Some Iraqi oil fields, especially the Amara field in Maysan Governorate (about 10 km southwest of the city of Amara), suffer from the problem of wet oil (emulsion) [4].

The presence of this contamination in the oil is a big problem that leads to reducing the efficiency of the units that the oil passes through production processes [5].

The presence of salts will lead to precipitation in the heat exchanger tubes and furnaces in the form of solid blocks that reduce the diameters of these tubes and then increase the skin temperature and cause damage with them, and therefore these units are completely damaged, which leads to a large loss in production due to the suspension of these units from intentional maintenance [6].

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As a result of the presence of water in the oil and its containment of a large number of salts that are mainly available in the form of chlorides (CaCl$_2$), (MgCl), and (NaCl), hydrochloric acid is formed as a result of the dissolution of calcium chloride during the distillation process, and this acid has a great corrosive effect, which causes Corrosion of units and equipment. [7].

Emulsions also cause an increase in energy consumption because the presence of water in the crude oil leads to an increase in energy consumption[8], all of these problems reduce the economic oil factor in the Iraqi market and the factor of the low quality of these heavy oils, according to (A. Saniere et al.,2004), options include improving quality to produce marketable crude oil, including carbon subtraction processes such as carbonization or hydrogen addition processes, the dilution process is one of the methods for improving heavy oils and the least costly, as higher quality oil is used to produce a product that can be further improved in another way[9].

The results showed that the (nano-SiO$_2$) should interact with asphalt and resin surfaces and reduce the stability of the membranes surrounding the emulsion droplets as the addition of nanomaterial accelerates the process of breaking the inner interfacial film and isolates water droplets faster and in the shortest time possible [10].

While (D.M. Pinchao, and et al) found that the optimum separation efficiency (92%) was achieved at a concentration of 1000 ppm SiO$_2$ nanoparticles and (5:5 ratio), an increase of 15% compared to the amount of water separated using only the de-emulsifying agent.

On the other hand, the concentrations of 4000ppm and 10,000ppm of SiO$_2$ nanoparticles reached much lower amounts than the water separation, 4%, respectively, due to the over-saturation in the mixture. [11].

In this research, water surfactants (that can be mixed with water) will be dealt with to tear the water droplet membrane and sediment it away from the oil drop, solid nanomaterials (powder) will be used where the action of the solid particles is to break the elastic membranes and thus drops coalesce with some of them and separated from the oil.

2- Experimental Work

2.1. Work method

The method of work that was relied upon is (bottle testing), which includes adding crude oil samples after mixing it with a homogeneous mixer device for a period of (6 minutes) to a group of glass cylinders containing gradients per volume unit (milliliter) after which the demulsifier is added and the bottle shaken for (3 Minutes) and then these samples are placed in a water bath with different temperatures (15, 50, 70, 100) C° for two hours, then reading the level of separation of water from oil and recording these readings within the time (120 minutes).

2.2. Explanatory Work Tables

Table 1. Brief the ratios and sizes adopted in the process of separating water from oil

Dose injection (ppm)	Nanomaterials concentration (ppm)	Sedimentation time (min)	Temperature C°	NaCl (ppm)	Mixing speed(rpm)	pH value
500	300	20	15	250	6000	2
1000	600	30		500		3
1500	900		50	750	10000	4
2000	1200	60		1000		5
2500	1500		70	1250	12000	6
3000	1800	120		1500		7
3500	2100		100	1750		8
	2400					9
	2700					10
	3000					11
						12

Table 2. Crude oil test results (Amara field) before treatment (Al-Dora Refinery)

TEST	RESULT
API gravity at 15.6 C	23.1
SP.GRAVITY at 15.6 C	0.9153
DENSITY at 15C	0.9148
SULFUR CONTENT % WT.	3.67
KIN.VISCOSITY CST. at 37.8C	34.1
SALT CONTENT% WT.	0.7800
SALT CONTENT PPM	7139.34
KUOP CHARACTERIZATION FACTOR	11.6
WATER CONTENT VOL.%	7.0

3- The Properties of The Demulsifies Used& Nanomaterial

3.1. The Properties of the Demulsifies

Table 3. Characteristics of the demulsifies are used

Name of demulsifies	Type of Demulsifiers	Description	HLB No.	Density gm/ml	M.W. gm/mol	Sp. Gr at 20C°	Viscosity 20 C° (cp)	Pour point	Flash Point C
Sodium dodecyl sulfate(SDS)	An ionic	White Powder	40	1.01	288.372	No info-rmation	/	/	170 °C
Diethylene glycol (DEG)	Nonionic	Colorless liquid	6.0	1.118	106.12	1.12	14.0 Cs	-11	154 °C
RB6000	)ionic(An	Brown liquid	/	/	/	0.94	<50	<-30 C	70 C >
SebaMax	)ionic(An	Brown liquid			No further relevant information	/	/	/	/

3.2. The Properties of the Nanomaterial

Table 4 Characteristics of the SiO$_2$ nanomaterial used

Nanomaterial	pH	Particle size(nm)	Mwt(g/mol)	Densit g/cm3	Purity %	Color and appearance	surface activity
SiO$_2$ (Silicon Oxide)	3.7	15-20	60.08	2.643	99.5+	White powder	Negative charged

4- Experimental Procedure

To know the stability of emulsions in the Amara oil field, it is necessary to note the figure below showing the amount of water droplets dispersed in one drop of oil, thus knowing exactly how to process and the amount of materials to be added during the test.
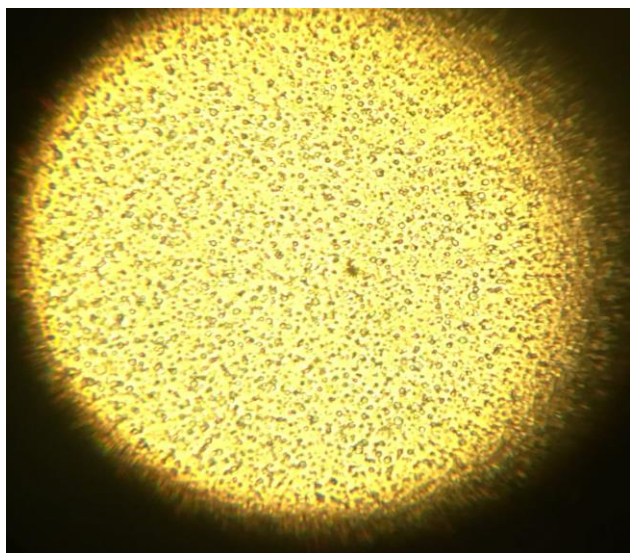

Fig. 1. A real picture for a drop of emulsified oil that is highly stable from the Amara field under an electron microscope (Ministry of Science and Technology - Environment and Water Laboratory)

At the beginning of the work, the brine solution is prepared after adding different proportions of (NaCl salt) with the emulsified oil and the mixing time is for (6 minutes) at different speeds (12,000,6000,10000 rpm) and then the nanomaterial is added (SiO$_2$) at different concentrations each time the treatment process is repeated and mix it with the previous solution for (5 minutes) on (hotplate stirrer), then put the homogeneous solutions after mixing in the test bottle and add demulsifier and close the bottle, then shake it for (3 minutes) by hand, after that it is placed in the water bath at a reservoir temperature of 70 ° C, as shown in Fig. **2**.

The samples are prepared as follows (oil emulsion with (saltwater) and demulsifiers/nanoparticle):-Four different aqueous solutions were prepared (First mixture: 100g water, 1 wt. % NaCl, and 1 wt. % SDS, and 1 wt. % SiO$_2$), (Second mixture: 100g water, 1 wt. % NaCl, and 1 wt. % Diethylene glycol, and 1 wt. % SiO$_2$), (Third mixture: 100g water, 1 wt. % NaCl, and 1 wt. % RB6000, and 1 wt. % SiO$_2$), (Fourth mixture:100g water,1wt.% NaCl, and 1 wt.% SebaMax, and 1 wt. % SiO$_2$), the percentages of water added to the oil were as shown in the table (5).

These models are re-equipped with the rest of the demulsifier types, temperatures, and speeds to observe and record the difference in the treatment process and separate the water from the oil.

Table 5. (water to oil ratio) Amarah crude oil was added to the aqueous solutions in the bottle test

Water to oil ratio
1:9
5:5
7:3
9:1

Fig. 2. Place test bottle samples in the water bath

5- Results and Discussion
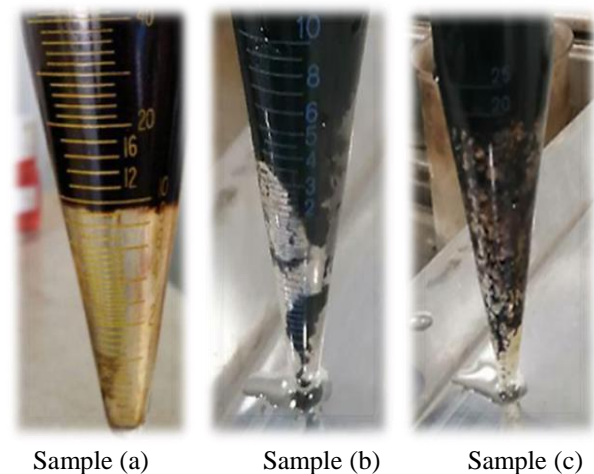

Sample (a)   Sample (b)   Sample (c)

Fig. 3. Three samples of (w/o) emulsion after treatment over time (30min) (by adding different types of demulsifiers) with concentration (500 ppm) for demulsifies and a temperature of (50 ° C) with mixing speed (10000 rpm) with (w/o) ratio is(1:9)

From left to right (with demulsifiers)
1- The results of the treatment for sample (a) with the demulsifiers type (SDS) showed good separation within a short time when the separation ratio reached (10ml)
2- The results of the treatment for sample (b) with the demulsifiers type (DEG) showed slightly separation within the same time when the separation ratio reached (6ml)
3- The results of treating the sample (c) with the type of demulsifiers (RB6000) showed a significant separation during the same time in which the level of separation was (15 ml).

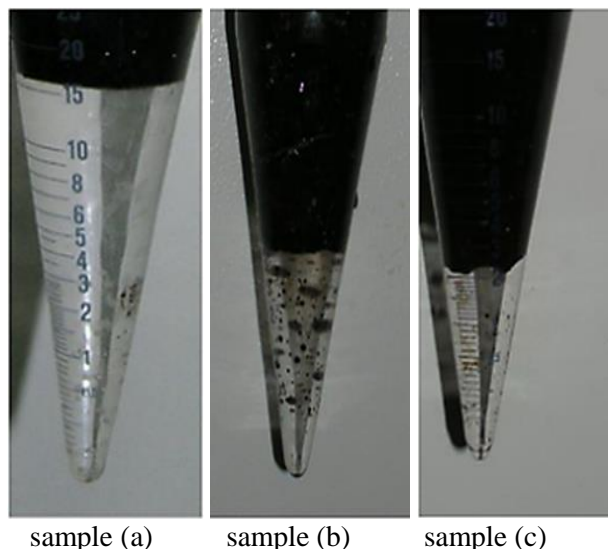sample (a)   sample (b)   sample (c)

Fig. 4. Three samples of (w/o) emulsion after treatment and a demulsifies (Seba Max) at the concentration (500 ppm), and a temperature of (15 ° C) and (5:5 w/o ratio)

From right to left

1-A Sample (c) showed the result of separation at a level of (2ml) after the passage of (20 min) time and at a mixing speed of (10000 rpm) without adding (SiO_2).

2-A sample (b) showed a separation result at a level of (5ml) after the passage of (30 min) time and at a mixing speed of (10000 rpm) without adding (SiO_2).

3-A Sample (a) showed a better separation result than previous samples with a separation level (17ml) after a (30 min) time and at a lower mixing speed of (6000 rpm) in the presence of the nanomaterial (SiO_2=300 ppm).

5.1. Temperature Effect

In Fig. **5**, the increase in the separation process is proportional to the increase in temperature over time, and the highest level of separation is at a temperature of $(70)°C$ and after (120 minutes).

The figure also shows that the wet oil was treated with a demulsifier (SibaMax) with a concentration of (500 ppm), where we notice that the separation rate started at (30)% at the temperature $(15)°C$ and the separation began to increase upward with the rise in temperature to $(70)°C$ which equal to (85%), but when the temperature increased to the maximum at (100 °C), the emulsified oil starts the intensity and stability increases, and transforming into a reverse emulsion, after (120 minutes).

It is observed that the heat in the process of separating the water from the oil has a basic effect; As it helps to reduce the viscosity of the oil, and the effect of heat in reducing viscosity helps to increase the separation speed by enhancing the fusion of the drops that will form large drops as a result of a collision with each other [12], despite the positive effects of heat on the entire process, there is some negative impact on oil containing light compounds, their evaporation may affect the total volume of oil, as approximately 1% of the total volume is lost, and also the release of these compounds or gases may cause a disruption that hinders the gathering Water droplets and prevents their stability, and this problem is addressed by taking into account the design of the buffer in the field; In new designs, oil is kept above the bubble pressure by placing small insulators above the treatment vessels [13].
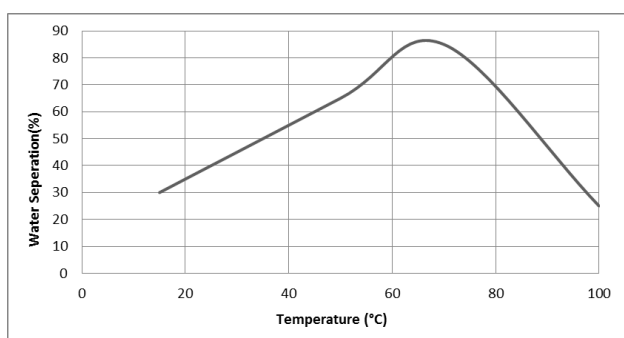

Fig. 5. The effect of different temperatures on (water –oil) separation at (500ppm) SebaMax, (10000rpm), (1:9 w/o ratio),NaCl concentration(250ppm), at different temperature (15,50,70,100) °C

5.2. pH effect

The pH of water has a strong influence on its emulsion stability (water/oil), the stable hard emulsion film contains organic acids and bases, asphalt, and solids with ionizing groups. The addition of inorganic acids and bases strongly influences their ionization in the interlayers and radically changes the physical properties of the films [14].

The pH of water affects the hardness of the interlayer membranes that need to be fused and precipitate into the bottom for the separation to succeed [15].

In Fig. **6**, in which the effect of the pH on the process of separating water from oil and in brine is shown as the pH (2 and 3) represent a stable emulsion that is difficult to separate easily, but with the passage of raising the pH away from the acidic medium and close to the basic direction, we notice the beginning of the separation process significantly compared to the acidic medium and the reason for this difference is due to the separation with the difference in the pH to the attractive forces and the repulsion provided by the salt medium by the presence of an (ionic demulsifiers), where the concentration of the brine solution increases as the pH rises [16].

The other reason for the high separation ratio whenever we exceed the pH value (7 and 8) to the imbalance of the stability of the emulsion and its disorder due to the loss of the surface tension force of the droplets heading towards coalescence, and the formation of larger drops, which leads to their sedimentation at the bottom and their separation from the oil droplets, and as a result of the difference in densities, the oil is up and the water settles down, which means a successful separation process and after 120 minutes have passed, but when the pH value increases more than necessary, we notice that a reverse emulsion is formed, and the separation value returns by dropping to a level lower at (pH = 11 and 12).[17]

The amount of pH is variable from distilled water to brine; this difference is due to the effect of ionization (ionic bonding/reaction in brine with asphalt). for most brine systems, there is an ideal pH level at which the membrane surrounding the droplets will exhibit minimal emulsion stability or maximum emulsion fracturing properties, and the pH value (optimal value) depends on two important factors (properties of the crude oil and brine composition). The last factor appears to be the most important. [18]
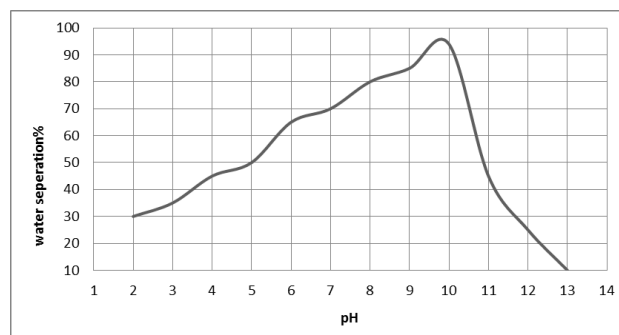

Fig. 6. Effect of pH on separation process at 50 C° with SebaMax at (1500 ppm) in the presence (SiO_2=900 ppm),(1200 rpm), NaCl concentration (750 ppm)

5.3. Effect of Injected Dose of Demulsifiers

Also, an important factor affecting the emulsion separation process is the amount or dose of demulsifiers added to the emulsified oil mixture. The amount of the added dose affects the success or failure of the separation process, as the large amount is harmful in the treatment process (excessive treatment state) which may cause an emulsion Reverse, while very low doses may lead to treatment failure due to insufficient dose breakage and penetration of the membranes of the drops of saltwater in the emulsified oil.

In Fig. **7**, the concentrations of the demulsifier (RB6000) ranged from (500ppm) to (2500ppm), where the separation ratio was at the lowest level at the concentration (500 ppm) was (29.7%), while the increase in the separation with the increase in the values of the demulsifier concentrations and reached the highest separation rate It is (75%) at the concentration (2500 ppm).
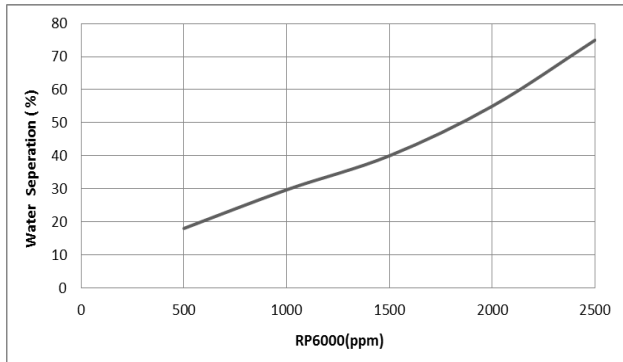
Fig. 7. Effect of Injected dose of demulsifier (RB6000) at (50°C),10000 rpm, (water/oil ratio= 7:3), at SiO$_2$ concentration (1800ppm),NaCl concentration (1000ppm)

5.4. Effect of Demulsifies Types

In Fig. **8** an illustration of the best separation when using a different group of demulsifiers where the separation ratio increases with (RB6000) and is slightly less than it with the use of the enhanced demulsifiers (SebaMax) and less than with (SDS) after the nanomaterial is mixed (SiO$_2$) with emulsion, the separation ratio increased and the treatment of wet oil was improved. this is due to the ionic surfaces of the demulsifiers, which can attract water droplets after penetration by the solid nanomaterial and thus collect and deposit them as a result of gravity and increase the weight of the droplet, so it is pushed back to the bottom of the bottle test is away from oil droplets and due to different densities, which requires oil to rise and water down.

In the case of the (DEG) demulsifiers with a positive (non-ionic) surface, its separation ratio is low compared to the rest of the aforementioned fractions, and it takes a longer time for the treatment result to appear.

And for the demulsifier to be effective, it must be mixed well with the emulsion for the molecules of the active chemical to surface to penetrate the flexible membranes surrounding the saline water system drops. If the mixing process is insufficient and slow, then the treatment is futile. The emulsifier breaker should be injected into the crude oil (the continuous phase in the emulsified mixture) typically through (homogeneous mixer at a variable and suitable speed) to form a one-way stream that is sufficient to mix the refractory with the emulsion taking into account the time sufficient for complete mixing [19].

The difference in the separation efficiency of each type of demulsifies is due to the different molecular weights of the polymeric compounds involved in the structure of each type, and consequently the difference in the interaction efficiency with the surfaces of the membranes surrounding the emulsion drop and the reduction of the surface tensile strength as the commercial demulsifiers are more feasible and effective than the local demulsifiers manufactured for treatment purposes with less stable emulsions.

The higher of molecular weight of the demulsifiers, the greater the separation efficiency. (RB6000 is the highest molecular weight) despite the lack of information on (RB6000 and Sebamax).
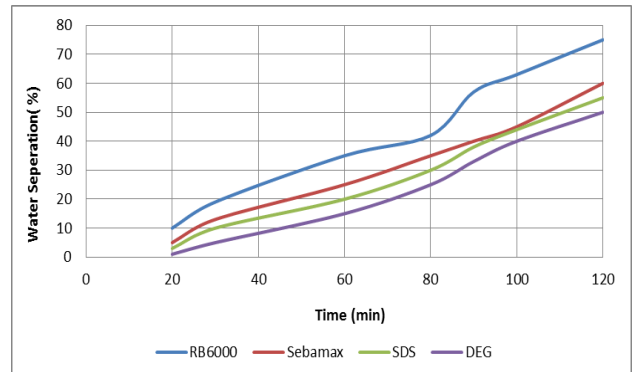

Fig. 8. Effect of demulsifies types with (SiO$_2$) at (2100 ppm) concentration of (SiO$_2$) with (2000ppm of demulsifiers) after (2hr),(7:3 water-oil ratio), (250 ppm NaCl) with mixing speed at (12000rpm) in (70°C).

5.5. Effect of Mixing Speed

Speed is an important factor in the wet oil treatment process. Increasing the mixing speed results in a more homogeneous mixture, thus increasing the collision of the mixture particles with the demulsifiers helps to separate faster.

Speed is also one of the factors that affect the temperature and increase the pressure on the membranes, as the high speed means the increase in the movement for emulsion droplets, that lead to a decrease in viscosity, so at the speed (12000 rpm) the separation process is faster and greater than the lowest speed (10,000 & 6000 rpm), but when the mixing is increased more than the required limit, we notice that the emulsified oil returns to a reverse emulsion at the speed (13000 rpm) as showing in Fig. **9**.
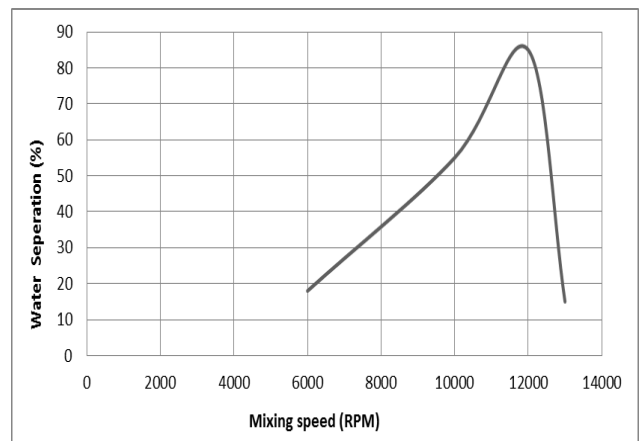

Fig. 9. Effect of mixing speed in wet oil separation

5.6. Nanomaterial Concentration Effect

Nanoparticles are the best suggestion when treating hydrocarbons (separating saltwater from oil), and studies have shown that nanoparticle such as (SiO_2) can remove oil drops from the emulsion faster compared to conventional separations this is due to the ability of the solid nanomaterial surfaces of a substance (SiO_2) to penetrate the water droplet and tear the interstitial membrane that prevents the drops from coalescing and separating them from the oil. Therefore, the solid nanomaterial possesses a high ability to reduce surface tension. It was observed that when using nanoparticles of (SiO_2) the separation process with the presence of demulsifies (RB6000, Seba max) is much larger in the test bottle after (40 min) and (120 min), which is the case when separating without nanomaterial, (as shown in Fig. **10**.

In the image in Fig. **10**, an emulsion (water/oil) before and after injection of the nanomaterial (SiO_2) where the nanomaterial contributed to tearing the membranes surrounding the water droplet, accumulating it and collecting it, thus depositing it on the bottom away from the oil drop, which made the emulsion less stable
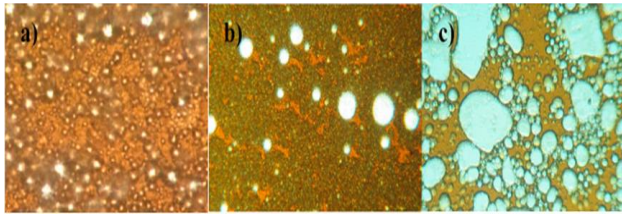

Fig. 10. Optical microscope photos of the w / o emulsion(A) 10 minutes, (b) after 40 minutes, (c) after injecting the nanomaterial, and collecting water droplets.

In Fig. **11**, we notice that the greater concentration of the nanomaterial added to the emulsion sample resulting greater the separation process over time, at the lowest concentration of nanomaterial which is (300 ppm) the separation ratio was lowest and equal to (20%), while the separation percentage reached the highest (88%) at the concentration (2700 ppm) after 120 minutes, while when the concentration increased above the permissible limit to (3000 ppm), the wet oil returns a reverse emulsifier.
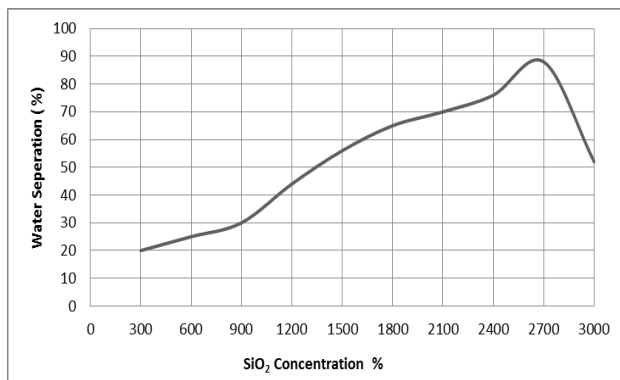

Fig. 11. Nanomaterial concentration effect

5.7. Salinity Effect

The salt concentration added to the emulsified oil has a major effect on the membrane droplet of saltwater in crude oil. The crude oil extracted from the reservoir is usually accompanied by water droplets in the form of a highly stable emulsion [20]. This salty water present in the oil contains asphalt, waxy materials, and other impurities, which are one of the factors that stabilize the emulsion. Asphalt plays a major role in forming the film or the interlayer that increases the repulsion forces between the water droplets [21], so comes the role of (NaCl) in tearing these membranes surrounded by water droplets and releasing them from repulsive forces to attract and integrate them and thus sediment them at the bottom of the test bottle and calculate the separation ratios, it has been observed that the higher TDS factor increases the separation.[22]

In other words, the results (bottle test) showed that the optimal concentration of the nano emulsification fraction increased its efficiency when increasing the concentration of salt (NaCl), as the (distribution of the size of the droplet DSD) increased as a result of adding salt and this increase is accompanied by a decrease in the emulsion viscosity, which leads to reduced emulsion stability [23].

Also, this increase is accompanied by an increase in the spread of small droplets and their precipitation over the larger droplets, thus increasing the drop's weight and fusion, which means its deposition at the bottom, which in turn increases the efficiency of the nanomaterials added to break the stable emulsion as in Fig. **12**.
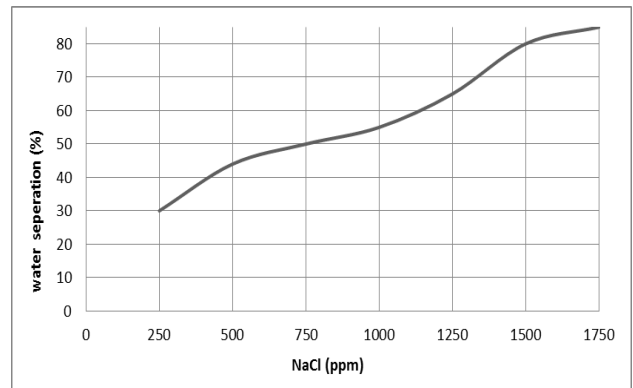

Fig. 12. The effect of salinity (from 250 to 1750 ppm) of NaCl) after 120 min at (2000 ppm concentration of Sebamax demulsifier) at 70 C° and (1000rpm) with (5:5 water-oil ratio), with a fixed concentration of nanomaterial (SiO_2) equal (1800ppm)

5.8. Effect of Surfactant

Here it must be noted that the treatment method in the Amara oil field is limited to the use of commercial demulsifiers (RB6000 & Sebamax) without any chemical additives that support the separation and treatment process.

In this paper, it had been focused on studying the effect of adding nanomaterial (SiO_2) and its support for demulsifiers in the wet oil treatment process, where it was observed that the relationship between surface stimuli (ionic –SiO_2) and demulsifiers is linear (23), which means that if we increase the surfactant twice, this corresponds to a doubling increase in the amount of demulsifiers needed to break down the emulsion, as shown in Fig. **13**
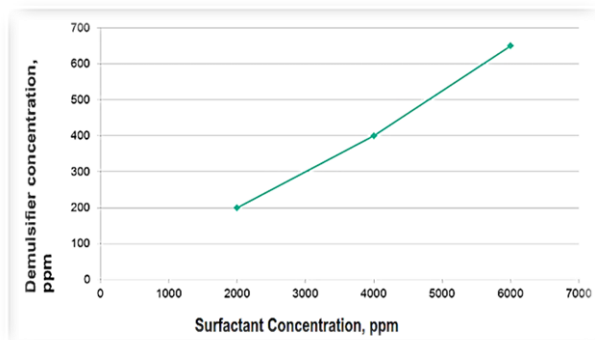

Fig. 13. Effect of surfactant (SiO_2) on demulsifier performance

6- Conclusions

The asphaltic functional groups become charged, which enhances the repulsion of the droplets and increases the elasticity of the interlayer, and the surface tension increases, and here comes the role of factors (pH and NaCl) in changing the charge of ions surrounding the water droplet membrane, so the electrostatic stability decreases, which helps the water droplets merge, which is a stage (Coalescence)

Heat and mixing speed have a major effect on reducing the viscosity of the oil and thus ease of processing and breaking emulsification, and the separation efficiency increases if the (SiO2) nanomaterial is added with the emulsification breaker (RB600 and SebaMax) and less than that with (SDS and DEG) as in Fig. **8**

The separation process is stabilized after two hours under precise laboratory conditions. All conditions and parameters, whether very few or very large, affect the wet oil treatment process (emulsion), as the emulsion is transformed into another type which is an emulsion (oil / in water).

Abbreviations

Acronym	Description
BS&W	Basic Sediment and Water
C°	Degree centigrade
DSD	Droplet size distribution
DEG	Diethylene glycol
Mwt	Molecular Weight
Ml	Milliliter
PPM	Parts per million
RPM	Rotation per minute
NaCl	Sodium chloride
SiO_2	Silicon Dioxide
v/v %	(Volume/Volume) Percentage
W/O	Water-in-oil emulsion
Wt. %	Weight Percentage

References

[1] A. Al-Alawy and M. Al-Ameri, "Treatment of Simulated Oily Wastewater by Ultrafiltration and Nanofiltration Processes", *ijcpe*, vol. 18, no. 1, pp. 71-85, Mar. 2017.

[2] Ajay Mandal, Achinta Bera, "Modeling of flow of oil-in-water emulsions through porous media", journal of petroleum science and technology,Vol.12No2(April 2015)

[3] Troner A.de Souzaa , Agnes de P.Scheera , MárciaCristina Khalilb, Carlos I. Yamamotoa, Luiz Fernando de L.LuzJr.a , "Emulsion inversion using solid particles" , Journal of Petroleum Science and Engineering ,V. 96–97, October 2012. Pages 49-57

[4] Kadhem Hammoud Manati ; (Report about Amara Gas Separation Plant), Maysan Oil Company (MOC), Operations Authority (Production and Discharge Authority), Petroleum Engineering Department (2018).

[5] Bhardwaj, A. and Hartland, S, "Studies on Build up of Interfacial Film at the Crude Oil/Water Interface", Journal of Dispersion Science and Technology, Vol 19. No.4,pages 465-473, (1998).

[6] Selvarajan Radhakrisnan, Anantha-subramaniam Sivakumar , Robert A. M, " Aqueous Dispersion of an oil Soluble demulsifier for breaking Crude Oil Emulsions", US Patent , No.6, pages 294,093,(2001).

[7] Swastic and das, S. ,"Effect of different acids on the scale in pipelines of Linz-Donawitz (LD) Plant (Steel Making Process)" ,. Advances in Chemical Engineering and Science,No5, pages 192-196, (2015).

[8] Siew fan wong,J.s.lim , Sharul sham dol," Crude oil emulsion: A review on formation, classification and stability of water-in-oil emulsions", journal of petroleum science and Engineering Vol.135,Nov.2015,pp 498-504.

[9] A. Saniere, I. Hénaut, J.F. Argillier," Pipeline Transportation of Heavy Oils a Strategic, Economic and Technological Challenge", Oil & Gas Science and Technology - Rev. IFP, Vol. 59No.5 (2004), pp. 455-466

[10] F. H. Wang, L. B. Shen, H. Zhu, K. F. Han, " The Preparation of a Polyether Demulsifier Modified by Nano-SiO2 and the Effect on Asphaltenes and Resins", Petroleum Science and Technology, Vol.29No24, (25-Oct,2011), pp2521-2529

[11] D. M. Pinchao, C. A. Cedeño, F. B. Cortés, C. A. Franco, "Water/oil emulsions separation using SiO_2 nanoparticles/surfactant-based nanofluids" , Universidad Nacional de Colombia , Acipet journal, 2015.

[12] Hemmingston, P.V., Silset, A., Hannisdal, A., Sjöblom, J; " Emulsions of heavy crude oils I: influence of viscosity, temperature and dilution"; . J. Disp. Sci. Technol. 2005. 26, 615–627.

[13] Jones, T.J., Neustadter, E.L., and Wittingham, K.P., "Water-in-Crude Oil Emulsion Stability and Emulsion Destabilization by Chemical Demulsifiers", J. Petrol .Can. Technol., pp 100-108, April-June (1978).

[14] Sunil Lalchand Kokal, 'Crude Oil Emulsions: A State-Of-The-Art Review' ; SPE journal, Vol.20, 2005.

[15] Kokal, S.L. and Sayegh, S.G., "Asphaltenes: The Cholesterol of Petroleum", SPE journal, March (1995).

[16] J.E. Strassner, "Effect of pH on Interfacial Films and Stability of Crude Oil-Water Emulsions ", Journal of Petroleum Technology, Society of Petroleum Engineer,V.20,pp 308-309, March 1968.

[17] Strassner, J.E., "Effect of pH on Interfacial Films and Stability of Crude Oil-Water Emulsions", J. Petrol. Technol, March (1968) , pp 303-312

[18] Salager, J.L., "The Fundamental Basis for the Action of a Chemical Dehydrant: Influence of Physical and Chemical Formulation on the Stability of an Emulsion" ,Int. Chem. Eng., Vol 30No1, pages 103-116 (1990).

[19] A.M.Alsabagha,M.E.Hassanb , S.E.M.Desoukya, N.M.Nassera , E.A.Elsharakya, M.M.Abdelhamid, " Demulsification of W/O emulsion at petroleum field and reservoir conditions using some demulsifiers based on polyethylene and propylene oxides" , Egyptian Journal of Petroleum, Volume 25,No.4, Pages 585-595, December 2016 .

[20] J.G. Delgado-Linares, J.C. Pereira , M.Rondón, J. Bullón, J.-L. Salager , " Breaking of water-in-crude oil emulsions. Estimating the demulsifier performance at optimum formulation from both the required dose and the attained instability"; Energy Fuels, Vol.30 No6 ,pages 5483-5491,(2016).

[21] J. Czarnecki, P. Tchoukov, T. Dabros ; "Possible role of asphaltenes in the stabilization of water-in-crude oil emulsions" ; Energy Fuels, Vol.26 (2012), pp. 5782-5786.

[22] Paul M. Mcelfresh , David Lee Holcomb , Daniel Ector , "Application of nanofluid technology to improve recovery in oil and gas", Society of Petroleum Engineers, (June 2012).

[23] M. Fortuny, C.B.Z. Oliveira, R.L.F.V. Melo, M. Nele, R.C.C. Coutinho, A.F. Santos, "Effect of salinity, temperature, water content, and pH on the microwave demulsification of crude oil emulsions" , Energy Fuels,Vol. 21 ,pages 1358-1364,(2007).

معالجة النفط الرطب في حقل العمارة النفطي باستخدام المادة النانوية(SiO₂) مع انواع من كواسر الاستحلاب

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الخلاصة

من أهم المشاكل في عملية إنتاج النفط وعند استمرار تدفقه هو النفط المستحلب (الماء في النفط) والذي بدوره يسبب العديد من المشاكل ، من خط الإنتاج إلى الأنابيب الممتدة التي يتم نقلها بعد ذلك إلى مصفى النفط للمعالجة. و لوحظ أن المادة النانوية (SiO₂) تدعم عملية الفصل بإضافتها إلى عينة المستحلب وأظهرت ارتفاعَ معدل الفصل مع كواسر الاستحلاب (RB6000) و (sebamax) حيث كانت نسبة الفصل أكبر من (90 و 80)٪ على التوالي ، وأقل من ذلك عند التعامل مع (Sodium Dodecyl Sulfate and Di Ethylene Glycol) ، كانت النسبة المئوية للفصل (60٪ و 50٪) على التوالي.   ترفع النسب العالية من (NaCl + الماء المقطر) من احتمال كفاءة الفصل حيث كان الفصل (79،88.5)٪ و (65.5، 55)٪ لـ (RB6000، SebaMax) على التوالي مع (SiO₂) عند 70درجة مئوية ، بينما كانت نتائج الفصل (85،77)٪ و (40،65) لـ (RB6000، Seba Max) على التوالي مع (SiO₂) عند 50 درجة مئوية بعد 120 دقيقة ، حيث كانت (نسبة الماء / الى النفط) (9: 1) لنتائج الفصل المرتفعة و (7: 3) لنتائج الفصل الأقل بسرعة (12000 دورة في الدقيقة) وبتركيز ملح (1500) جزء في المليون وأقل من هذه النتائج في الظروف الحجمية والزمنية المنخفضة. يتعامل ملح كلوريد الصوديوم مع أغشية الجدار الذي يفصل القطرات ويقلل من لزوجتها. أما بالنسبة لعامل الأس الهيدروجيني ، فهو عند القيمة (2 و 3) يمثل مستحلبًا ثابتًا يصعب فصله بسهولة ، ولكن مع مرور ارتفاع الرقم الهيدروجيني بعيدًا عن الوسط الحمضي وقريبًا من الاتجاه القاعدي ، فإن زيادة واضحة في عملية الفصل لوحظت مقارنة مع الوسط الحمضي بقيم أقل ، بعد 120 دقيقة بدا الفصل جيد الكفاءة ، حيث وصل إلى (60 و 70) ٪ على التوالي ، بينما وصل المستحلب في نفس الوقت إلى مستوى أكثر كفاءة فصل مع الرقم الهيدروجيني (8 و 7) يساوي (80 و 87.3) ٪، عند 50 درجة مئوية مع كاسر استحلاب SebaMax بوجود (SiO₂)، وبنفس قيم الأس الهيدروجيني ، لوحظ زيادة في الفصل مع زيادة درجة الحرارة إلى (70 درجة مئوية).

الكلمات الدالة: مستحلب, كاسر استحلاب, نفط خام , مستحلب (الماء/في النفط), مادة نانوية, ماء مالح