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IOP Conference Series: Earth and Environmental Science

Preface

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Preface

Greetings and a warm welcome to the expansive compilation of research and scholarly contributions presented in the Proceedings of the ICEMINE 2023. In the spirit of intellectual exploration and collaboration, this voluminous collection encapsulates the diverse and profound discussions that unfolded during the conference. As we delve into the following pages, readers will encounter a comprehensive exploration of knowledge, innovation, and interdisciplinary collaboration within the overarching theme of ICEMINE 2023.

ICEMINE 2023 is the 6th International Conference hosted by the Faculty of Mineral Technology, Universitas Pembangunan Nasional "Veteran" Yogyakarta, Indonesia. The conference was held at Grand Keisha Hotel, Yogyakarta, Indonesia, on the 9th of November 2023. The theme of this year's program is *"Accelerating the advancements in lower carbon energy for a sustainable environment"*.

We extend our appreciation to our esteemed partner university, whose unwavering dedication and scholarly contributions have significantly enriched the contents of this conference proceedings. In collaboration with our partner universities, Trisakti University and PEM Akamigas, UPN Veteran Yogyakarta creates an academic platform that fosters diverse perspectives, innovative ideas, and interdisciplinary exchange. Their insightful research and collaborative spirit have undeniably elevated the quality of discourse within our academic community, fostering an environment conducive to intellectual growth and innovation.

Furthermore, we would like to express our profound gratitude to our sponsors, whose generous support has been pivotal in bringing this event to success. Their unwavering commitment to advancing research and cultivating intellectual exchange underscores the importance of their role in shaping the trajectory of our academic disciplines.

Reflecting on Sustainability in Indonesia

In recent years, the imperative to decrease carbon emissions and shift towards energy sources with lower carbon footprints has become exceptionally crucial. Emphasizing the importance of transitioning to cleaner energy sources is paramount for preserving our environment and addressing climate change. The significance of advancing lower carbon energy technologies cannot be overstated, as they play a vital role in mitigating the adverse impacts of climate change and ensuring a sustainable environment for future generations. As scholars and researchers, we carry a distinct responsibility to accelerate the development of these technologies, driving innovation, encouraging critical thinking, and offering the expertise and solutions needed to forge a more sustainable future.

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The chosen theme for ICEMINE 2023, *Accelerating the advancements in lower carbon energy for a sustainable environment,* resonates with the evolving landscape of academic inquiry and technological advancement. This theme has served as a catalyst for researchers to delve into various aspects, spanning the theoretical frameworks to practical applications. The rich tapestry of this proceedings volume mirrors the comprehensive exploration undertaken by the conference participants, representing a mosaic of perspectives that collectively contribute to the ongoing narrative of Sustainability.

Within this volume lies a plethora of research, articles, case studies, and theoretical explorations carefully curated from the vast pool of submissions and presentations at the conference. These contributions, emanating from a global community of earth science scholars, reflect the breadth and depth of insights shared during ICEMINE 2023. The contributions cover a wide spectrum of earth sciences, which are:

1. Geological Science and Engineering
2. Geophysics, Geomatics and Geochemistry
3. Earth Resources Project Evaluation and Valuation
4. Petroleum and Geothermal Engineering
5. Mining and Metallurgical Engineering
6. Taxation and Policy
7. Conservation, Geoheritage and Geopark
8. Disaster Management
9. Reclamation and Environmental Issues

Navigating the future: a vision for what lies ahead

As we engage with the contents of this proceedings volume, let us not only celebrate the documented achievements but also contemplate the trajectory of our respective fields. The ideas presented here have the potential to seed new research directions, innovative solutions, and transformative advancements. Readers are encouraged to interact critically with the content, fostering discussions and collaborations that transcend traditional academic silos. The interdisciplinary nature of the contributions invites us to explore the intersections of knowledge, where groundbreaking ideas often emerge from the convergence of diverse perspectives. May the knowledge shared within this volume inspire future generations, spark new avenues of inquiry, and contribute to the advancement of our collective understanding.

Cordially yours,

Dr. Widyawanto Prastistho

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KEYNOTE SPEAKERS

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Muhammad Irvingia Al Farizzi	Telomoyo Volcano Complex Geotourism: An In-Depth Analysis and Future Development	Geological Engineering UPNVY
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Muhammad Naufal Hisya Himendra	Comparative Analysis of The Use Emulsion and Watergel Explosive on Fragmentation at PT Dahana Site Kaltim Jaya Bara, East Kalimantan	Mining Engineering, Trisakti University
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Laboratory study on the performance of AOS surfactant in increasing oil recovery

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Laboratory study on the performance of AOS surfactant in increasing oil recovery

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Abstract. The decline in oil recovery in the oil and gas field is a problem that must be faced along with increasing energy needs. Efforts are made to increase oil recovery reserves with advanced methods, namely Enhanced Oil Recovery. In this study, an AOS (alpha olefin sulfonate) surfactant solution was used. Tests were conducted with varying concentrations at a salinity of 7,000 ppm. Phase behavior tests were also conducted for 7 days at 80 °C. The oil recovery value of the surfactant solution was also investigated. The testing stages carried out were density, interfacial tension, and core flooding tests. After making the surfactant solution sample, a density test was conducted at 30 and 80 °C. Finally, the core flooding test. The IFT results of the surfactant solution reached the critical micelle concentration (CMC) point so that it could reduce the interfacial tension well between oil and formation water in the reservoir with an interfacial tension value of 0.8212087 dyne/cm. Core flooding results are based on surfactants that reach the CMC point. There is a surfactant with a concentration of 1% Salinity 7,000 ppm at the CMC point with a recovery factor of 7.2727%.

1. Introduction

The decline in oil recovery in oil and gas fields is a problem that must be faced along with the increasing need for petroleum energy. Increasing oil recovery reserves requires an advanced method, namely Enhanced Oil Recovery (EOR). EOR is one of the methods that can be used to increase the amount of hydrocarbons that can be obtained from a field after primary and secondary production is completed [1]. There are various EOR methods consisting of chemical injection, gas injection, thermal injection, and microbial injection. Sweep efficiency can be improved by lowering the oil-water mobility ratio which is affected by fingering [2]. Chemical injection, which can be alkaline, surfactant, or polymer. The EOR stage is carried out after the end of the water injection process if the amount of oil remaining in the reservoir is still quite large [3].

The anionic surfactant used for this study is alpha-olefin sulfonate (AOS), where AOS surfactant has relatively lower adsorption on sandstone [4]. In addition, AOS surfactants provide outstanding detergency, high compatibility with hard water, and good wetting and foaming properties with CO2 even when the porous medium is partially saturated with oil. These properties make AOS surfactants excellent candidates for (CO_2) foam applications, e.g., EOR projects aiming to produce more oil from underground reservoirs [5].

Research conducted on a laboratory scale aims to determine the value of density and specific gravity to changes in temperature 30 ° C and 80 ° C in brine, crude oil, and AOS surfactant. From the physical test process, it was found that the higher the concentration of the solution, the value of density, viscosity, and specific gravity will also increase [6][7]. To determine the interfacial tension properties of the AOS surfactant against Crude Oil, before conducting the IFT test, first conduct a phase behavior test to determine the appropriate salinity and type of emulsion that can mix with crude oil to reduce interfacial tension or to study the behavior of hydrocarbon mixtures, salinity, and surfactant systems at cool temperatures [8]. Some opinions state that this phase behavior test is a faster and easier test stage in determining the IFT value and the effective performance of the surfactant solution being tested [9]. A good result in this phase behavior test is that surfactants with certain concentrations and salinity form a middle-phase emulsion [10] . This center phase emulsion is one of the main mechanisms that indicate the success of EOR using surfactants in addition to the oil-surfactant IFT value of less than 10 mN/m [11]; a decrease in the IFT of other oils-fluids and control of wettability in rock pores [12].

Surfactant injection is widely used in EOR techniques because the application technique is relatively simple and the recovery obtained is relatively large compared to conventional water injection [1]. The mechanism of increasing recovery with surfactants lowers the interfacial tension, decreases the [13]mobility of the pressing fluid, and communicates with a wider reservoir volume limit, so the addition of surfactant concentration of micelle formation is called critical micelle concentration (CMC) which is higher to achieve the desired mobility control [14]. The mechanism of action of surfactants in reducing interfacial tension, the hydrophilic part (like water) will enter the polar solution and the lipophilic part (likes oil) will enter the non-polar solution so that the surfactant will combine two compounds that actually cannot join [15]. This research uses sandstone rock samples as reservoir media,

2. Methods

The research was conducted in the enhanced oil recovery (EOR) laboratory, at the Faculty of Earth and Energy Technology (FTKE), Universitas Trisakti. The research work steps carried out in this laboratory include the preparation of synthetic formation water, preparation of surfactant solution, measurement of physical properties of the solution, measurement of interfacial tension, and injection of AOS surfactant.

The materials used in this research are AOS (alpha olefin sulfonate) surfactant solution with concentrations of 0.3; 0.5, 0.75; 0.9; and 1% with a salinity of 7,000 ppm, crude oil with API of 41°API.

2.1. Tools and materials

The preparation and experiments carried out in this laboratory began with the preparation of solutions, namely brine, and surfactant, then testing the physical properties of the solution, namely density at 30 and 80 °C, then interface tension at 80 °C. Then the selection of the most optimum solution was carried out, measurements were made at a concentration of 0.3; 0.5, 0.75; 0.9; and 1%. The next step is to test the Interfacial Tension value using the Spinning Drop Tensiometer Series 500D which is based on the balance of centrifugal force and interfacial tension[8]. to get the CMC or Critical micellar concentration point where to find the lowest and most economical interface tension point.

The salinity of the formation water used in this study was 7,000 ppm, so as not to reduce the ability of surfactants to increase oil recovery from the model, made by dissolving 7 grams of NaCl into 1000 ml of distilled water stirred with a magnetic stirrer. The oil used was light oil with an API value of 41°API.

Measurement of fluid density and specific gravity is done using a tool called Density meter. The measurement of interfacial tension using Spinning Drop Tensiometer Series 500D. For AOS surfactant injection testing of sandstone rocks using a core holder.

2.2. Research Procedure

The following is the work procedure carried out in this study:

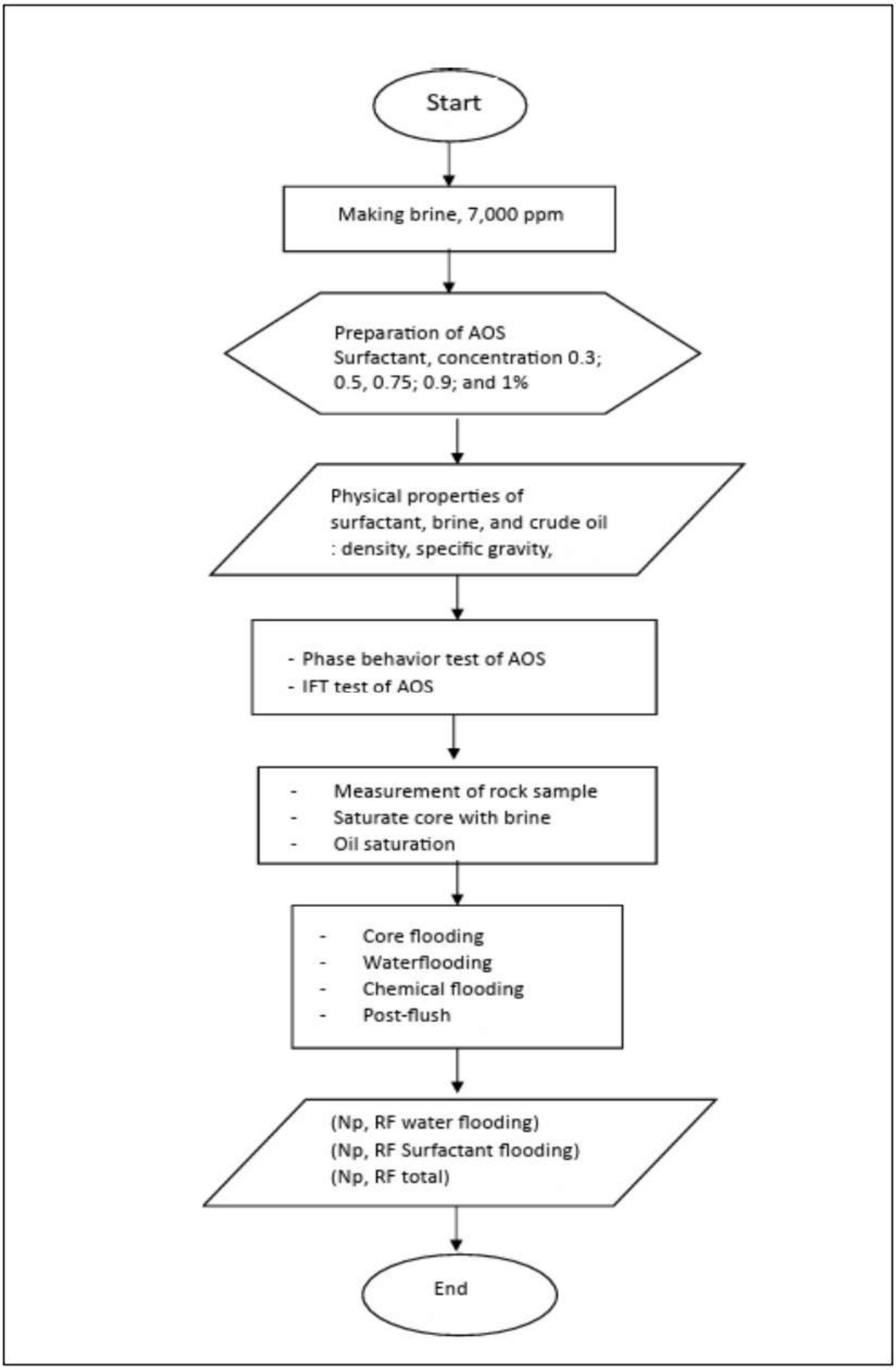

Figure. 1. Flow chart of the research.

3. Results and discussion

There are several stages of research and their results, namely making surfactant solution, surfactant solution density test, phase behavior test, interfacial tension test of surfactant solution, sandstone core measurement, and core flooding test. These stages have results that can be accounted for because this research is primary data that is directly researched objectively in the laboratory.

3.1 Solution preparation

Brine making is done to design the formation of water contained in the reservoir. The brine made comes from a mixture of Sodium Chloride or NaCl with Aquadest. This is done so that the water made has an ion content in water to be similar to the content of formation water.

Table. 1 Results of brine preparation.

No sample of Brine	Salinity of brine (ppm)	Aquadest volume (ml)	NaCl weight (gr)
1	7,000	1,000	7

In making brine with a salinity of 7,000 ppm or 7 gr/L. Where 7 grams of NaCl powder (sodium chloride) is placed in a beaker containing 1 liter of distilled water.

$$Salinity\ of\ \ brine = \frac{NaCl\, weight\ (gr)}{Aquadest\ volume\ (ml)} *)$$

Surfactant AOS (alpha olefin sulfonate) has a form of solid to measure how much the mass of AOS can be formed into a solution of Surfactant AOS where 1 gram per 100 ml is equal to 1%. The making of AOS can be seen in Table. 2.

Table. 2 Preparation of AOS Surfactant.

Sample name of Surfactant	Surfactant concentration (%)	The volume of Brine (ml)	AOS weight (gr)
AOS-1	0.3	500	1.5
AOS-2	0.5	500	2.5
AOS-3	0.75	500	3.75
AOS-4	0.9	500	4.5
AOS-5	1	500	5

AOS surfactant was made as much as 250 ml for one sample. There are 10 samples used in this final project research. Where type A AOS surfactant will be used to measure fluid physical properties at 30 °C (room temperature) and type B AOS surfactant will be used to measure fluid physical properties up to core flooding at 80 °C (reservoir temperature). The AOS surfactant has various concentrations. including 0.3; 0.5; 0.75; 0.9; and 1% with a salinity of 7.000 ppm.

3.2 Density Test

Density testing uses a tool called Densitometer DM-4100. Where testing using a densitometer includes the density and Specific Gravity of a surfactant solution. brine. to Crude Oil. The results of density testing can be seen in Table 3 regarding the density and specific gravity of crude oil and brine.

Table. 3 Density and specific gravity of crude oil and saltwater.

Sample Name	Temperature (deg C)	API	Density (gr/cc)	SG
Rantau *crude oil*	30	41.3561	0.816	0.8186
	80	45.2424	0.7786	0.8006
Brine 7000 ppm	30	-	1.0001	1.0044
	80	-	0.9687	0.9968
Aquadest	30	10	1	1

AOS surfactant testing using a Densitometer can determine density and Specific Gravity. Performed first at a temperature of 30 °C after completion. then changed to a temperature of 80 °C. This requires a short time because the 80 °C temperature takes time to rise due to the gradual increase in temperature on the densitometer. if not done properly there will be an error in the reading of the tool.

Table. 4 Density and Specific Gravity of AOS Surfactant.

Sample of Surfactant	Concentration (%)	Temperature (deg C)	Density (gr/cc)	SG
AOS 1	0.3	30	1.0001	1.0045
		80	0.9503	0.9772
AOS 2	0.5	30	1.0006	1.0049
		80	0.9527	0.9797
AOS 3	0.75	30	1.0008	1.0050
		80	0.9694	0.9968
AOS 4	0.9	30	1.0012	1.0056
		80	0.9701	0.9972
AOS 5	1	30	1.0013	1.0057
		80	0.9703	0.9975

3.3 Phase behavior

Testing the value of phase behavior test between oil with the name "Rantau field crude oil" and AOS surfactant. This test uses a 4 ml tube for seven days heated to a temperature of 80 °C in the oven.

Table. 5 Phase behavior of AOS Surfactant.

No	Observation time	Description	AOS				
			0.3%	0.5%	0.75%	0.9%	1.00%
0	Start	Oil (ml)	4	4	4	3.2	4
		Emulsion (ml)	2.8	2.7	3.05	1.75	3.05
		Surfactant (ml)	1.2	1.3	0.95	1.45	0.95
1	30 minutes	Oil (ml)	4	4	4	3.2	4
		Emulsion (ml)	2.25	3.05	2.45	1.45	2.75
		Surfactant(ml)	1.75	0.95	1.55	1.75	1.25
2	1 hour	Oil (ml)	4	4	4	3.2	4
		Emulsion (ml)	2.15	2.35	2.35	1.4	2.55
		Surfactant(ml)	1.85	1.77	1.65	1.8	1.45

No	Observation time	Description	AOS				
			0.3%	0.5%	0.75%	0.9%	1.00%
3	2 hours	Oil (ml)	3.95	3.98	4	3.2	4
		Emulsion (ml)	2.05	2.13	2.25	1.34	2.45
		Surfactant(ml)	1.9	1.85	1.75	1.86	1.55
4	24 hours	Oil (ml)	2.1	2.12	2.15	2.2	2.9
		Emulsion (ml)	0.05	0.05	0.1	0.2	1
		Surfactant(ml)	2.05	2.07	2.05	2	1.9
5	24 hours	Oil (ml)	2.1	2.12	2.13	2.15	2.65
		Emulsion (ml)	0.05	0.04	0.08	0.15	0.72
		Surfactant(ml)	2.05	2.08	2.05	2	1.93
6	24 hours	Oil (ml)	2.1	2.12	2.13	2.12	2.4
		Emulsion (ml)	0.04	0.04	0.08	0.09	0.45
		Surfactant(ml)	2.06	2.08	2.05	2.03	1.95
7	24 hours	Oil (ml)	2.01	2.12	2.13	2.12	2.27
		Emulsion (ml)	0.04	0.04	0.08	0.09	0.29
		Surfactant(ml)	2.06	2.08	2.05	2.03	1.98
8	72 hours	Oil (ml)	2.1	2.1	2.13	2.1	2.2
		Emulsion (ml)	0.04	0.02	0.08	0.07	0.2
		Surfactant(ml)	2.06	2.08	2.05	2.03	2

There are results from Table. 5 Obtained a graph of emulsion gain data on the mixture of AOS surfactant with oil found in the graph of the gain value of the phase behavior test on the AOS surfactant found in Figure. 2 It is known that 1% AOS surfactant has a stable concentration in the phase behavior test.

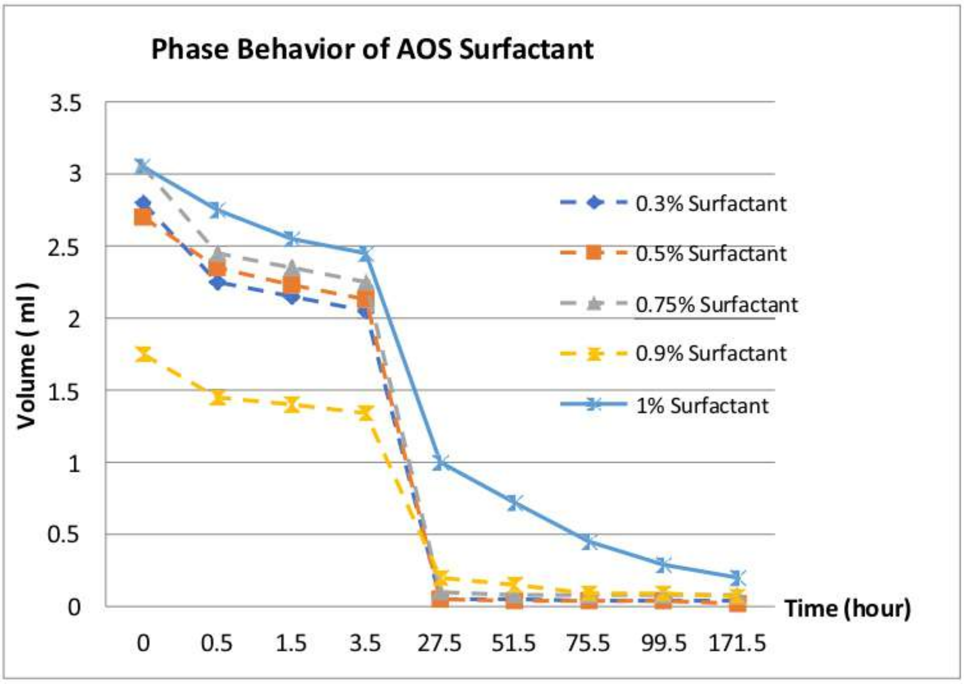

Figure. 2 Phase Behaviour of AOS Surfactant at salinity 7,000 ppm.

3.4 Interfacial Tension

The interfacial Tension Test uses a Spinning Drop Tensiometer by placing 2 ml of surfactant in a capillary tube. and then dripping with crude oil from the Rantau field. Testing the IFT value is carried out by surfactants that are stable in the Phase behavior test. Where 1% AOS was measured at a temperature of 80 °C. IFT measurements were carried out at a temperature of 80 °C on Rantau Crude Oil with 1% AOS (salinity of 7,000ppm) inserted into the spinning drop tensiometer series TX 500D. Then. the capillary tube was rotated by the spinning drop at a rate of 6,000 rpm for 30 minutes at a temperature of 80 °C.

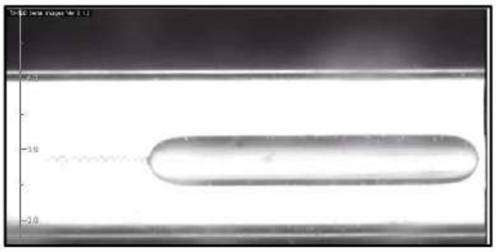

Figure. 3 IFT value acquisition of AOS surfactant.

Figure. 3 displays the results of IFT testing on each solution with crude oil samples. Based on the test. the IFT result for 1% AOS surfactant (7,000 ppm salinity) is 0.821309 dyne/cm.

3.5 Core test

Measurement of sandstone cores or sandstone rock samples with a caliper to determine the bulk volume of the rock core when it is still empty and the weight of the core when it is not filled. After that. immerse the core using the brine that has been made so that the brine can fill the pores of the rock. The parameters measured are bulk volume. pore volume. dimension or size of sandstone core. and porosity. Then oil saturation is carried out to determine the OOIP value in the rock sample. Rock sample B8 has the following size specifications as follows.

Table. 6 Measurement of rock sample B8.

Nama Core	**B8**
rock type	Barea Sandstone
diameter (cm)	2.590
height (cm)	3.595
bulk volume (cc)	18.81
empty weight (gr)	40.319
fill weight	44.08
pore volume (cc)	3.87
porosity (%)	20.60
OOIP (cc)	2.2

3.6 Surfactant Injection

The Core Flooding test uses a core holder where the core will be injected with brine and AOS surfactant with a concentration of 1% salinity of 7,000 ppm. Waterflood injection uses 3 tubes. while surfactant injection requires 5 tubes. The first to the third tube is the process of waterflooding. while the fourth to the eighth tube is the process of AOS surfactant injection.

Table. 7 Core Flooding Tests with AOS Surfactant.

no	Injection type	fluid out (ml)	oil out (ml)	brine out (ml)	OOIP	PV	RF	Np surfactant	RF surfactant
0	no injection	0	0	0	0	0	0	0	0
1	Waterflood 1	2.2	1.4	0.8	2.2	1.4	63.64%		
2	Waterflood 2	2.2	0.01	2.19	2.2	1.41	64.09%		
3	Waterflood 3	2.2	0.01	2.19	2.2	1.42	64.55%		
4	AOS 1 injection	2.2	0.05	2.15	2.2	1.47	66.82%	0.05	2.2727%
5	AOS 2 injection	2.2	0.1	2.1	2.2	1.57	71.36%	0.15	6.8182%
6	AOS 3 injection	2.2	0.01	2.19	2.2	1.58	71.82%	0.16	7.2727%
7	AOS 4 injection	2.2	0	2.2	2.2	1.58	71.82%	0.16	7.2727%
8	AOS 5 injection	2.2	0	2.2	2.2	1.58	71.82%	0.16	7.2727%
	TOTAL RF AOS								7.2727%

From Table. 7, a graph of Crude oil recovery data is obtained when waterflood injection and AOS surfactant injection at a concentration of 1% salinity of 7,000 ppm. During the waterflood, 1.42 ml of oil was produced with a recovery factor of 64.55%. During the injection of AOS surfactant 1% salinity 7,000 ppm, 0.56 ml of oil was produced with a recovery factor of 7.2727%. Figure. 4 is a graph of the crude oil recovery factor obtained per tube.

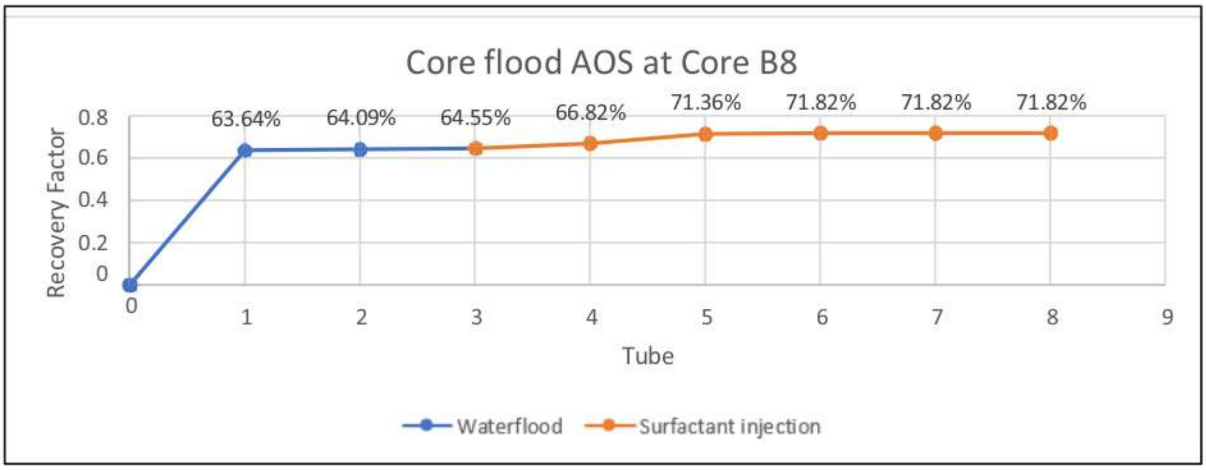

Figure. 4 Graph of RF Value at 1% AOS Surfactant 7,000 ppm Salinity.

In Fig.4 there are documented results of oil recovery during the Core Flooding process where tubes 1-3 from the left are the water flooding process. while tubes 5-8 to the right are the injection of AOS surfactant 1% salinity 7,000 ppm.

4. Conclusion

1. The result of the research that has been done, is evident that with the addition of temperature from 30 to 80°C, the value of density, specific gravity, and viscosity has decreased.
2. In the phase passing test for seven days, AOS surfactant with 1% concentration is close to the middle phase, so for the IFT test, 1% concentration AOS is taken.
3. The interfacial tension test, the IFT value of 1% AOS is 0.005565 dyne/cm.
4. In the water injection, 1.42 ml of oil was obtained with an RF gain of 64.55%.

5. In the surfactant injection, 0.56 ml of oil was produced with a recovery factor of 7.2727% .

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