International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 08 August 2024
DOI: 10.47191/ijcsrr/V7-i8-51, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

The Laboratory Test of AOS and ABS Surfactant at 60°C for EOR Process

Samsol[1], Syamsul Irham[1], Sigit Rahmawan[1], Asri Nugrahanti[1], Onnie Ridaliani[1], Kevin Endryan Nugroho[1], Nabilla Afzan Abdul Aziz[2]

[1]Petroleum Engineering Department, Universitas Trisakti, Jakarta, Indonesia
[2]Institute of Hydrocarbon Recovery, Universiti Teknologi PETRONAS, Malaysia

ABSTRACT

Background: By 2021, global oil demand is expected to rise by 5.3 million barrels per day (bopd), while oil output is anticipated to decrease gradually. The fall in oil production was attributed to a decline in reservoir pressure and a depletion of oil reserves in the field. Surfactants are employed as a technique in Enhanced Oil Recovery (EOR) to enhance the extraction of oil.

Objective: This study investigates two different forms of surfactant solutions, specifically AOS (alpha olefin sulfonate) and ABS (alkyl benzene sulfonate). The two surfactants were evaluated at five distinct concentration levels, specifically 5%, 6%, and 7%. Both have a salinity level of 7,000 parts per million (ppm). AOS and ABS were selected as research materials because to their capacity to decrease interfacial tension.

Method: A phase behavior test was conducted to assess the durability of the foam throughout a 21-day measurement period at a temperature of 60°C. In addition, the research also seeks to ascertain the efficacy of oil recovery from the surfactant solution under investigation.

Results: This study is a controlled experiment conducted in a laboratory setting to examine the effects of AOS and ABS surfactants on sandstone rocks. The AOS and ABS surfactant solution was prepared by combining AOS powder and 70% ABS surfactant liquid with brine containing a salinity concentration of 7,000 ppm. The research procedure comprises multiple stages, such as density testing and phase behavior testing.

Conclusion: Based on this study, it may be inferred that concentrations beyond 5% did not yield middle-phase emulsions. Nevertheless, the oil recovery rate escalated to 68% as a result of the water flooding injection test and ongoing surfactant injection.

KEYWORDS: Alpha Olefin Sulfonate, Alkyl Benzene Sulfonate, Interfacial Tension, Recovery Factor

INTRODUCTION

In 2021, global oil consumption experienced a growth of 5.3 million barrels (Meilanie, 2021), but oil production is expected to decline due to diminishing reservoir pressure and depleted oil reserves in the field (Kusumastuti et al., n.d.). In 2021, the average output of crude oil and condensate in Indonesia was 660 thousand barrels of oil per day (MBOPD) (Rita, 2012).

Surfactants contribute to the reduction of interfacial tension, resulting in the dissolution of oil and water at the contact zone between the two substances, and enhancing sweep efficiency (Setiati et al., 2022). Surfactant flooding, which was first used in the 1960s, has significantly improved the efficiency of oil recovery by reducing the tension between fluids, resulting in higher oil output and decreased water production (Damanik et al., 2018).

The study has multiple primary objectives. Firstly, ascertain the compatibility between AOS (Alpha Olefin Sulfonate) and ABS (Acrylonitrile Butadiene Styrene) surfactants. Additionally, ascertain the density, specific gravity, and phase behavior of both AOS and ABS surfactants in relation to crude oil having an API of 90. The objective of the phase behavior test, as described by Sheng (date not provided), is to ascertain the characteristics of the emulsion formed by the introduction of AOS and ABS surfactants into crude oil. The study involved doing laboratory tests such as density testing, phase behavior testing, and interfacial tension testing. The study performed density measurements to determine the density of AOS and ABS surfactant fluids (Pauhesti et al., 2018). Phase behavior testing is a crucial component of surfactant screening parameters in order to determine the most appropriate surfactant properties for usage as injection fluids. The creation of an emulsion during phase behavior testing is significantly influenced by temperature, type of surfactant, salinity of dissolved water, and concentration levels of surfactants and oil in the reservoir. Chemical injection with surfactants is a widely used enhanced oil recovery (EOR) technique. Surfactants are used as a fluid to decrease the interfacial tension between the injected fluid and oil (E. C. C. G. V. Y. T. F. Donaldson, 1985). The creation of a middle-phase

ISSN: 2581-8341

Volume 07 Issue 08 August 2024

DOI: 10.47191/ijcsrr/V7-i8-51, Impact Factor: 7.943

IJCSRR @ 2024

www.ijcsrr.org

microemulsion is crucial in order to choose the most appropriate surfactant for a specific oil reservoir. The surfactant's appropriateness becomes apparent when a stable microemulsion is formed at the interface of oil and water. The middle phase's behavior is influenced by temperature, salt level, and surfactant content. The microemulsion is formed during the intermediate phase, also known as the mixed phase, which represents the conditions where substances can mix together. On the other hand, the upper and lower phases represent the conditions where substances cannot mix together.

METHODOLOGY

The laboratory research process consists of multiple stages. Initially, the process involves the creation of synthetic formation water. Subsequently, the surfactant solution is meticulously produced. Precise data is obtained by density measurements. The subsequent step involves conducting a phase behavior test. In addition, measurements of interfacial tension and injection of surfactants are conducted.

The materials used in this study include AOS (alpha olefin sulfonate) and ABS (alkyl benzene sulfonate) surfactant solutions with concentrations of 5%, 6%, and 7% with a salinity of 7000 ppm, crude oil with an API of 39 ^{o}API.

The laboratory initiated a sequence of preparations and experiments, commencing with the creation of solutions, specifically brine and AOS and ABS surfactants. Subsequently, experiments were conducted to analyze the tangible characteristics of the solution, including its density and phase behavior at a temperature of 60°C. Subsequently, a suitable resolution was chosen to determine the nature of the emulsion and assess its stability over a period of twenty-one days. Density measurements were conducted on AOS and ABS surfactants at concentrations of 5%, 6%, and 7%. Subsequently, an aqueous stability test will be performed to assess the homogeneity of the solution. Subsequently, a phase behavior test was conducted to ascertain the nature of the phase present and assess the stability of the produced emulsion. The salinity of the brine or synthetic formation water utilized in this investigation is 7,000 parts per million (ppm). This is done to guarantee that the surfactants' efficacy in enhancing oil recovery from the model is unaffected. The process of creating brine involves dissolving 7 grammes of NaCl into 1000 cc of purified water. Then agitated with a mixer. The oil utilized is a low-density oil with an API rating of 39 ^{o}API.

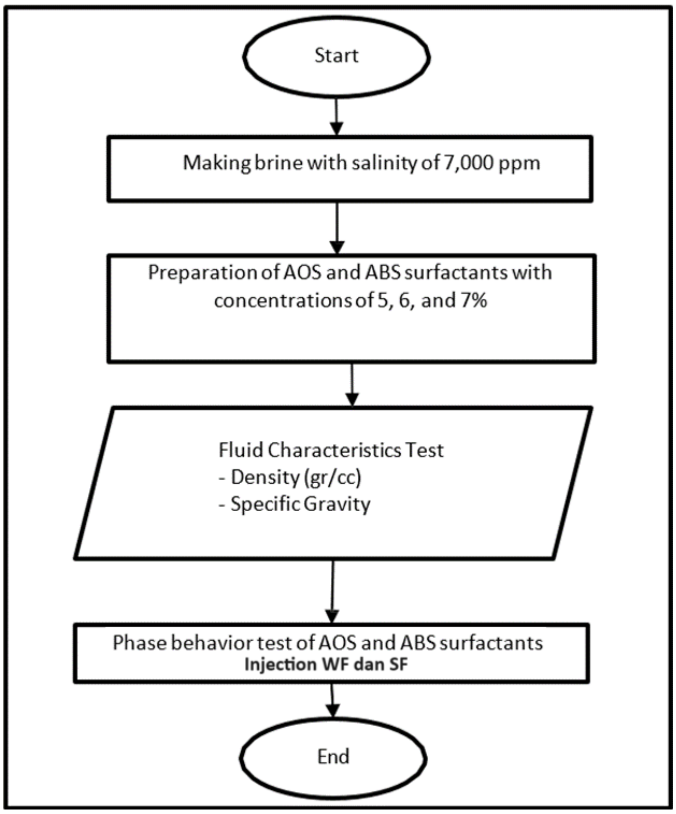

Figure 1. Flow Chart

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 08 August 2024
DOI: 10.47191/ijcsrr/V7-i8-51, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Measurement of fluid density and specific gravity is carried out using a tool called a Density meter. In this study, phase behavior testing was carried out for 21 days to determine the acquisition of a stable emulsion against Crude Oil (Suparmanto et al., 2023).

RESULTS AND DISCUSSION

In the study entitled " The laboratory test of AOS and ABS Surfactant at 60oC for EOR process". There is research results conducted in the Enhanced Oil Recovery laboratory of Petroleum Engineering, Trisakti University

The first step involves creating synthetic formation water or brine with a salinity of 7,000ppm. This is achieved by combining Sodium Chloride (NaCl) powder with distilled water. The brine functions as a solvent for AOS surfactants, whereas ABS acts as a solute. The physical features of these two surfactants, specifically their density and phase behaviour, will be compared.

A. Density

In density testing using a Densitometer, information about the density and Specific Gravity of AOS and ABS Surfactant solutions can be obtained. This process is carried out at a temperature of 60 0C (Torsaeter & Abtahi, 2003). In this test, the tool used is the density meter DMA 4100M, which has the ability to determine the density and Specific Gravity of AOS and ABS Surfactant solutions. As with the previous use of the densitometer, it was carried out at a temperature of 60 oC.

Table 1. Density and Specific Gravity of ABS Surfactants at Temperature 60 ^{0}C

Sampel of Surfactant	Surfactant concentration (%)	Temperature (deg C)	Density (gr/cc)	Specific Gravity
AOS	5	60	0,9944	1,0114
	6	60	0,9959	1,0130
	7	60	0,9964	1,0134
ABS	5	60	0,9872	1,0041
	6	60	0,9874	1,0042
	7	60	0,9876	1,0043

The following are the results of density and specific gravity measurements of brine and crude oil at a temperature of 60 0C

Table 2. Density and Specific Gravity of oil and brine

Sample		Temperature (°C)	°API	Density (gr/cc)	SG
Crude oil		60	39	0,827	0,8299
Brine	7000 ppm	60	-	0,9483	0,9753

In table 2 above, the results of the density readings of crude oil and brine with a salinity of 7000 ppm at a temperature of 60 oC are obtained. In crude oil, the density obtained is 0.827 gr/cc, the SG value is 0.8299 and the API degree is 39 oAPI. In brine with a salinity of 7000 ppm, the density obtained is 0.9956 gr/cc and the SG value is 1.0031.

B. Phase Behavior Test

A Phase Behavior Test was performed to examine the phase behavior between Crude oil 39 0API and surfactants Alkyl Benzene Sulfonate and Methyl Ester Sulfonate. The experiment was carried out by utilizing a 5 ml measuring tube for a duration of twenty-one days, while subjecting it to a temperature of 60°C within an oven. The results of the Phase behavior of ABS surfactants can be found in Table 3 below. Phase behavior of Rantau crude oil was assessed at a temperature of 60°C, using concentrations of 5%, 6%, and 7%, together with a salinity level of 7,000 ppm. To perform the phase behavior test of crude oil with AOS surfactants, combine 2 ml of crude oil with 2 ml of AOS and ABS surfactants in a tube. Shake the tube vigorously for 2 minutes to create an emulsion. Subsequently, it was subjected to an oven at a precise temperature of 60°C for a duration of 504 hours. The data graph illustrating the emulsion yield on MES surfactant versus Crude oil 39 0 API oil may be observed in the results of the phase behavior analysis of AOS and ABS surfactants, as depicted in Figure 2 below.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 08 August 2024
DOI: 10.47191/ijcsrr/V7-i8-51, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Table 3. Phase behavior test of ABS Surfactant.

Types of Surfactants	Concentration (%)	Phase	Volume at Observation Time (hours)									Total of Emulsion (%)	Types of Emulsion Phase
			0	**0,5**	**1**	**2**	**24**	**48**	**168**	**336**	**504**		
Alpha Olefin Sulfonate	5	crude	0	0,1	1,5	1,5	1,9	1,93	1,98	2	2	1,25%	down
		emulsion	**3,5**	**2,1**	**0,6**	**0,6**	**0,2**	**0,12**	**0,07**	**0,05**	**0,05**		
		surfactant	0,5	1,8	1,9	1,9	1,9	1,95	1,95	1,95	1,95		
	6	crude	0	0,1	0,5	1,5	1,6	1,8	1,9	1,95	1,95	1,25%	up
		emulsion	**3,35**	**1,95**	**1,5**	**0,5**	**0,4**	**0,2**	**0,1**	**0,05**	**0,05**		
		surfactant	0,65	1,95	2	2	2	2	2	2	2		
	7	crude	0	0,1	0,3	0,5	0,7	1,8	1,84	2	2	0,00%	-
		emulsion	**3,6**	**1,95**	**1,75**	**1,55**	**1,35**	**0,25**	**0,16**	**0**	**0**		
		surfactant	0,4	1,95	1,95	1,95	1,95	1,95	2	2	2		
Alkyl Benzene Sulfonate	5	crude	0,1	0,3	0,6	0,65	0,65	0,8	1,17	1,2	1,2	20,00%	Up
		emulsion	**1,9**	**1,7**	**1,4**	**1,35**	**1,35**	**1,2**	**0,83**	**0,8**	**0,8**		
		surfactant	2	2	2	2	2	2	2	2	2		
	6	crude	0	0,8	0,85	0,9	1	1,1	1,45	1,85	1,85	3,75%	Up
		emulsion	**2**	**1,2**	**1,15**	**1,1**	**1**	**0,9**	**0,55**	**0,15**	**0,15**		
		surfactant	2	2	2	2	2	2	2	2	2		
	7	crude	0	1,1	1,1	1,15	1,4	1,5	1,57	1,8	1,8	5,00%	Up
		emulsion	**2**	**0,9**	**0,9**	**0,85**	**0,6**	**0,5**	**0,43**	**0,2**	**0,2**		
		surfactant	2	2	2	2	2	2	2	2	2		

In the measurement of phase behavior at a temperature of 60 °C in crude oil, the value is 39 oAPI with AOS and ABS with concentrations of 5, 6, and 7% with a salinity of 7000ppm. When conducting the phase behavior of crude oil with AOS surfactant. Observe the emulsion yield for 3 weeks or 21 days from each AOS and ABS surfactant, where the emulsion yield on the twenty-first day is 0.5; 0.5, and 0 ml, respectively. So that the total emulsion of AOS 5%, 6%, and 7% with a salinity of 7000ppm is 1.25; 1.25; and 0% with the type of upper phase emulsion or Winsor 2 on AOS surfactant concentration of 6%. In the measurement of phase behavior at a temperature of 60 °C in crude oil, the value is 39 oAPI with ABS 5, 6, and 7% with salinity 7000ppm. When conducting the crude oil phase behavior with ABS surfactant. There was an emulsion gain on the twenty-first day of 0.8; 0.15; and 0.2 ml respectively. So that the total emulsion of ABS 5, 6, and 7% with a salinity of 7000ppm was 20.00; 3.75; and 5.00% with the type of upper phase emulsion or Winsor 2. The results of the phase behavior of AOS and ABS surfactants at a temperature of 60 °C are shown in Table 3.

In Table 3 Measurement of phase behavior at a temperature of 60 °C in crude oil is worth 39 oAPI with ABS 5%, 6%, and 7% with a salinity of 7000ppm. A stable AOS surfactant was obtained at a concentration of 6% with an emulsion yield of 1.25% and the type of upper fluid phase. This can be seen in Figure IV.2 related to the graph of the yield of AOS surfactant, emulsion, and crude oil at a concentration of 6% AOS surfactant. While in ABS surfactant, a stable emulsion yield was obtained at a concentration of 5% with an emulsion yield of 20% and the type of upper fluid phase.

In Table 3 it can be seen that AOS surfactant with a concentration of 6% obtained a high emulsion content of around 1.25% with the upper phase. Based on this, the most appropriate concentration can be determined compared to other concentrations tested in this study, especially to reduce interfacial tension. The results of this study are illustrated in Figure 3.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 08 August 2024
DOI: 10.47191/ijcsrr/V7-i8-51, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

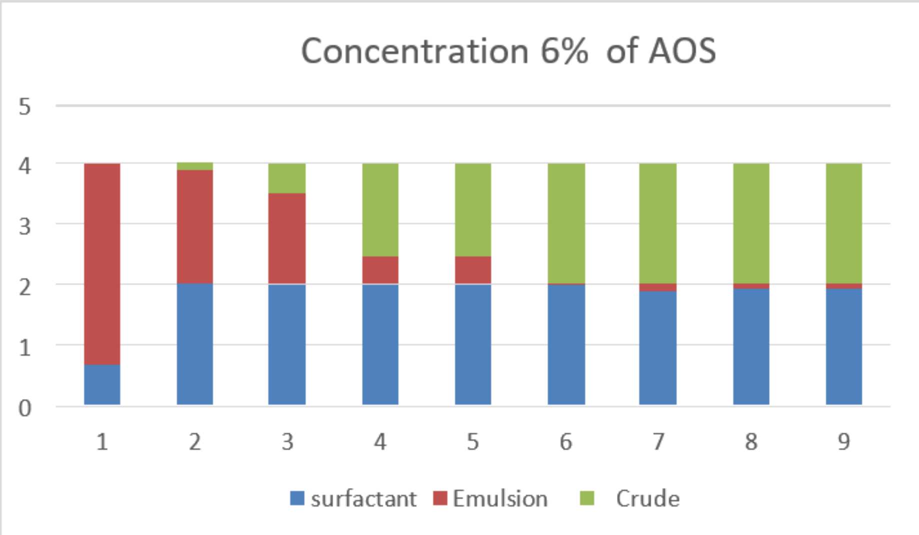

Figure 2. Graph of the results of the phase behavior test on AOS surfactant with a concentration of 6%

Table 3 shows that ABS surfactant with a concentration of 5% obtained a high emulsion content of around 20%. Based on this, the most appropriate concentration can be determined compared to other concentrations tested in this study, especially to reduce interfacial tension. The results of this study are illustrated in Figure 3.

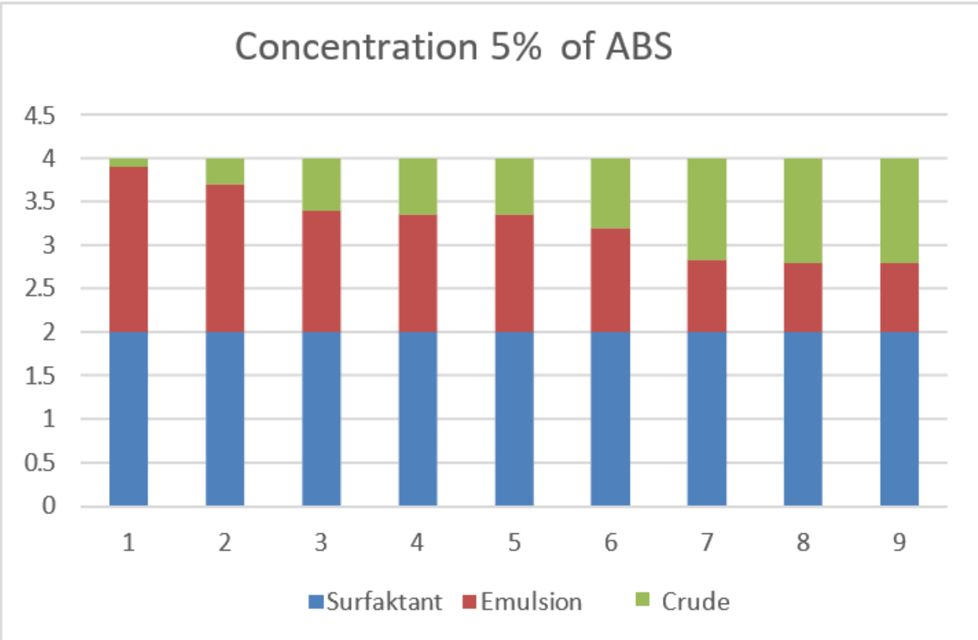

Figure 3. Graph of the results of phase behavior test results for ABS surfactant at 5% concentration.

Subsequently, the injection procedure is conducted utilizing sandstone rocks obtained from the Berea core. The injection test commences with the introduction of water, followed by the subsequent injection of a surfactant. After evaluating the outcomes of the previous surfactant test, a 5% AOS surfactant was chosen. The water flooding injection test yielded a 46% oil recovery, followed by the injection of AOS surfactant, which resulted in a 22% recovery. The combined oil recovery resulting from these two injections amounted to 68%.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 08 August 2024
DOI: 10.47191/ijcsrr/V7-i8-51, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

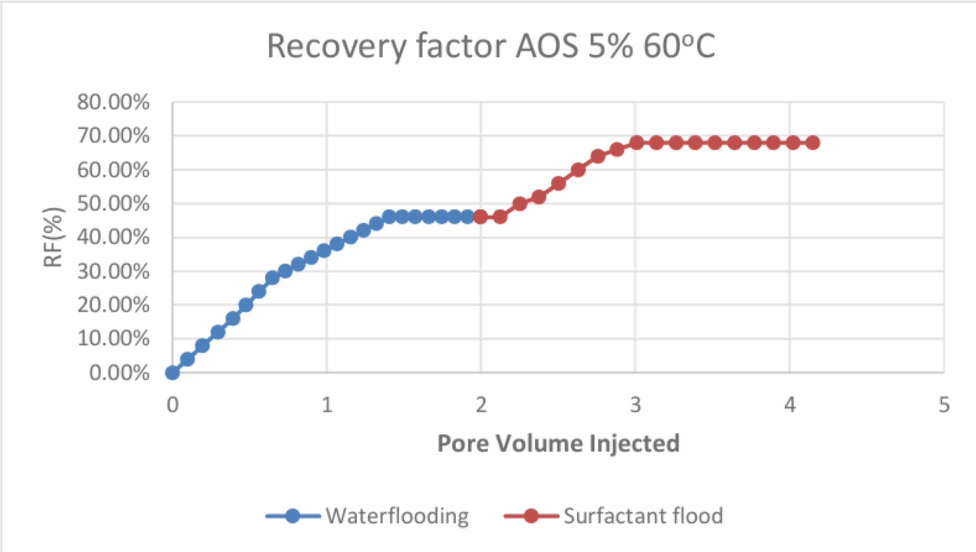

Figure 4. Results of oil recovery with water injection and 5% AOS surfactant

CONCLUSION

The investigation yielded the following conclusions.

1. At a temperature of 60 0C, density measurements were obtained for AOS (alpha olefin sulfonate) with concentration variations of 5, 6, and 7%, obtained 0.9944; 0.9959; and 0.9964 gr/cc.
2. At a temperature of 60 0C, density measurements were obtained for ABS (alkyl benzene sulfonate) with concentration variations of 5, 6, and 7%, obtained 0.9872; 0.9874; and 0.9876.
3. In the Phase Behavior test of AOS (alpha olefin sulfonate) surfactants at a temperature of 600C, more stable results were obtained at a concentration of 6% with an emulsion yield of 1.25% with the type of upper phase emulsion.
4. In the Phase Behavior test of ABS (alkyl benzene sulfonate) surfactants at a temperature of 600C, more stable results were obtained at a concentration of 5% with an emulsion yield of 20% with the type of upper phase emulsion.
5. Emulsion results were not produced when concentrations exceeded 5%. Nevertheless, the oil recovery increased by 68% as a result of the water flooding injection test followed by surfactant injection.

REFERENCES

1. Bera, A., & Mandal, A. (2015). Microemulsions: a novel approach to enhanced oil recovery: a review. In Journal of Petroleum Exploration and Production Technology. https://doi.org/10.1007/s13202-014-0139-5
2. Damanik, M., Kasmungin, S., Sudibjo, R., Magister,), Perminyakan, T., & Trisakti, U. (2018). Study Peningkatan Oil Recovery Pada Injeksi Surfaktan-Polimer Pada Batuan Karbonat. In Jurnal Penelitian dan Karya Ilmiah Lembaga Penelitian Universitas Trisakti (Vol. 3, Issue 1).
3. Donaldson, E. C. C. G. V. Y. T. F. (1985). Enhanced Oil Recovery: Fundamentals and analysis (E. C. Donaldson, G. V Chilingarian, & T. F. Yen, Eds.; 1st ed., Vol. 17). Elsevier, 1985.
4. Kusumastuti, I., Erfando, T., & Hidayat, F. (n.d.). Effects of Various Steam Flooding Injection Patterns and Steam Quality on Oil Recovery Factor. In Kusumastuti (Vol. 8, Issue 1).
5. Marques, E. F., & Silva, B. F. B. (2013). Surfactants, Phase Behavior. In Encyclopedia of Colloid and Interface Science (pp. 1290–1333). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-20665-8_170
6. Meilanie, A. S. (2021). Analisis Kinerja Surfaktan Aos (Alpha Olefin. 10).