Laboratory Studies of the Phase Microemulsions between Oil, Gaberoun Lake Water, and Surfactant Systems by using Phase Behavior Test

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Abstract— **Microemulsion phase behavior is the most important phenomenon related to any type of chemical enhanced oil recovery (EOR) using surfactant. An EOR process in which a small amount of surfactant is added to an aqueous fluid injected to sweep the reservoir. The presence of surfactant reduces the interfacial tension between the oil and water phases to improve oil recovery. This research was conducted through interaction with the micelles of a surfactant in a Gaberoun Lake Water (GLW), a substance spontaneously dissolves to form a stable and clear solution. The laboratory experiment was designed to solubilize the oil by GLW with oil and surfactant to form an emulsion (ME) consisting of oil and water. The GLW and surfactant water were prepared by different concentrations and salinity as aqueous. The aqueous was injected into special glass tubes and placed inside the oven at different temperatures from 30 ^oC to 70 ^oC at ambient pressure. The glass tubes were left until equilibrium condition for 72 hours. In this study, ~~new~~ results using dead oil and surfactant with Libyan leak water were presented. The range of the thickness of the ME from 0.1ml to 1.4 ml. The result showed that the ME was decreased with a decrease in surfactant concentration values and increased with a decrease salinity. The findings in this research that GLW can be used for oil recovery processes.**

Index Terms: **Microemulsions, Gaberoun Lake Water, Surfactants, Salinity, Temperature, Oil.**

I. INTRODUCTION

A microemulsion is a system of water, oil and an amphiphile which is a single optically isotropic and thermodynamically stable liquid solution [1] and [2]. Microemulsion found their application in chemical enhanced oil recovery due to their ability to eliminate the capillary forces by generating ultra-low interracial tension between the aqueous phase and the oil in place [3].

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In some respects, microemulsions can be considered as small-scale versions of emulsions, i.e., droplet type dispersions either of oil-in-water (o/w) or of water-in-oil (w/o), with a size range in the order of 5−50 nm in drop radius. A well-known classification of microemulsions is identified four general types of phase equilibrium [4]: Type I: the surfactant is preferentially soluble in water and oil-in-water (o/w) microemulsions form (Winsor I). Type II: the surfactant is mainly in the oil phase and water-in-oil (w/o) microemulsions form. Type III: a three-phase system where a surfactant-rich middle-phase coexists with both excess water and oil surfactant-poor phases (Winsor III or middle-phase microemulsion). Type IV: a single-phase (isotropic) micellar solution, that forms upon addition of a sufficient quantity of amphiphile (surfactant plus alcohol) [5].

Surfactants are surface-active agents and it consist of lipophilic moiety and hydrophilic moiety in a molecule. They significantly alter the interfacial properties between two kinds of fluids like the interfacial tension between water and oil [6]. Typically, surfactants can be categorized in Anionic surfactants, Cationic Surfactants, Zwitterionic Surfactants, and Nonionic surfactant. They can work in three different ways:

1. Roll-up: The surfactant lowers the oil/solution and fabric/solution interfacial tensions and in this way lifts the stain of the fabric.
2. Emulsification: The surfactant lowers the oil-solution interfacial tension and makes easy emulsification of the oily soils possible.
3. Solubilization: Through interaction with the micelles of a surfactant in a solvent (water), a substance spontaneously dissolves to form a stable and clear solution.

Phase behavior test studies of brine surfactant oil system evaluated in the microemulasion formulation for production enhancement are very time consuming; however, this is the best way to select a system that meets the requirements for the application for a range of salinity or brine density and temperature. System formulated with anionic surfactants exhibit a more significant effect of salinity than system for mutated with nonionic surfactant. However, salinity also has an effect on nonionic surfactants, such as the ethoxylates [7]. Temperature is another important variable that affects the performance of system containing surfactant. Anionic surfactant typically become more hydrophilic as temperature increases, whereas nonionic surfactant presents the opposite trend [8]. The main objective of phase behavior test is to find the chemical formula for a specific application. Next equations and figure 1 help facilitate understanding of how the data in the different columns of Table 1A, 2A, and 3A are calculated [5].

$$\text{Solubilization oil} = \text{Top of ME} - \text{Aqueous Level} \quad (1)$$

$$\text{Solubilization water} = \text{Aqueous Level} - \text{Bottom of ME} \quad (2)$$

$$\text{Oil solubilization ratio} = \frac{Sol.oil}{Total\ Vol.-Aquesous\ Level} * 100 \quad (3)$$

$$\text{Water solubilization ratio} = \frac{Sol.water}{Total\ Vol.-Aquesous\ Level} * 100 \quad (4)$$

$$\text{Concentration solute (w/v \%)} = \frac{mass\ of\ solute\ (g)}{volume\ of\ solution\ (ml)} * 100 \quad (5)$$

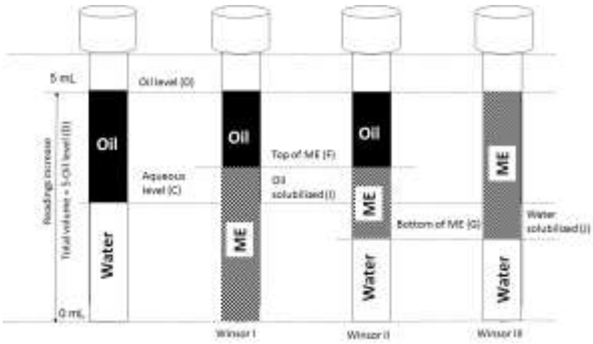

Figure 1 .Schematic to Show How Salinity Scan Test Data are Measured and Calculated.

II. EXPERIMENTAL MATERIALS

There are two types of surfactant were used in this study which are; Sodium Dodecyl Sulfate (SDS) and Cetyltrimethylammonium Bromide (CTAB). Thermal Silicon, Oven, Scale for sampling, Water Hyperventilation, Heater, and Mixer. Burette, Sticker, and Magne were used. Light crude oil that has a low density and low viscosity, low specific gravity was used in this study. Gaberoun Lake Water was used in this study.

III. EXPERIMENT PREPARATION AND PROCEDURES

Preparation of Acidity (Ph): The original acidity of GLW is approximately equal to 10.

Preparation of Salinity (ppt): The GLW was dilute by adding distilled water to get different salinity (35, 25, 15, 5, 0.5 and 0.1 ppt), as shown in the figure 2.

Figure 2.GLW with Different Salinity.

Preparation GLW with Different Salinity and concentration surfactants.

Next table 1 shows the experimental preparation results of the current research with surfactant (SDS Surf. and CTAB Surf.).

Table 1. Cases With Different Concentration Of Surfactant And Salinity.

Cases	Salinity	Surf. Conc. (w/v%)	
	Ppt	SDS Surf.	CTAB Surf.
Case#1	35	0.05	0.5
	25		
	15		
	5		
	0.5		
	0.1		
Case#2	35	0.1	1.0
	25		
	15		
	5		
	0.5		
	0.1		
Case#3	35	0.15	1.5
	25		
	15		
	5		
	0.5		
	0.1		
Case#4	35	0.2	2
	25		
	15		
	5		
	0.5		
	0.1		

IV. RESULTS AND DISCUSSIONS

1. *Case#1: Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5.*

Table The results of the different salinity with SDS Surf. 0.05 and CTAB Surf 0.5 at room temperature is 12^{o}C. It can be seen that, the aqueous level was stable at 2.5 ml and the oil level was stable at 5 ml as shown in Figure 3.

Figure 3: Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at 12°C.

Figures 4, 5, and 5, and Table A show the results of the different salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at oven temperature is 30°C. From this table, it can be seen that, the aqueous level which stable at 2.5 ml and the oil level was stable 5 ml. After 72 hr, the amount of aqueous (0.5ml) was dissolved in oil at salinity 35ppt and 25ppt, and at salinity was dissolved in salinity 15ppt, 5ppt and 0.5ppt with 0.2 ml. The amount of aqueous (0.1ml) was dissolved in oil at salinity 0.1ppt. From this result, it can see that, ME were in the type III. Also as shown in the figure 4, it can be assumed that ME in the third phase and that depending on the color. It can be noted that, the oil with black and brine with an aqueous color and ME with a golden color. Figure 5 shows an example of zoom ME results with salinity is 25ppt at oven temperature is 30 °C. Figure 6 shows the solubilization ratio plot. It conducted that, the optimum salinity of this case is range between 18 and 22ppt.

Figure 4: Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at 30°C.

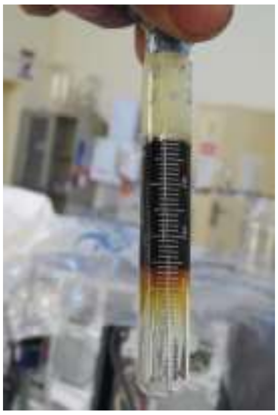

Figure 5: Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at 30°C.

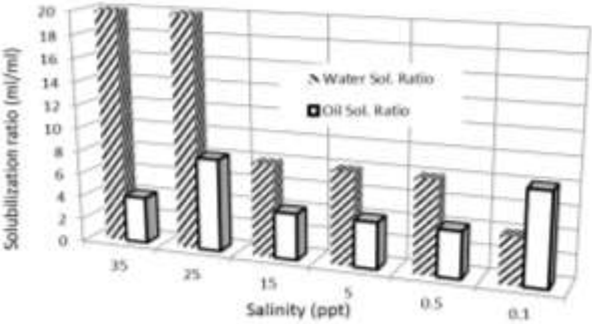

Figure 6: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at 30°C.

Figures 7 and 8, and Table A show the results of the different salinity with SDS Surf. 0.05 and CTAB Surf 0.5 at oven temperature is 50°C. It can be seen that, the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt and 25ppt with 0.7 ml, and at salinity 15ppt, 5ppt, 0.5ppt, 0.1ppt with 0.1 ml. from this results, we assumed that, the ME in the type III. Figure 7 shows that, the ME is higher than at 30°C in Figure 4. Figure 8 shows the solubilization ratio plot results of the different salinity with SDS Surf. 0.05 and CTAB Surf 0.5 at oven temperature is 50°C.

Figure 7: Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf .0.5 at 50°C.

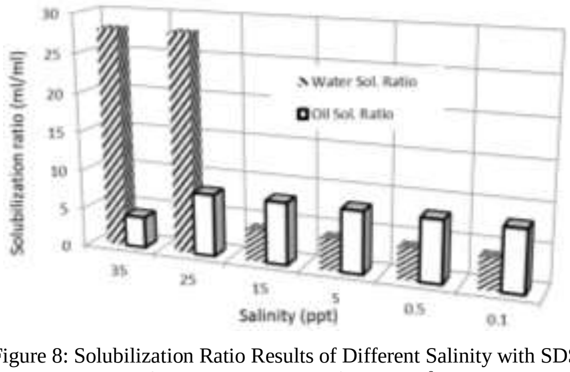

Figure 8: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf .0.5 at 50°C.

Figures 9 and 10, and Table A show the results of the different salinity with SDS Surf. 0.05 and CTAB Surf 0.5 at oven temperature is 70°C. It can be seen, that the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt with 0.3 ml, and at salinity 25ppt, 15ppt, 5ppt, 0.5ppt and 0.1ppt with0.1 ml. From the results above, it can be assumed that, the ME in the type III. Figure 8 shows that the color of the aqueous is golden color while the ME layer was dark gold. Figure 10 shows the solubilization ratio results of different salinity with SDS Surf. 0.05 and CTAB Surf 0.5 at 70°C.

Figure 9: Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf .0.5 at 70°C.

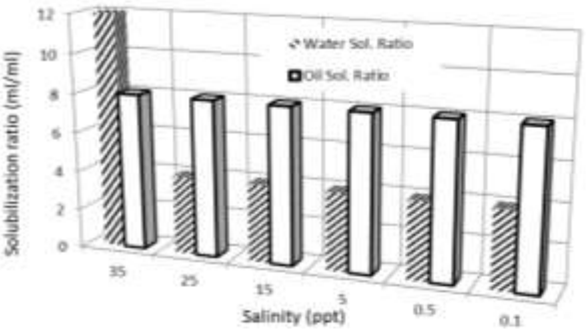

Figure 10: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at 70°C.

2. *Case#2: Different Salinity with SDS Surf. 0.1 and CTAB Surf 1.*

Figures 11 and 12, and Table B show the results of the different salinity with SDS Surf. 0.1 and CTAB Surf. 1 at oven temperature is 30°C. It can be seen, the aqueous level is stable at 2.5ml and the oil level is stable at 5ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt, 15ppt, 5ppt and 0.5ppt with 0.4 ml, at salinity 25ppt with 0.5 ml, and at 0.1ppt with 0.3 ml. From the above results, it can be assumed that, the ME in the type III.

Figure 11: Results of Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 30°C.

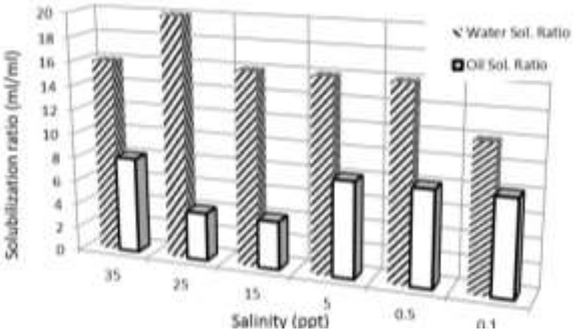

Figure 12: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 30°C.

Figures 13 and 14, and Table B show the results of the different salinity with SDS Surf. 0.1 and CTAB Surf. 1 at oven temperature is 50°C. It can be seen, that the aqueous level is stable at 2.5 ml and the oil level is stable 5 ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt with 0.9 ml, and at salinity 25ppt with 1.1 ml, and at salinity 15ppt with 0.7 ml, and at salinity 5ppt, 0.5ppt and 0.1ppt with 0.1 ml. From the results above, it can be assumed that the ME in the type III. Figure 13 shows that, the ME is higher than at 30°C. Figure 14 shows the solubilization ratio results of different salinity with SDS Surf. 0.1 and CTAB Surf 1 at 50°C.

Figure 13: Results of Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 50°C

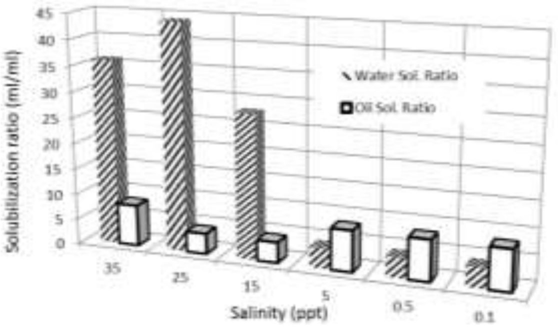

Figure 14: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 50°C.

Figures 15 and 16, and Table B show the results of the different salinity with SDS Surf. 0.1 and CTAB Surf. 1 at oven temperature is 70°C. It can be seen, the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt with 0.6 ml, and at salinity 25ppt with 0.9 ml, and at salinity 15ppt, 5ppt, 0.5ppt and 0.1ppt with 0.1 ml. Based on above results, indicated that, the ME in the type III. Figure 15 shows that, the ME is higher and darker than at 50°C. Figure 16 shows the solubilization ratio results of different salinity with SDS Surf. 0.1 and CTAB Surf 1 at 70^{o}C.

Figure 15: Results of Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 70^{o}C.

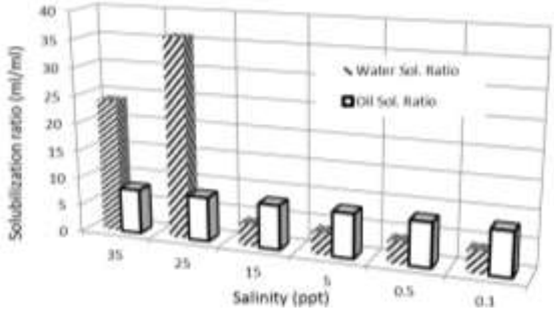

Figure 16: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 70^{o}C.

3. *Case#3: Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5.*

Figures 17 and 18, and Table C show the results of the different salinity with SDS Surf. 0.15 and CTAB Surf. 1.5 at oven temperature is 30^{o}C. It can be seen, the aqueous is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt, 15ppt and 0.1ppt with 0.3 ml, and at salinity 25ppt, 5ppt, and 0.5ppt with 0.4ml. From the above results, it can be assumed that the ME in the type III. Figure 17 shows that, the ME is has a clear golden color. Figure 18 shows the solubilization ratio results of different salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 30 ^{o}C.

Figure 17: Results of Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 30 ^{o}C.

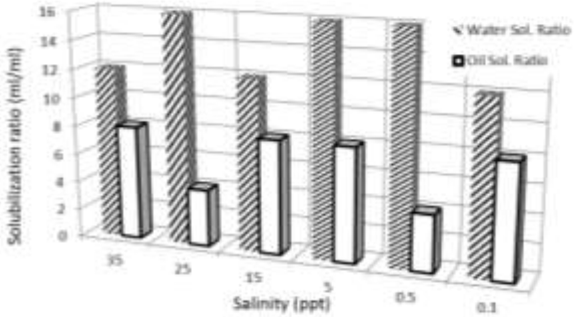

Figure 18: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 30 ^{o}C.

Figures 19 and 20, and Table C show the results of the different salinity with SDS Surf. 0.15 and CTAB Surf. 1.5 at oven temperature is 50^{o}C. It can be seen, the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, it can be amount of aqueous is dissolved at salinity 35ppt with 1 ml, and at salinity 25ppt with 1.2 ml, and at salinity 15ppt with 0.5 ml, and at salinity 5ppt with 0.3 ml, and at salinity 0.5ppt with 0.2ml, and at salinity 0.1 with 0.1 ml. Figure 18 shows that, the thickness of the ME in 35ppt, 25ppt, and 15ppt is thick than in 5ppt, 0.5ppt, and 0.1ppt. Figure 20 shows the solubilization ratio results of different salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 50 ^{o}C.

Figure 19: Results of Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 50 ^{o}C.

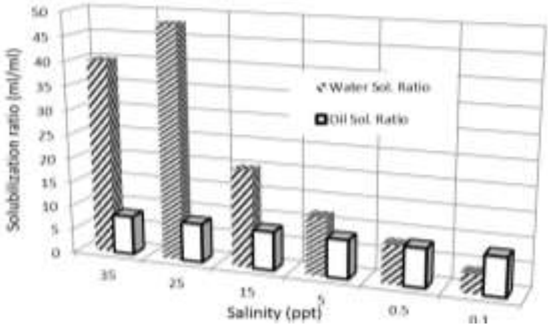

Figure 20: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 50 ^{o}C.

Figures 21 and 22, and Table C show the results of the different salinity with SDS Surf. 0.15 and CTAB Surf. 1.5 at oven temperature is 70^{o}C. It can be seen, that the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, in the table, the amount of aqueous is dissolved at salinity 35ppt with 0.8 ml, and at salinity 25ppt with 1.1 ml, and at salinity 15ppt, 5ppt, 0.5ppt and

0.1ppt with 0.1 ml. Figure 21 shows that, the brine has a golden color. Figure 22 shows the solubilization ratio results of different salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 70 °C.

Figure 17: Results of Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 70 °C.

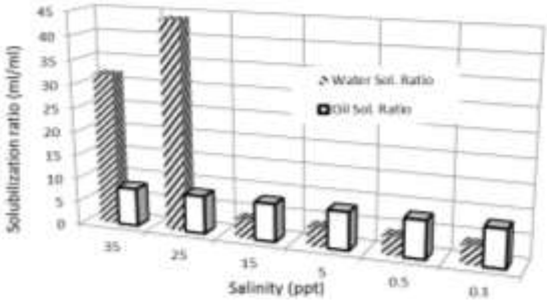

Figure 22: Solubilization Ratio Results of Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 70 °C.

4. *Case#4: Different Salinity with SDS Surf. 0.2 and CTAB Surf 2.*

Figures 23 and 24, and Table D show the results of the different salinity with SDS Surf. 0.2 and CTAB Surf. 2 at oven temperature is 30°C. It can be seen, the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt and 25ppt with 0.5 ml , and at salinity 15ppt, 5ppt, and 0.5ppt with 0.4 ml, and at salinity 0.1ppt with 0.3 ml. From the above results, the ME is the type III. Figure 23 shows the results of the different salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 30 °C**.** Figure 24 shows Solubilization Ratio Plot Results of Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 30 °C.

Figure 23: Results of the Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 30 °C

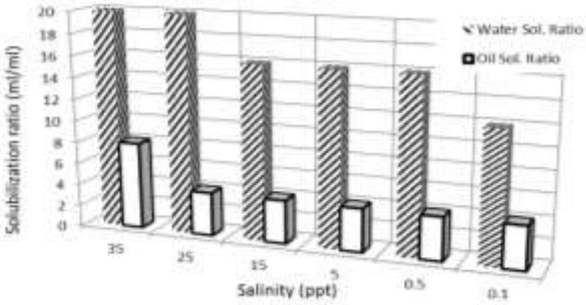

Figure 24: Solubilization Ratio Plot Results of Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 30 °C.

Figures 25, and 26, and Table D show the results of the different salinity with SDS Surf. 0.2 and CTAB Surf. 2 at oven temperature is 50°C. It can be seen, the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, the amount of aqueous is dissolved at salinity 35ppt with 0.9 ml, and at salinity 25ppt with 1 ml, and at salinity 15ppt with 0.7 ml, and at salinity 5ppt with 0.3ml, and at salinity 0.5ppt with 0.4ml, and at salinity 0.1ppt with 0.2 ml. Figure 25 shows that, the ME is higher than at 30°C. Figure 26 shows Solubilization Ratio Plot Results of Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 50 °C.

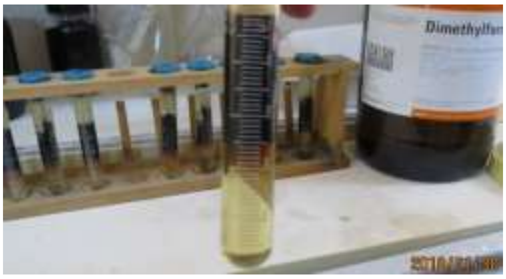

Figure 25: Results of the Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 50 °C

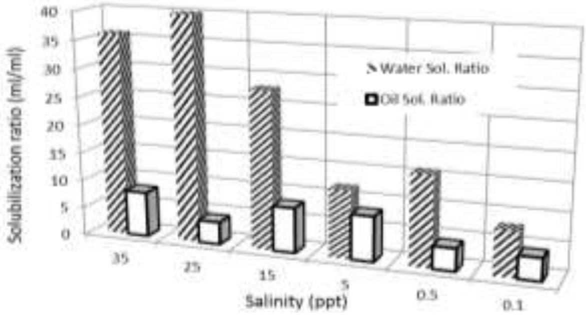

Figure 26: Solubilization Ratio Plot Results of Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 50 °C.

Figures 27, and 28, and Table D show the results of the different salinity with SDS Surf. 0.2 and CTAB Surf. 2 at oven temperature is 70°C. It can be seen, the aqueous level is stable at 2.5 ml and the oil level is stable at 5 ml. After 72 hr, the amount of aqueous dissolved at salinity 35ppt with 0.9 ml, and at salinity 25ppt with 1.1 ml, at salinity 15ppt with 0.8 ml, and at salinity 5ppt, 0.5ppt and 0.1ppt with 0.1 ml. Figure 27 shows the results of the different salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 70 °C**.** Figure 28 shows solubilization ratio plot results of different salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 70 ^oC. After 72 hours, the samples in the oven at 70 °C that have low salinity, they did not have a ME. The brine has a golden color for all concentrations and samples with high salinity and the ME was higher than in previous temperatures.

Figure 27. Results of the Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 70 ^oC

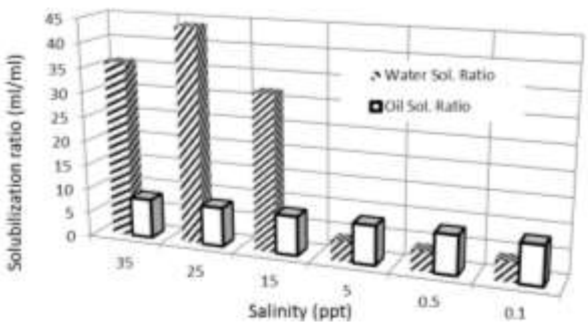

Figure 28: Solubilization Ratio Plot Results of Different Salinity with SDS Surf. 0.2 and CTAB Surf. 2 at 70 ^oC.

V. CONCLUSION

The phase behavior tests has been successfully applied to determine microemulsions between oil, Gaberoun Lake Water Injection, and surfactant systems with different temperature. The effect of temperature on microemulaion phase behavior is very important to develop a successful surfactant formulation for enhanced oil recovery. F-Glass Tubes with a Wider Diameter have been used to measure the micromulaion phase behavior of dead oil a wide range of temperature to enable the same critical observation of IFT as experimental done glass pipettes at ambient pressure. In this study, new results using dead oil add surfactant with Libyan leak water were presented. The range of the thickness of the ME from 0.1ml to 1.4 ml. The result showed that the ME was decreased with a decrease in surfactant concentration values and increased with a decrease salinity. When the surfactant concentration and the salinity was high, the ME was higher than when the surfactant concentration and the salinity is low. It was noticed that, the best ME when the oven temperature was 50 ^oC for all cases. From these results and calculation, it was assumed that, the ME took the third phase (the type III (middle-phase microemulsion)). After 72 hours, the samples in the oven at 70 °C that have low salinity, they did not have a ME. The brine has a golden color for all concentrations and samples with high salinity and the ME was higher than in previous temperatures. The findings in this research that GLW can be used for oil recovery processes.

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APPENDIX

Table A. Case#1: Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5.

	A	B	C	D	E	F	G	H	I	J	K	L	M
	Surf#A. Con	**Surf#B. Con**	**Salinity**	**At Start of Test**		**Total Vol.**	**In Equilibrium**		**Type**	**Sol. Oil**	**Sol. Water**	**Oil Sol. Ratio**	**Water Sol. Ratio**
				Aqueous Level	**Oil Level**		**Top of ME**	**Bottom of ME**					
	wt%		**ppt**			**ml**	**ml**	**ml**		**ml**	**Ml**	**ml/ml**	**ml/ml**
Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 At 12 °C	0.05	0.5	35	2.5	5	5	0	0	-	0	0	0	0
			25	2.5	5	5	0	0	-	0	0	0	0
			15	2.5	5	5	0	0	-	0	0	0	0
			5	2.5	5	5	0	0	-	0	0	0	0
			0.5	2.5	5	5	0	0	-	0	0	0	0
			0.1	2.5	5	5	0	0	-	0	0	0	0
Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at 30 °C	0.05	0.5	35	2.5	5	5	2.6	2	III	0.1	0.5	4	20
			25	2.5	5	5	2.7	2	III	0.2	0.5	8	20
			15	2.5	5	5	2.6	2.3	III	0.1	0.2	4	8
			5	2.5	5	5	2.6	2.3	III	0.1	0.2	4	8
			0.5	2.5	5	5	2.6	2.3	III	0.1	0.2	4	8
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5 at50 °C	0.05	0.5	35	2.5	5	5	2.6	1.8	III	0.1	0.7	4	28
			25	2.5	5	5	2.7	1.8	III	0.2	0.7	8	28
			15	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
Different Salinity with SDS Surf. 0.05 and CTAB Surf. 0.5At 70 °C	0.05	0.5	35	2.5	5	5	2.7	2.2	III	0.2	0.3	8	12
			25	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			15	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4

Table B. Case#2: Different Salinity with SDS Surf. 0.1 and CTAB Surf 1.

	A	B	C	D	E	F	G	H	I	J	K	L	M
				At Start of Test			In Equilibrium						
	Surf#A. Con	Surf#B. Con	Salinity	Aqueous Level	Oil Level	Total Vol.	Top of ME	Bottom of ME	Type	Sol. Oil	Sol. Water	Oil Sol. Ratio	Water Sol. Ratio
	wt%		ppt			ml	ml	ml		ml	Ml	ml/ml	ml/ml
Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 30 ºC.	0.1	1	35	2.5	5	5	2.7	2.1	III	0.2	0.4	8	16
			25	2.5	5	5	2.6	2	III	0.1	0.5	4	20
			15	2.5	5	5	2.6	2.1	III	0.1	0.4	4	16
			5	2.5	5	5	2.7	2.1	III	0.2	0.4	8	16
			0.5	2.5	5	5	2.7	2.1	III	0.2	0.4	8	16
			0.1	2.5	5	5	2.7	2.2	III	0.2	0.3	8	12
Different Salinity with SDS Surf. 0.1 and CTAB Surf 1 at 50ºC	0.1	1	35	2.5	5	5	2.7	1.6	III	0.2	0.9	8	36
			25	2.5	5	5	2.6	1.4	III	0.1	1.1	4	44
			15	2.5	5	5	2.6	1.8	III	0.1	0.7	4	28
			5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
Different Salinity with SDS Surf. 0.1 and CTAB Surf 1at 70ºC.	0.1	1	35	2.5	5	5	2.7	1.9	III	0.2	0.6	8	24
			25	2.5	5	5	2.7	1.6	III	0.2	0.9	8	36
			15	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4

	Table C. Case#3: Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5.												
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
				At Start of Test			**In Equilibrium**						
	Surf#A. Con	**Surf#B. Con**	**Salinity**	**Aqueous Level**	**Oil Level**	**Total Vol.**	**Top of ME**	**Bottom of ME**	**Type**	**Sol. Oil**	**Sol. Water**	**Oil Sol. Ratio**	**Water Sol. Ratio**
	wt%		**ppt**			**ml**	**ml**	**ml**		**ml**	**Ml**	**ml/ml**	**ml/ml**
Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 30ºC.	0.15	1.5	35	2.5	5	5	2.7	2.2	III	0.2	0.3	8	12
			25	2.5	5	5	2.6	2.1	III	0.1	0.4	4	16
			15	2.5	5	5	2.7	2.2	III	0.2	0.3	8	12
			5	2.5	5	5	2.7	2.1	III	0.2	0.4	8	16
			0.5	2.5	5	5	2.6	2.1	III	0.1	0.4	4	16
			0.1	2.5	5	5	2.7	2.2	III	0.2	0.3	8	12
Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5 at 50ºC.	0.15	1.5	35	2.5	5	5	2.7	1.5	III	0.2	1	8	40
			25	2.5	5	5	2.7	1.3	III	0.2	1.2	8	48
			15	2.5	5	5	2.7	2	III	0.2	0.5	8	20
			5	2.5	5	5	2.7	2.2	III	0.2	0.3	8	12
			0.5	2.5	5	5	2.7	2.3	III	0.2	0.2	8	8
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
Different Salinity with SDS Surf. 0.15 and CTAB Surf 1.5at 70oC.	0.15	1.5	35	2.5	5	5	2.7	1.7	III	0.2	0.8	8	32
			25	2.5	5	5	2.7	1.4	III	0.2	1.1	8	44
			15	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4

	Table D. Case#4: Different Salinity with SDS Surf. 0.2 and CTAB Surf 2.												
	A	B	C	D	E	F	G	H	I	J	K	L	M
				At Start of Test			In Equilibrium						
	Surf#A. Con	Surf#B. Con	Salinity	Aqueous Level	Oil Level	Total Vol.	Top of ME	Bottom of ME	Type	Sol. Oil	Sol. Water	Oil Sol. Ratio	Water Sol. Ratio
	wt%		ppt			ml	ml	ml		ml	Ml	ml/ml	ml/ml
Different Salinity with SDS Surf. 0.2 and CTAB Surf 2 at 30 °C.	0.2	2	35	2.5	5	5	2.7	2	III	0.2	0.5	8	20
			25	2.5	5	5	2.6	2	III	0.1	0.5	4	20
			15	2.5	5	5	2.6	2.1	III	0.1	0.4	4	16
			5	2.5	5	5	2.6	2.1	III	0.1	0.4	4	16
			0.5	2.5	5	5	2.6	2.1	III	0.1	0.4	4	16
			0.1	2.5	5	5	2.6	2.2	III	0.1	0.3	4	12
Different Salinity with SDS Surf. 0.2 and CTAB Surf 2 at 50 °C.	0.2	2	35	2.5	5	5	2.7	1.6	III	0.2	0.9	8	36
			25	2.5	5	5	2.6	1.5	III	0.1	1	4	40
			15	2.5	5	5	2.7	1.8	III	0.2	0.7	8	28
			5	2.5	5	5	2.7	2.2	III	0.2	0.3	8	12
			0.5	2.5	5	5	2.6	2.1	III	0.1	0.4	4	16
			0.1	2.5	5	5	2.6	2.3	III	0.1	0.2	4	8
Different Salinity with SDS Surf. 0.2 and CTAB Surf 2 at 70 oC.	0.2	2	35	2.5	5	5	2.7	1.6	III	0.2	0.9	8	36
			25	2.5	5	5	2.7	1.4	III	0.2	1.1	8	44
			15	2.5	5	5	2.7	1.7	III	0.2	0.8	8	32
			5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.5	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4
			0.1	2.5	5	5	2.7	2.4	III	0.2	0.1	8	4