



Sebha University
Faculty of Engineering
Department of Petroleum Engineering

**Thesis Submitted in Fulfillment of the Requirements for Degree of
Bachelor's:**

**Phase behaviours study using different types of
surfactant**

Students Achievement

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الآية القرآنية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿ وَقُلْ رَبِّ زِدْنِي عِلْمًا ﴾

سورة طه (114)

شكر وتقدير

بسم الله الرحمن الرحيم

الحمد لله الذي أتم علينا نعمه وعلمنا مالم نكن نعلم من العلم، نود أن نشكر عائلاتنا الذين كانوا الداعمين الأساسيين في الوصول إلى هذه المرحلة من المستوى التعليمي وكذلك نشكر كل معلم علمنا وساهم في وصولنا إلى هذه المرحلة.

الشكر والتقدير إلى المشرفين على هذا البحث الأستاذ/ حمد ابوعزوم شلش، الأستاذة/ مسعودة فرحات على المعلومات القيمة التي قدموها لنا طوال فترة البحث.

وكذلك نشكر مركز أبحاث النفط طرابلس وعلى رأسهم الأستاذ/ علي الجحاوي على حسن استقبالهم.

Abstract:

In this research, three types of surfactants were used: the first type is Sodium Dodecyl Sulfate SDS, the second type is commercial soap, and the third type is laboratory-prepared soap.

Three soaps with different proportions were placed in a test tube containing an equal proportion of oil and water

The samples were divided into two phases, one containing the original water salinity and the other containing the water salinity diluted to half.

By exposing the samples to a different temperature, a layer of microemulsion was formed in both the soap that was prepared in the laboratory and the commercial soap. It was found that the first type of Sodium Dodecyl Sulfate SDS surfactant mixed oil with water, and the microemulsion layer did not form.

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Chapter1

Introduction

1: Introduction:

The oil is a naturally occurring hydrocarbon material that is believed to have formed from animal and vegetable debris in deep sedimentary beds. The petroleum, being less dense than the surrounding water, was expelled from the source beds and migrated upward through porous rock such as sandstone and some limestone until it was finally blocked by nonporous rock such as shale or dense limestone. In this way, petroleum deposits came to be trapped by geologic features caused by the folding, faulting, and erosion of Earth's crust. This system (trap, hydrocarbons and porous media) calls the reservoir, where the production of petroleum comes from the reservoir to the surface. The production process pass through three main periods; primary, secondary and tertiary enhance oil recovery EOR.

1.1 Definition of Enhanced Oil Recovery:

Enhanced oil recovery (EOR) aims to increase the oil recovery factor. Oil recovery can be divided into three types/stages: primary oil recovery, secondary oil recovery and tertiary oil recovery. Primary oil recovery refers to the oil recovery utilizing the initial formation energy of the oil layer without additional fluid injection. Specifically, primary oil recovery makes use of the elastic energy of oil layer, potential energy of water, and volumetric energy of gas expansion to drive oil. Secondary oil recovery refers to the oil recovery after primary oil recovery, with general fluid (such as water and gas) injected. Tertiary oil recovery refers to the oil recovery after secondary oil recovery, with special fluid (such as polymer solution, alkali solution, surfactant solution or their mixture, CO₂ and steam) injected. Generally speaking, 10–25% of underground crude oil can be recovered during primary oil recovery, and an additional 10–25% during secondary oil recovery. That is to say, only 25–50% of underground crude oil can be recovered after these two stages of oil recovery [1].

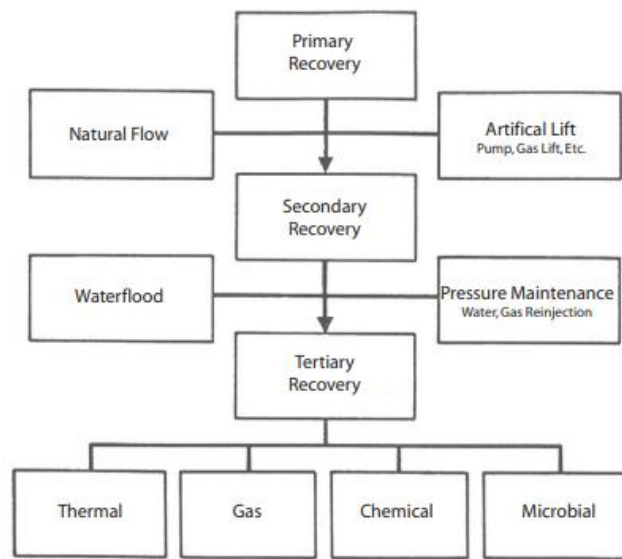


Figure 1.1 Methods for oil recovery [2]

1.2 Chemical Flooding:

Oil recovery by the application of chemical EOR methods is accomplished by the injection of chemicals such as polymers, surfactants, and alkalis into the reservoir. These chemicals are mixed with water and injected through the injection well, which displaces the reservoir fluids toward the production well. The displacement efficiency of the injected slug depends on the chemicals used in the injected slug. The chemicals injected into the reservoir lead to changes in the properties of the aqueous phase of the reservoir, causing the displacement of the trapped crude oil[3].

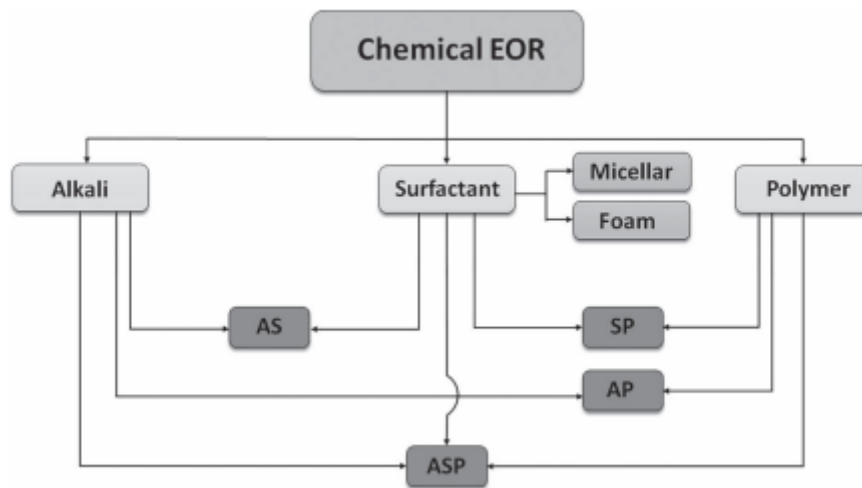


Figure 1.2 Classification of chemical EOR technologies[3].

1.3 Surfactants:

Surfactants are organic compounds, also termed as ‘surface active agents’. Surfactants contain at least one lyophilic (solvent-loving) and at least one lyophobic (solvent-fearing) group in the molecule. In usual circumstances, the solvent is water and the terms hydrophobic and hydrophilic are used for solvent-fearing and solvent-loving groups, respectively. Traditionally, the polar group is termed as ‘head,’ and the long non-polar chain is known as ‘tail’

The hydrophilic group is usually polar and is soluble in water while the hydrophobic group is non-polar and is water-insoluble, soluble in non-polar phases. Due to this unique ability to have two different groups available in the same molecule, surfactants act on the interface of two immiscible phases (e.g., water and oil) and lower the interfacial tension (IFT) between these two phases. During this IFT lowering process, the hydrophilic part of the surfactants remains in the water, while the hydrophobic part tries to remain in the oil, making more contact between the two phases and causes the IFT to reduce. The interfacial tension is called surface tension when air is in the non-polar phase[4].

1.4 Research Objectives:

This experimental study is directed towards the study of phase behavior test , the main purpose of thesis are:

1. To make it easy to understood the microemolsion.
2. As comprehensive literature study for microemolsion and surfactant.
3. To understand the factors effect during the experimental such as PH, salinity and temperature.
4. To understand the basic concept of phase behavior test, the way to design.
5. Estimate the best oil recovery for the different cases

Chapter2

Literature Review

2.Literature Review:

2.1 Introduction:

This chapter provides a literature review of previous work and relevant theory and concepts pertaining to the subject of this research. It includes phase behavior and, followed by description of chemicals used in this research. The following chapter will discuss the procedures and methods used in this research.

2.2 Phase Behaviour, Interfacial Tension and Microstructure of Microemulsions

Microemulsions are macroscopically isotropic mixtures of at least a hydrophilic, a hydrophobic and an amphiphilic component. Their thermodynamic stability and their nano-structure are two important characteristics that distinguish them from ordinary emulsions which are thermodynamically unstable. The extensive research on microemulsions was prompted by two oil crises in 1973 and 1979, respectively. To optimise oil recovery, the oil reservoirs were flooded with a water–surfactant mixture. Oil entrapped in the rock pores can thus be removed easily as a microemulsion with an ultra-low interfacial tension is formed in the pores. Obviously, this method of tertiary oil recovery requires some understanding of the phase behaviour and interfacial tensions of mixtures of water/salt, crude oil and surfactant[5].

2.3 Phase behavior:

The primary aim of microemulsion research is to find the conditions under which the surfactant solubilises the maximum amounts of water and oil, i.e. the phase behaviour has to be studied. As the effect of pressure on the phase behaviour is (in general) rather weak [30], it is sufficient to consider the effect of the temperature. Furthermore, it has been shown that simple ternary systems consisting of water, oil and non-ionic n-alkyl polyglycol ethers (CiEj) exhibit all properties of complex and technically relevant systems [6]. Therefore, we will first describe the phase behaviour of ternary non-ionic microemulsions[5].

2.4 Microemulsions:

Microemulsions are dispersions of oil and water stabilized by surfactant molecules. In some cases, they are made with other liquids, such as ionic liquids or non-aqueous solvents (CO₂ under pressure, for instance). In this section, only the oil and water dispersions will be addressed. Microemulsions are frequently dispersions of droplets, either of oil-in-water (O/W) or of water-in-oil (W/O), i.e., small-scale versions of emulsions Figure. (2.1) [6].

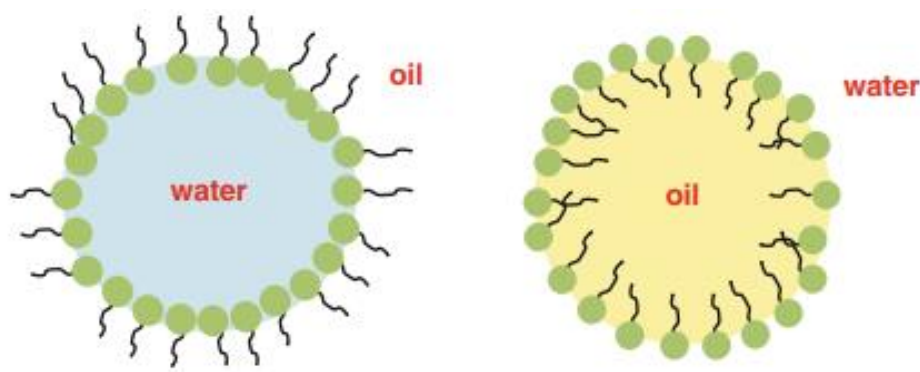


Figure 2.1

2.5 Types of Microemulsions:

Oil-in-water emulsions (O/W): In this type of emulsion, the continuous phase is water and oil is the dispersed in water. As the definition suggests, water is in large amounts, continuous, and oil is in relatively small amounts, discontinuous, dispersed in the continuous water phase[4].

Water-in-oil emulsion (W/O): This type of emulsion is the vice versa of the first type in which water from the dispersed phase and the oil from the dispersion phase is called a water-in-oil emulsion. Oil in this type is continuous, large in volume, and water is discontinuous, smaller in volume[4].

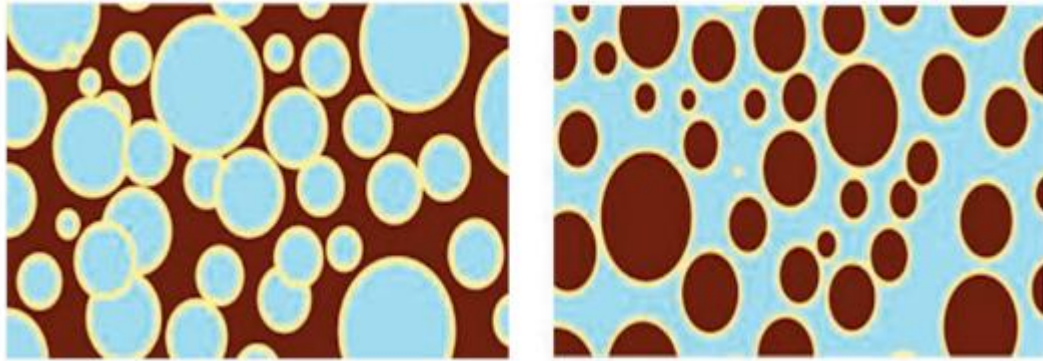


Figure 2.2 Water-oil (W/O) emulsion (left) and oil-water (O/W) emulsion (right)[7]

2.6 Polymer flooding:

Polymer flooding improves the water flooding process by delaying water breakthrough time and viscous fingering problems. Moreover, in polymer flooding, the viscosity of the water is enhanced with high-molecular-weight polymers[12].

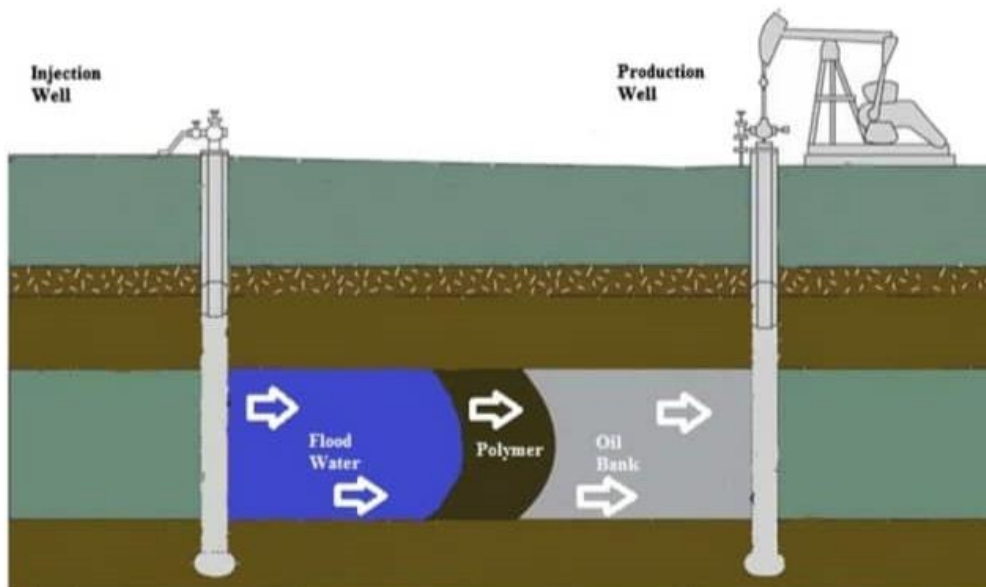


Figure 2.3 Polymer flooding[13]

2.7 Alkali flooding

Alkali flooding is a fascinating area of research that shows promising results towards higher oil recovery in both laboratory and pilot/oil field scales. A significant attraction to execute alkali flooding was recognized in different countries like China, USA, Saudi Arabia, Canada and so on [1-5]. The most commonly used alkalis that are deployed for flooding are NaOH [6], Na_2CO_3 [7], NaCl [5], (9) KOH [4], $\text{NaB}(\text{OH})_4$ [8] and NaPO_3 [4], and their success depends on the nature of crude oil and reservoir properties[14].

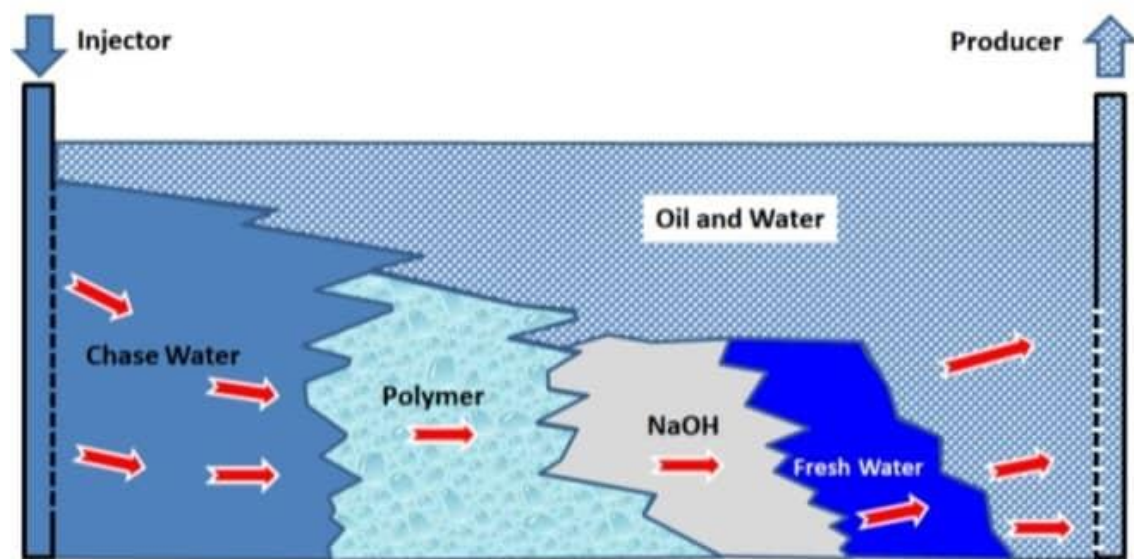


Figure 2.4 Alkali flooding[15]

2.8 Surfactant flooding:

Surfactant flooding is an Enhanced Oil Recovery technique in which the mobility of residual oil in the reservoir is increased by reducing the Interfacial Tension (IFT) between the injected fluid and the reservoir oil[16].

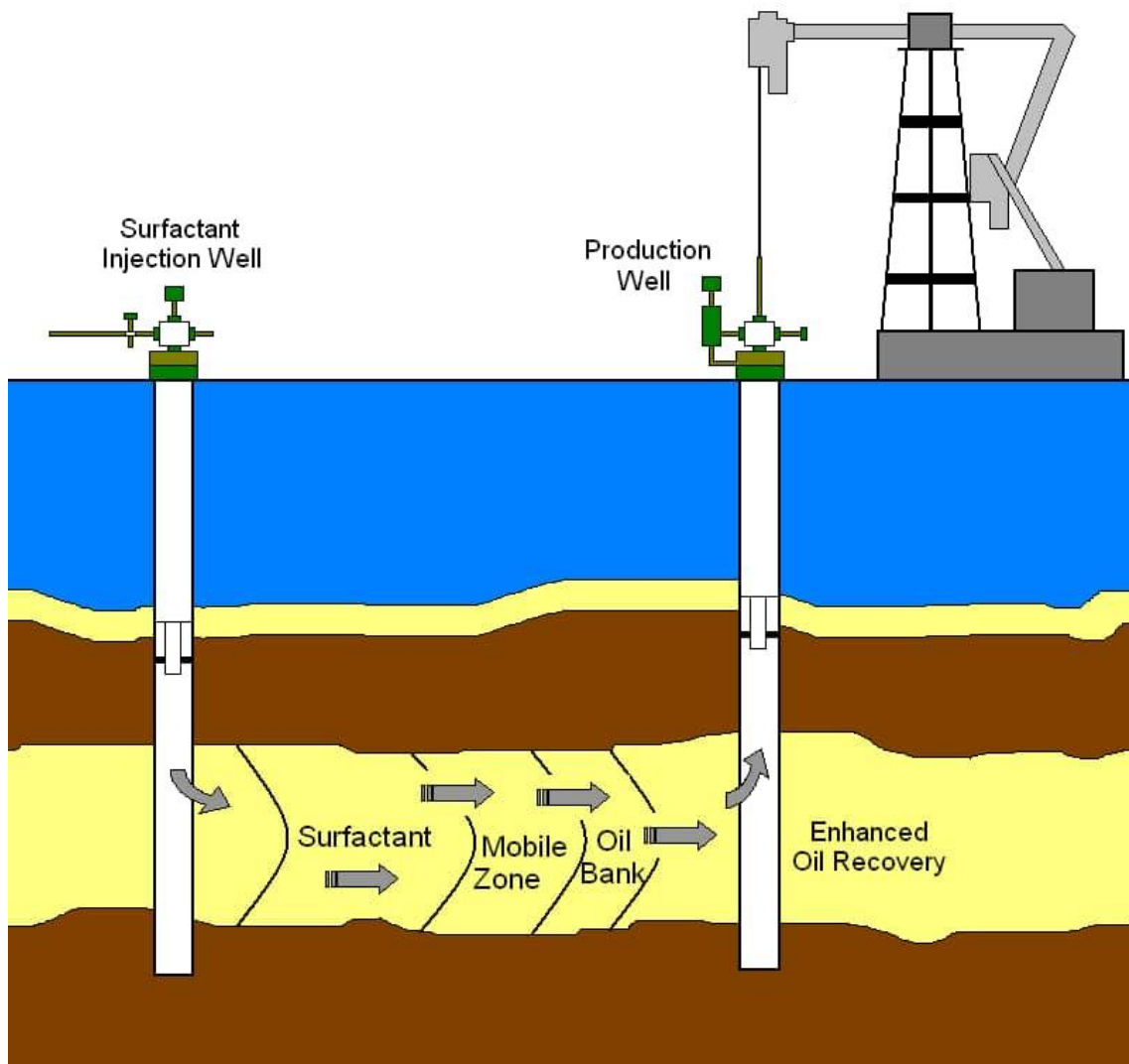


Figure 2.5 Surfactant flooding[17]

2.9 Surfactants:

Surface active substances or surfactants are amphiphilic compounds having a lyophilic, in particular hydrophilic, part (polar group) and a lyophobic, in particular hydrophobic, part (often hydrocarbon chain). The amphiphilic structure of surfactants is responsible for their tendency to concentrate at interfaces and to aggregate in solutions into various supramolecular structures, such as micelles and bilayers. According to the nature of the polar group, surfactants can be classified into nonionics and ionic, which may be of anionic, cationic, and amphoteric or zwitterionic nature[8]

2.10 Types Surfactants:

Anionic Surfactants are dissociated in water in an amphiphilic anion*, and a cation*, which is in general an alkaline metal (Na^+ , K^+) or a quaternary ammonium. They are the most commonly used surfactants. They include alkylbenzene sulfonates (detergents), (fatty acid) soaps, lauryl sulfate (foaming agent), di-alkyl sulfosuccinate (wetting agent), lignosulfonates (dispersants) etc... Anionic surfactants account for about 50 % of the world production[9]

Nonionic Surfactants come as a close second with about 45% of the overall industrial production. They do not ionize in aqueous solution, because their hydrophilic group is of a nondissociable type, such as alcohol, phenol, ether, ester, or amide. A large proportion of these nonionic surfactants are made hydrophilic by the presence of a polyethylene glycol chain, obtained by the polycondensation of ethylene oxide. They are called polyethoxylated nonionics. In the past decade glucoside (sugar based) head groups, have been introduced in the market, because of their low toxicity. As far as the lipophilic group is concerned, it is often of the alkyl or alkylbenzene type, the former coming from fatty acids of natural origin. The polycondensation of propylene oxide produce a polyether which (in opposition to polyethylene oxide) is slightly hydrophobic. This polyether chain is used as the lipophilic group in the so-called polyEOpolyPO block copolymers, which are most often included in a different class, e.g. polymeric surfactants, to be dealt with later[9].

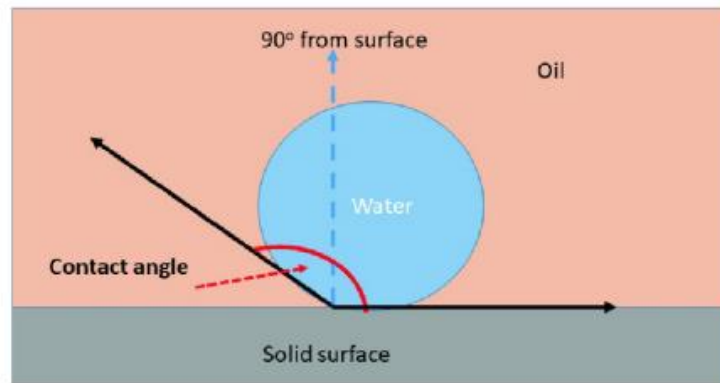
Cationic Surfactants are dissociated in water into an amphiphilic cation and an anion, most often of the halogen type. A very large proportion of this class corresponds to nitrogen compounds such as fatty amine salts and quaternary ammoniums, with one or several long chain of the alkyl type, often coming from natural fatty acids. These surfactants are in general more expensive than anionics, because of a the high pressure hydrogenation reaction to be carried out during their synthesis. As a consequence, they are only used in two cases in which there is no cheaper substitute, i.e. (1) as bactericide, (2) as positively charged substance which is able to adsorb on negatively charged substrates to produce antistatic and hydrophobant effect, often of great commercial importance such as in corrosion inhibition[9].

2.11 Interfacial Tension (IFT):

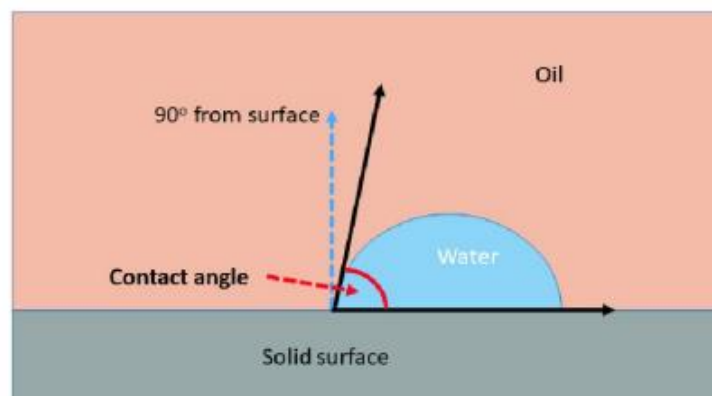
IFT is caused by the difference in the cohesive forces of molecules within one phase and the adhesive forces of dissimilar molecules at the interface. IFT is the force per unit length parallel to the interface between two phases, such as oil and water. It is the excess free energy per unit area and is reported in dynes/cm or mN/m. The IFT between crude oil and water is generally in the range of 20–30 mN/m. Due to the high IFT, the oil and water behave like two immiscible phases, and the water alone is unable to drive off the oil trapped in the pores. For EOR applications, it is generally implied that the IFT value should be decreased to 10–3 mN/m, which can be achieved by using surfactants. When the IFT is reduced between the oil and water, these phases become more “alike,” and hence, a near miscibility condition can be achieved. The two near miscible phases can progress through the porous medium together, and hence, the improved oil recovery is achieved[4].

2.12 Wettability:

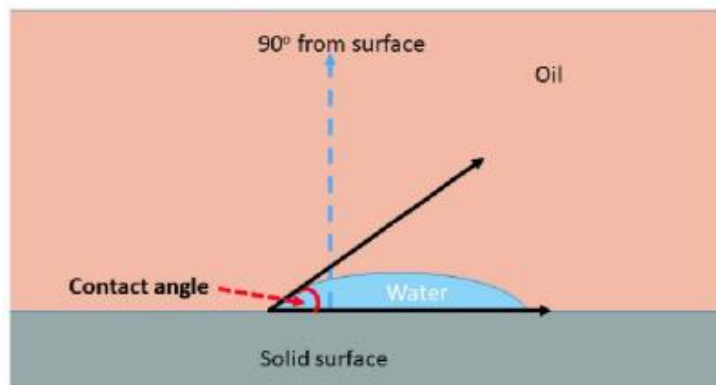
Wettability refers to the preference of one fluid to spread over or adhere to the solid surface in the presence of other immiscible fluids. In a typical reservoir, wettability is mainly dependent on the chemical composition of the rock, composition of the fluids such as water and oil mixture, the initial water saturation, and the reservoir temperature. It is one of the most important properties of the reservoir. Wettability conditions are essential in defining and understanding the interactions between rock/water, rock/oil, and water/oil under given reservoir conditions. Wettability can be determined by many methods, but two methods, the Amott test, and the USBM (US Bureau of Mines) test, both employing the displacement behavior of rock/brine/oil, are generally used. Both tests are derived from the capillary pressure phenomena. The contact angle is also used for wettability determination as shown in Figure. (2.3). It is based on the wetting properties of fluid towards the surface and is usually measured through the denser liquid phase, which is commonly the brine. Generally, for an oil/water system, wettability can be defined according to the contact angle between the water drop and solid surface or oil drop and solid surface. Generally, if the contact angle is 0° – 75° , the rock is water wet; if 75° – 115° , it is intermediate, and with an angle of 115° – 180° , the rock will be oil-wet.



A) Oil wet system, contact angle $\approx 115^\circ \sim 180^\circ$



B) Mixed wet system, contact angle $\approx 75^\circ \sim 115^\circ$



C) Water wet system, contact angle $\approx 0^\circ \sim 75^\circ$

Figure. 2.6 a, b, c Contact angles defining the wettability of an oil/rock/water system. a Oil wet system,

2.13 permeability

is the intrinsic characteristic of a material that determines how easily a fluid can pass through it. In the petroleum industry, the darcy is the standard unit of measure for permeability[10].

Chapter 3

Experimental Apparatus and Materials

3. Experimental Apparatus and Materials:

3.1 Introduction:

The experimental equipment, supplies, substances, and computations utilized for data processing are all described in this chapter. The apparatus, chemicals, and calculations for the microemulsion phase behavior will be described in different parts.

3.2 Apparatus:

This section describes the tools, procedures, and calculations needed to carry out tests on the aqueous stability and microemulsion phase behavior.

3.2.1 Pipe holder

A tube holder capable of carrying 24 tubes perpendicularly as shown in fig(3.1)



Figure. 3.1 Pipe holder

3.2.2 Oven:

The following figure (3.2) shows a memmert oven that has the ability to adjust temperatures from 0 to 200 degrees Celsius



Figure. 3.2 Oven

3.2.3 PH device

The following figure shows a device to measure pH



Figure. 3.3 PH

3.2.4 Scale for sampling:

Figure 3.4 shows Kern scale EMB200-3 used in this study, ranging from the measurement range from 0.001 to 200g



Figure. 3.4 Scale for sampling

3.2.5 Tubes:

Figures 3.5 show the glass tubes with a volume of , 50ml



Figure. 3.5 Tubes

3.2.6 Spoon

The Figure 3.6 shows the spoon that was used to raise soap samples from the box and put them on the scales



Figure. 3.6 Spoon

3.3 Materials

3.3.1 Water of Alghani:

In this form, water from the Sirte Basin, Al-Farot reservoir, and Al-Ghani field was used



Figure. 3.7 Water of Alghani

3.3.2 Distillated Water:

In this study, distilled water was obtained by this device



Figure. 3.8 Distillated Water

3.3.3 Oil:

It was discovered in 1972 in the western sirte basin and the AL-GHANI AL- FAROUD oil reservoir was discovered in January 1978.

While the Al-ghni field station was built and began operation in 1980.



Figure. 3.9 Oil

Table 3.1: Oil Composition Used in This Study

Chemical formula	IUPAC name	Result (wt %)
C ₂ H ₆	Ethane	0.032
C ₃ H ₈	Propane	0.487
C ₄ H ₁₀	Isobutene	0.371
C ₄ H ₁₀	n-Butane	1.465
C ₅ H ₁₂	Isopentane (common name)	1.807
C ₅ H ₁₂	n-Pentane	2.038
C ₆ H ₁₄	Hexane	5.215
C ₇ H ₁₆	Heptane	10.345
C ₈ H ₁₈	Octane	9.351
C ₉ H ₂₀	Nonane	9.157
C ₁₀ H ₂₂	Decane	7.8
C ₁₁ H ₂₄	Undecane	6.232
C ₁₂ H ₂₆	Dodecane	4.668
C ₁₃ H ₂₈	Tridecane	5.426
C ₁₄ H ₃₀	Tetradecane	5.095
C ₁₅ H ₃₂	Pentadecane	4.945
C ₁₆ H ₃₄	Hexadecane	3.445
C ₁₇ H ₃₆	Heptadecane	3.506
C ₁₈ H ₃₈	Octadecane	3.429
C ₁₉ H ₄₀	Nonadecane	3.012
C ₂₀ H ₄₂	Eicosane	1.828
C ₂₁ H ₄₄	Hencosane	1.628
C ₂₂ H ₄₆	Docosane	1.435
C ₂₃ H ₄₈	Tricosane	1.223
C ₂₄ H ₅₀	Tetraicosane	1.038
C ₂₅ H ₅₂	Pentacosane	0.845

C ₂₆ H ₅₄	Hexacosane	0.802
C ₂₇ H ₅₆	Heptaicosane	0.742
C ₂₈ H ₅₈	Octacosane	0.604
C ₂₉ H ₆₀	Nonacosane	0.509
C ₃₀ H ₆₂	Triacontane	0.429
C ₃₁ H ₆₄	Hentriacontane	0.382
C ₃₂ H ₆₆	Dotriacontane	0.302
C ₃₃ H ₆₈	Tritriacontane	0.232
C ₃₄ H ₇₀	Tetratriacontane	0.175
Totals		100.000

3.3.4 Sodium Dodecyl Sulfate:

SDS is an anionic detergent that can link its hydrocarbon chain to hydrophobic pockets inside of globular proteins, leaving the ionized sulphonate (SO₃) group protruding into the medium and changing the native globular or fibrous tertiary structure of a protein into a linear one[11].

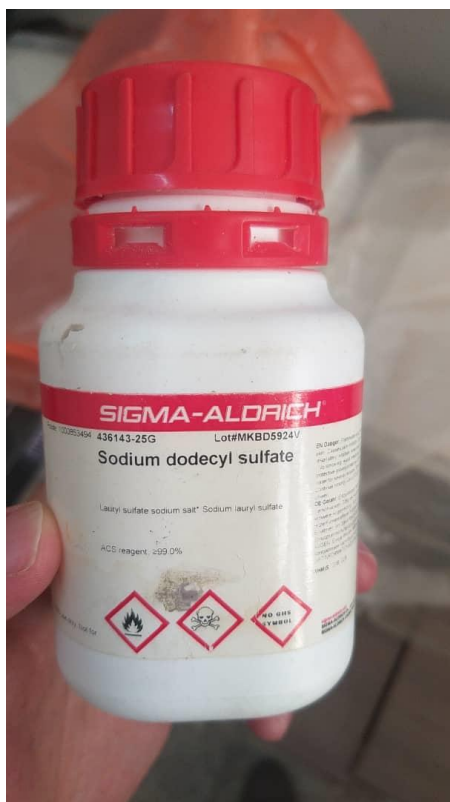


Figure. 3.10 Sodium Dodecyl Sulfate

Table 3. 2: Demonstrates Some Properties Sodium Dodecyl Sulfate Used in This Study.

Properties	
Chemical formula	$\text{NaC}_{12}\text{H}_{25}\text{SO}_4$
Molar mass	288.372 g/mol
Appearance	white or cream-colored solid
Odor	Odorless
Density	1.01 g/cm ³
Melting point	206 °C (403 °F; 479 K)
Surface tension:	
CMC	8.2 mM at 25 °C
Refractive index (n_D)	1.461

3.3.5 Commercial soap:



Figure. 3.11 Commercial soap

3.3.6 Laboratory soap

It was prepared in the laboratory by mixing sodium chloride, water and olive oil



Figure. 3.12 Laboratory soap

Chapter 4

Experiment Procedures

4. Experiment Procedures:

4.1 Measurement PH:

The PH of the water sample in the Ghanaian field was measured by a device ORION 4 STAR. It was noted that the PH value was 6.95

4.2 Preparation of Salinity

The salinity of the water sample in the Ghanaian field was measured by a device ORION 4 STAR. It was noted that the salinity value was 30 $\mu\text{c}/\text{cm}$

The salinity was reduced by distilled water to half by the following equation

$$C_1V_1 = C_2V_2$$

4.3 Experiment Steps

- The first case (original salinity water)

Three types of surfactants were used (SDS, commercial soap, and laboratory-prepared soap (AB)).

- 1- The tubes were cleaned with distilled water
- 2- The tubes were placed in the carrier, as the volume of the tube is 50 ml
- 3- The volume of the tube was divided into three sections, one third for water, one third for oil, and one third for vacuum.
- 4- The tubes were filled with 16 ml of (Ghani field water) using a pipette
- 5- Different weights of surfactants were placed, 0.05g, 0.1g, 0.15g, 0.2g.
- 6- 16 ml of oil was filled using a pipette
- 7- The tubes were closed with a wooden stopper
- 8- The samples were placed at room temperature for 48 hours, and then the samples were placed in the oven at different temperatures 30c, 40c, 50c, 60c, 70c, 80c. The samples were left for 48 hours at each temperature

- The second case (reduced salinity water)

Three types of surfactants were used (SDS, commercial soap, and laboratory-prepared soap).

- 1- The tubes were cleaned with distilled water
- 2- The tubes were placed in the carrier, as the volume of the tube is 50 ml
- 3- The volume of the tube was divided into three sections, one third for water, one third for oil, and one third for vacuum.
- 4- The tubes were filled with 16 ml of (Ghani field water) using a pipette
- 5- Different weights of surfactants were placed, 0.05g, 0.1g, 0.15g, 0.2g.
- 6- 16 ml of oil was filled using a pipette
- 7- The tubes were closed with a wooden stopper
- 8- The samples were placed at room temperature for 48 hours, and then the samples were placed in the oven at different temperatures 30c, 40c, 50c, 60c, 70c, 80c. The samples were left for 48 hours at each temperature

Chapter 5

Experiment Results

5. Experiment Results:

5.1 Oil and Al-Ghani field water with ph and different salinity without Surfactant Results:

Next table describes the experimental results and discussion of the current research with different salinity of and Al-Ghani field water but without surfactant

Table 5. 1: Cases with Different Concentration Salinity and without Surfactant

Case	Salinity	PH
	$\mu\text{c}/\text{cm}$	
Case1	30	6.95
	15	
Case2	30	6.95
	15	
Case3	30	6.95
	15	

5.2 case 1 at (original Salinity) use surfactant SDS:

5.2.1 case#1 at 30 c (Room Temperature):

At this temperature, the water level in the Ghani field is constant at (16 ml) and the oil level is constant at (16 ml).

After 48 hours, we noticed a change in the volume of water and oil, and the emulsion layer did not form.

5.2.2 Case1 at 40 (Oven Temperature):

At this temperature, the water level in the Ghani field is constant at (16 ml) and the oil level is constant at (16 ml).

After 48 hours, we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in Figure (5.2)



Figure. 5.2 Case1 at 40 (Oven Temperature)

5.2.3 Case1 at 50 (Oven Temperature):

At this temperature we notice a change ,This is done by mixing oil with water, due to the presence of a surfactant. As shown in the following Figure (5.3)



Figure. 5.3 Case1 at 50 (Oven Temperature)

5.2. 4 Case1 at 60 (Oven Temperature)

At this temperature we notice the change. This is done by mixing oil with water, due to the presence of a surfactant. As shown in the following figure (5.4)



Figure. 5.4 Case1 at 60 (Oven Temperature)

5.2. 5 Case1 at 70 (Oven Temperature):

At this temperature, the mixing of oil with water increased, As shown in the following figure (5.5)



Figure. 5.5 Case1 at 70 (Oven Temperature)

5. 3 Case1 at (Reduced salinity) use surfactant SDS:

5.3.1 Case1 at 30 c (Room Temperature):

At this temperature, the water level in the Ghani field is constant at (16 ml) and the oil level is constant at (16 ml).

After 48 hours, we noticed a change in the volume of water and oil, and the emulsion layer did not form.

5.3.2 Case1 at 40 (Oven Temperature):

At this temperature we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in Figure (5.8)



Figure. 5.8 Case1 at 40 (Oven Temperature)

5.3.3 Case1 at 50 (Oven Temperature):

At this temperature we notice a change ,This is done by mixing oil with water, due to the presence of a surfactant. As shown in the following figure (5.9)



Figure. 5.9 Case1 at 50 (Oven Temperature)

5.3. 4 Case1 at 60(Oven Temperature)

At this temperature we notice the change. This is done by mixing oil with water, due to the presence of a surfactant. As shown in the following figure (5.10)



Figure. 5.10 Case1 at 60(Oven Temperature)

5.3. 5 Case1 at 70(Oven Temperature):

At this temperature there is no change, As shown in the following figure (5.11)



Figure. 5.11 Case1 at 70 (Oven Temperature)

5. 4Case 2at (original Salinity) use Commercial soap (Soussi):

5.4.1 case# 2at 30 c (Room Temperature):

At this temperature, the water level in the Ghani field is constant at (16 ml) and the oil level is constant at (16 ml).

After 48 hours, we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.2)

5.4. 2 case# 2at 40c (Oven Temperature):

At this temperature we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.2)

5.4.3 Case 2at 50 c (Oven Temperature):

At 50 degrees Celsius, we noticed a change in the volume of oil and water as shown in table (5.2).

After 48 hours, we observed the formation of a thin layer of microemulsion As shown in the following Figure (5.13)



Figure. 5.13 Case 2at 50 c (Oven Temperature)

5.4.4 Case 2at 60 c (Oven Temperature):

At 60 degrees Celsius, we noticed a change in the volume of oil and water as shown in the table (5.2)

After 48 hours, we noticed an increase in the thickness of the microemulsion layer, as shown in the following figure (5.14).



Figure. 5.14 Case 2at 60 c (Oven Temperature)

5.4. 5 Case 2at 70c (Oven Temperature):

At 70degrees Celsius, we noticed a change in the volume of oil and water as shown in the table (5.2)

After 48 hours, we noticed an increase in the thickness of the microemulsion layer, as shown in the following figure (5.15).



Figure. 5.15 Case 2at 70c (Oven Temperature)

5. 5 Case 2at (Reduced salinity) use Commercial soap (Soussi):

5.5.1 Case 2at 30 c (Room Temperature):

At this temperature, the water level in the Ghani field is constant at (16 ml) and the oil level is constant at (16 ml).

After 48 hours, we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.3)

5.5. 2 Case 2at 40c (Oven Temperature):

At this temperature we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.3)

5.5.3 Case 2at 50 c (Oven Temperature):

At 50 degrees Celsius, we noticed a change in the volume of oil and water as shown in table (5.3).

After 48 hours, we observed the formation of a thin layer of microemulsion As shown in the following figure (5.17)



Figure. 5.17 Case 2at 50 c (Oven Temperature)

5.4.4 Case 2at 60 c (Oven Temperature):

At 60 degrees Celsius, we noticed a change in the volume of oil and water as shown in the table (5.3)

After 48 hours, we noticed an increase in the thickness of the microemulsion layer, as shown in the following figure (5.18).



Figure. 5.18 Case 2at 60 c (Oven Temperature)

5.5. 5 Case 2at 70c (Oven Temperature):

At 70degrees Celsius, we noticed a change in the volume of oil and water as shown in the table (5.3)

After 48 hours, we noticed an increase in the thickness of the microemulsion layer, as shown in the following figure (5.19).



Figure. 5.19 Case 2at 70c (Oven Temperature)

5. 6case 3 at (original Salinity) use Laboratory prepared soap (AB):

5.6.1 Case 3 at 30 c (Room Temperature):

At this temperature, the water level in the Ghani field is constant at (16 ml) and the oil level is constant at (16 ml).

After 48 hours, we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.2)

5.6. 2 Case3 at 40c (Oven Temperature):

At this temperature we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.2)

5.6.3 Case 3 at 50 c (Oven Temperature):

At 50 degrees Celsius, we noticed a change in the volume of oil and water as shown in table (5.2).

After 48 hours, we observed the formation of a thin layer of microemulsion As shown in the following figure (5.21)



Figure. 5.21 Case 2at 50 c (Oven Temperature)

5.6.4 Case 3 at 60 c (Oven Temperature):

At 60 degrees Celsius, we noticed a change in the volume of oil and water as shown in the table (5.2)

After 48 hours, we noticed an increase in the thickness of the microemulsion layer, as shown in the following figure (5.22).



Figure. 5.22 Case 2at 60 c (Oven Temperature)

5.6. 5 Case 3 at 70c (Oven Temperature):

At 70degrees Celsius, we noticed a change in the volume of oil and water as shown in the table (5.2)

After 48 hours, we noticed an increase in the thickness of the microemulsion layer, as shown in the following figure (5.23).

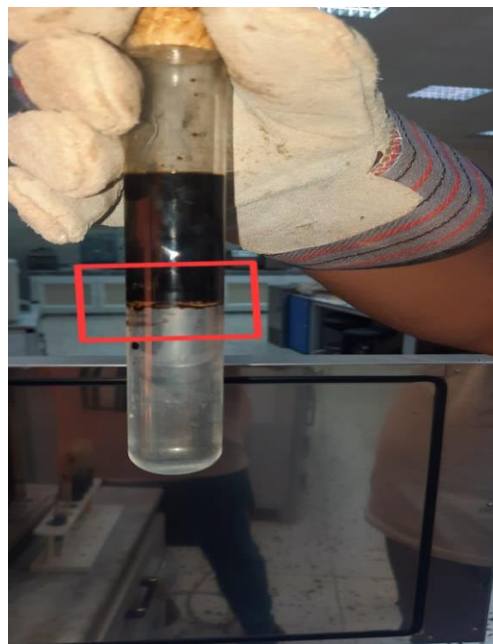


Figure. 5.23 Case 2at 70c (Oven Temperature)

5. 7 Case 3 at (Reduced salinity) use Laboratory prepared soap (AB):

5.7.1 Case 3 at 30 c (Room Temperature):

At this temperature, the water level in the Ghani field is constant at (16 ml) and the oil level is constant at (16 ml).

After 48 hours, we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.3)

5.7. 2Case 3 at 40c (Oven Temperature):

At this temperature we noticed a change in the volume of water and oil, and the emulsion layer did not form. As shown in table (5.3)

5.7.3 Case 3 at 50 c (Oven Temperature):

At 50 degrees Celsius, we noticed a change in the volume of oil and water as shown in table (5.3).

After 48 hours, we observed the formation of a thin layer of microemulsion As shown in the following figure (5.25)



Figure. 5.25 Case 2at 50 c (Oven Temperature)

5.7.4 Case 3 at 60 c (Oven Temperature):

At 60°C, the volume of oil remains constant at 16 ml, and the volume of water remains constant at 16 ml.

After 48 hours, we observed an increase in the thickness of microemulsion layer



Figure. 5.26 Case 2at 60 c (Oven Temperature)

5.7. 5 Case 3 at 70c (Oven Temperature):

At 70degrees Celsius, we noticed a change in the volume of oil and water as shown in the table (5.3)

After 48 hours, we noticed an increase in the thickness of the microemulsion layer, as shown in the following figure (5.27).



Figure. 5.27 Case 2at 70c (Oven Temperature)

Table (5.2): Result of micro-emulsion (Original salinity)

		At room temperature			At 40°C			At 50°C			At 60°C			At 70°C		
	At start experiment Water level 16 ml & oil level 16 ml	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level
SDS	0.05	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.9	-
	0.1	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.9	-
	0.15	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.9	-
	0.2	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.9	-
Soussi commercial (soap)	0.05	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.05	15.2	16.2	0.1	15	15.9	0.15
	0.1	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.05	15.2	16.2	0.1	15	15.9	0.15
	0.15	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.2	15	15.9	0.25
	0.2	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.2	15	15.9	0.25
Laboratory soap (AB)	0.05	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.05	15.2	16.2	0.1	15	15.9	0.2
	0.1	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.2	15	15.9	0.25
	0.15	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.2	15	15.9	0.25
	0.2	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.2	15	15.9	0.25

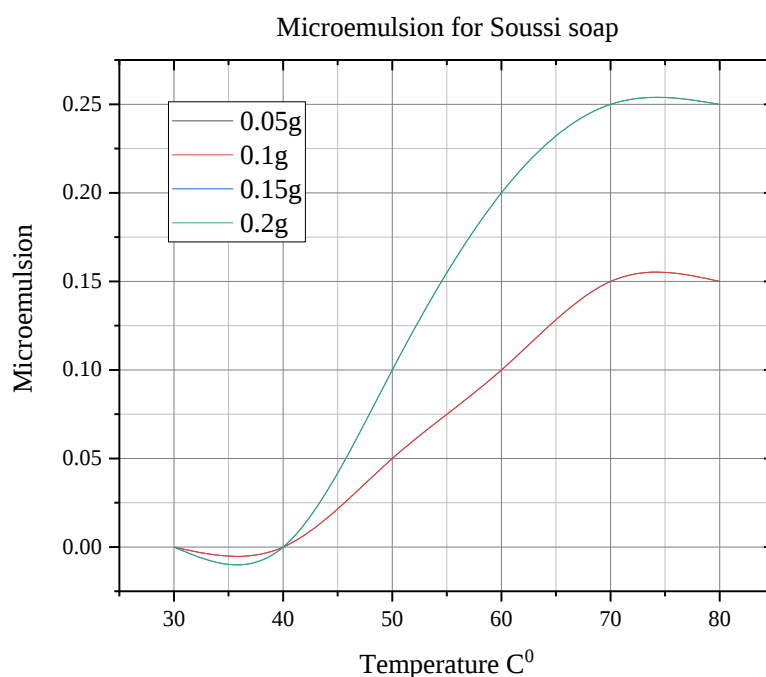


Figure. 5.29 Emulsifier in commercial soap (Soussi)

figure (5.29) shows the change in the volume of the emulsion in commercial soap (Soussi) with a difference in temperature at 48 hours for each temperature.

At room temperature, the volume of the emulsion was not formed for all scenarios, but when the temperature was raised to 50 degrees Celsius, there was a change in the volume of the oil and a small layer of micro-emulsion began to form in all scenarios, and the volume of the micro-emulsion ranged from 0.05 to 0.1 ml.

As the temperature rose to 60 degrees Celsius, the emulsion layer increased, ranging in size from 0.1 to 0.2 ml. Finally, at a temperature of 70 degrees Celsius, there was a clear effect on temperature, as the emulsion volume ranged between 0.15 to 0.25 ml for all scenarios. The maximum emulsion volume was 0.25 ml, as shown in the figure (5.29).

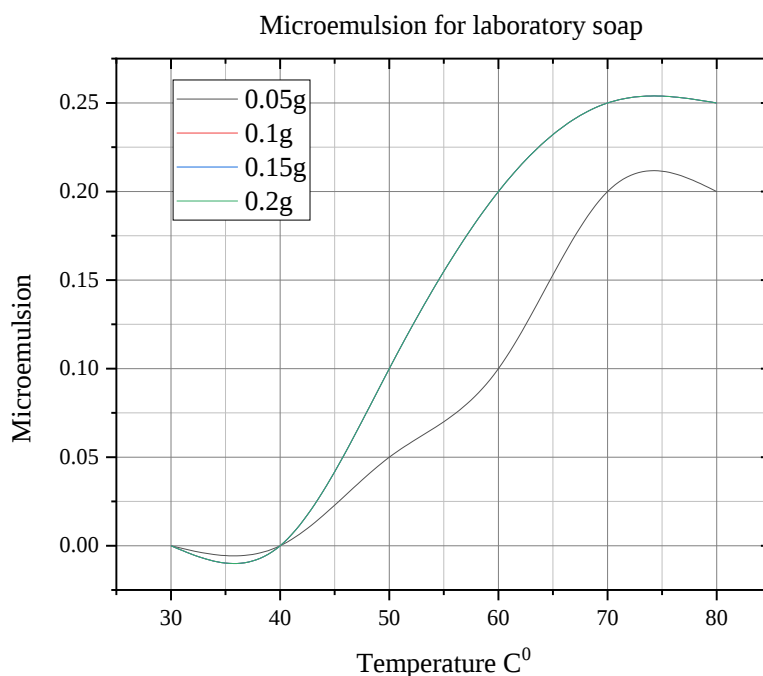


Figure. 5.30 emulsion in laboratory soap (AB)

figure (5.30) shows the change in the volume of the emulsion in laboratory soap (AB) with a difference in temperature at 48 hours for each temperature.

At room temperature, the volume of the emulsion was not formed for all scenarios, but when the temperature was raised to 50 degrees Celsius, there was a change in the volume of the oil and a small layer of micro-emulsion began to form in all scenarios, and the volume of the micro-emulsion ranged from 0.05 to 0.1 ml.

As the temperature rose to 60 degrees Celsius, the emulsion layer increased, ranging in size from 0.1 to 0.2 ml. Finally, at a temperature of 70 degrees Celsius, there was a clear effect on temperature, as the emulsion volume ranged between 0.2 to 0.25 ml for all scenarios. The maximum emulsion volume was 0.25 ml, as shown in the figure (5.30).

Table (5.3): Result of micro-emulsion (Salinity reduced by half)

		At room temperature			At 40°C			At 50°C			At 60°C			At 70°C		
	At start experiment Water level 16 ml & oil level 16 ml	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level	Oil level	Water level	Emulsion level
SDS	0.05	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.8	-
	0.1	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.8	-
	0.15	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.8	-
	0.2	15.5	16.5	-	15.4	16.5	-	15.3	16.4	-	15.2	16.2	-	15	15.8	-
Soussi commercial (soap)	0.05	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.15	15	15.8	0.2
	0.1	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.15	15	15.8	0.2
	0.15	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.15	15.2	16.2	0.25	15	15.8	0.3
	0.2	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.15	15.2	16.2	0.25	15	15.8	0.3
Laboratory soap (AB)	0.05	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.1	15.2	16.2	0.15	15	15.8	0.2
	0.1	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.15	15.2	16.2	0.25	15	15.8	0.3
	0.15	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.15	15.2	16.2	0.25	15	15.8	0.3
	0.2	15.5	16.5	-	15.4	16.5	-	15.3	16.4	0.2	15.2	16.2	0.3	15	15.8	0.35

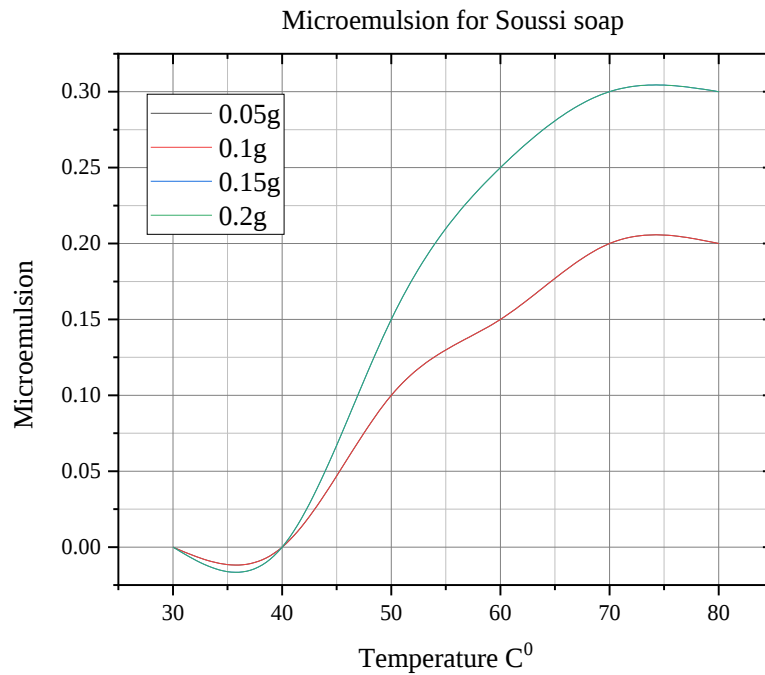


Figure 5.31 Micro emulsion in commercial soap (Soussi)

Figure (5.31) shows the change in the volume of the emulsion in commercial soap (Soussi) with a difference in temperature at 48 hours for each temperature.

At room temperature, the volume of the emulsion was not formed for all scenarios, but when the temperature was raised to 50 degrees Celsius, there was a change in the volume of the oil and a small layer of micro-emulsion began to form in all scenarios, and the volume of the micro-emulsion ranged from 0.1 to 0.15 ml.

As the temperature increased to 60 degrees Celsius, the emulsion layer increased, ranging in size from 0.15 to 0.25 ml. Finally, at a temperature of 70 degrees Celsius, there was a clear effect on temperature, as the emulsion volume ranged between 0.2 to 0.3 ml for all scenarios. The maximum emulsion volume was 0.3 ml, as shown in the figure (5.31).

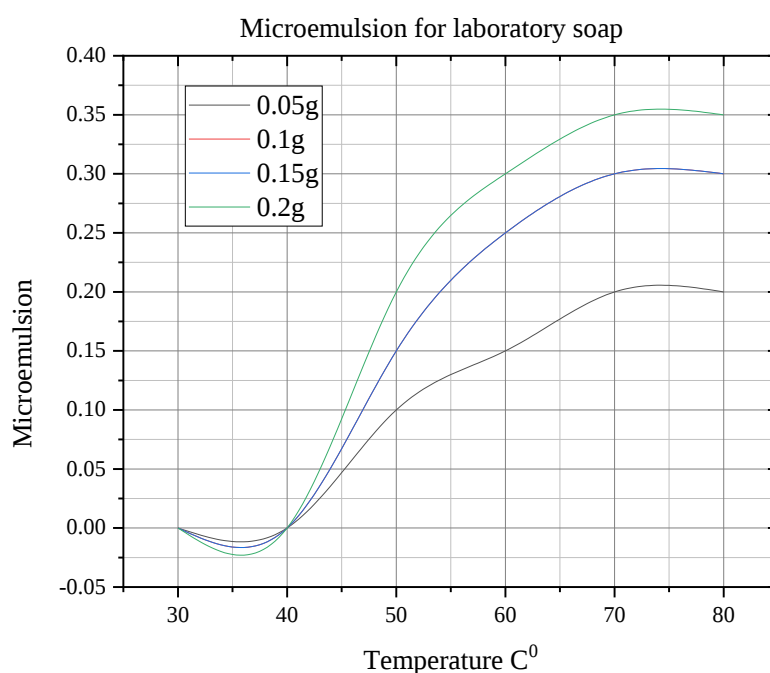


Figure 5.32 emulsion volume in functional soap (AB)

Figure (5.32) shows the variation in emulsion volume in functional soap (AB) with temperature variations at 48 dry for each temperature.

At room temperature, the emulsion volume was formed for all scenarios, but when the temperature was raised to 50 degrees Celsius, there was a change in the volume of the oil and a small component of the microemulsion appeared to form in all scenarios, and the volume of the microemulsion was between 0.1 to 0.2 ml.

As the temperature rises to 60 degrees Celsius, the emulsified cloth volume ranges from 0.15 to 0.3 ml. Finally, at a temperature of 70 degrees Celsius, there was a clear effect at all temperatures, as the total volume emulsified between 0.2 to 0.35 ml for all scenarios. The maximum emulsion volume was 0.35 ml, as in the figure (5.32).

Chapter 6

Conclusion and Recommendation

6. Conclusion and Recommendation:

6.1 Conclusion:

1. It was observed that a thin layer of microemulsion began to form at a temperature of 50 degrees
2. At 60 degrees, the microemulsion layer increased
3. The time factor at room temperature and temperature of 80 has no effect
4. The best scenario is laboratory soap (AB) in diluted water at 70 degrees

6.2 Recommendation:

We recommend using other types of homemade soap and using different concentrations and temperatures

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