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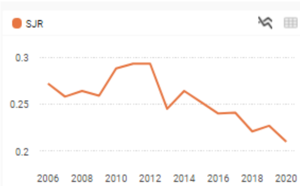

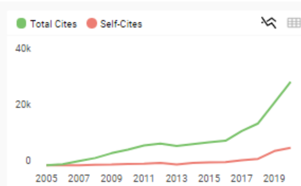

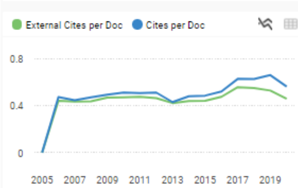

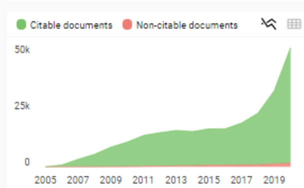

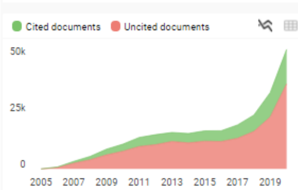

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The alternative solutions of bagasse to improve Indonesian oil production in low salinity

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The alternative solutions of bagasse to improve Indonesian oil production in low salinity

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Abstract. Indonesia is one of the largest sugarcane producing countries in the world. At present, the use of bagasse is only as compost, electricity generation, etc. In the oil industry, bagasse can use as a base material in making surfactants that function as fluid reservoir oil injection to improve oil recovery factors, so it is good to develop a type of plant-based local surfactant with a lot of raw materials in Indonesia. The purpose of this study was to see that bagasse can increase the oil recovery factor at low salinity. The methods used is a laboratory study using a concentration of 1%; 1.5%; 2%; 2.5% and 3% NaLS and salinity of 4000 ppm, 5000 ppm, and 15000 ppm NaCl. The Surfactant first conducted a compatibility test then core flooding was carried out to obtain the recovery factor value. The results obtained were surfactants with variations of 1.5% 4000 ppm; 1.0% 15000 ppm; and 1.5% 15000 ppm which passes the compatibility test with the recovery factor value sequentially is 3.24%; 3.62%; and 5.34%. It shows that NaLS surfactant can increase the oil recovery factor at low salinity by 5.34% by optimizing 1.5% NaLS 15000 ppm concentration.

1. Introduction

Oil production targets in Indonesia are increasing year by year, for example in 2022 according to the Special Task Force for Upstream Oil and Gas Business Activities, the national oil production target reaches 1 Million Barrels / Day. Whereas public consumption reaches 1.6 Million Barrels / Day. So from that, the strategy to achieve the production target of 1 Million BOPD is to conduct new field exploration and conduct enhanced oil recovery (EOR) [1].

One of the EOR methods is the injection of surfactant [2-4]. During this type of surfactant used is petroleum sulfonate. The falling price of crude oil has caused the operating cost to be more expensive and has an impact on the high price of petroleum sulfonate surfactants. Another alternative that can use is the type of surfactant with plant-based ingredients which mostly found in Indonesia.

According to food trade, Indonesia is one of the largest sugar producing countries in the world. Currently, the use of bagasse is only as compost, animal feed, electricity generation and as a material for paper [5]. But through the process of hydrolysis and sulfonation, the bagasse can be used as a surfactant that functions as a fluid reservoir oil injection at low salinity to improve recovery factor [6-10], So it is good to develop a type of local surfactant, made from plant-based materials with a source of raw materials that are widely available in Indonesia.

The purpose of this study was to see that bagasse can increase the oil recovery factor at low salinity.

2. Methods

The design of this study is analytic research and experimental research which both functions to find out the causal relationship between two operational variables, differences, relationships, and researcher intervention. The researcher will intervene on source data such as concentration and salinity used. Thus, the researchers used their relationship to obtain optimal results [11].

This research used a laboratory study with reservoir conditions. The concentration of NaLS Bagasse surfactant used is 1%; 1.5%; 2%; 2.5% and 3% NaLS and salinity used were 4000 ppm, 5000 ppm, and 15000 ppm NaCl. The surfactant solution will be measured at 60oC. During core flooding, the type of rock used is sandstone and the type of oil used is light oil.

Figure 1 shows the workflow of the study starting with the laboratory set up, the preparation of the surfactant solution; then the surfactant was first conducted a compatibility test, then the core flooding was carried out to obtain the recovery factor value.

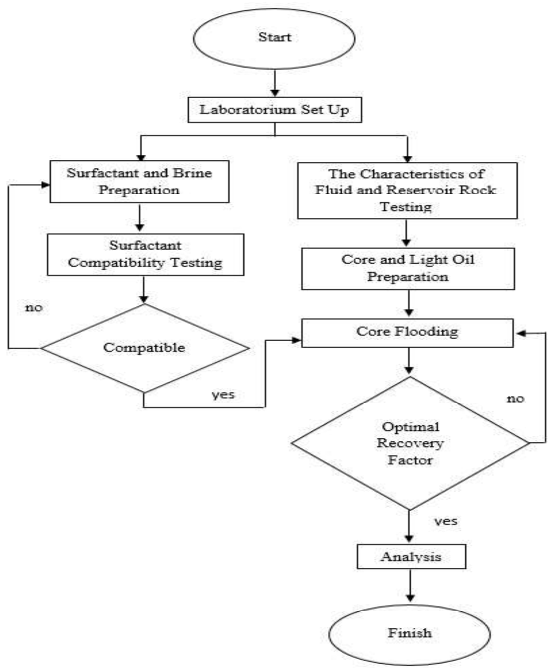

Figure 1. Flowchart of research work.

Surfactant compatibility screening or testing includes aqueous stability test, phase behavior test, thermal stability test, interfacial tension test. The Aqueous stability test aims to determine whether the surfactant solution compatible the formation of water from a reservoir [12]. Aqueous stability is done by dissolving surfactant in formation water for 48 hours of observation in a 60°C oven.

The behavior test phase aims to determine the exact salinity and type of emulsion that can mix with crude oil [13] to be able to reduce interface tension or to study the behavior of a mixture of hydrocarbons, salinity and surfactant systems at the desired temperature [14-16]. Thermal stability test and interfacial tension test aim to determine the resistance of the surfactant to heat and to see trends in changes in IFT values that occur during heating [17].

3. Results and discussion

Table 1 shows the results of screening tests or compatibility of various surfactant solutions showing that three solutions passed the test, with variations of 1.5% 4000 ppm with code CF 1; 1% 15000 ppm with code CF 5; and 1.5% 15000 ppm with code CF 7. Aqueous Stability testing shows that the surfactant solution with code CF 1, CF 5, CF 7 is compatible with formation water which is characterized by the solution remaining clear during the test of 504 hours. The higher the salinity and concentration, the more likely it is to form colloids and suspensions along with the length of time observed.

As a result of the Phase Behaviour Test, the best emulsion is the middle phase emulation that represents the miscible pressure conditions. From the results of the Thermal test and IFT which produce the lowest value is the CF code 7. The best surfactant must meet the requirements of one of the low IFTs. Requirements include good oil emulsion capability, thermal stability, and low cost [18,19]

Table 1. Screening results or surfactant compatibility.

Code	Concentration (%)	Salinity (ppm)	Aqueous Stability Test	Phase Behavior Test			Thermal Stability Test	IFT (mN/m)
				Emulsion type	Emulsion Stability, hour	emulsion (%)		
CF 1	1.5	4000	transparent	middle phase	336	28.8	stable	2.44
CF 5	1	15000	transparent	middle phase	336	8.75	stable	2.93
CF 7	1.5	15000	transparent	middle phase	48	3.75	stable	2.11

Table 2 and Figure 2 are summaries of the results of core flooding, where the objective is to obtain the value of the recovery factor from surfactant injection. In the CF 1 code, the recovery factor (RF) is 3.24% with a total recovery of 30.61%. While for CF 5, the RF price is 3.62% with a total RF of 39.87%; and also for CF 7, the RF is 5.34% with a total RF of 42.7%.

The highest RF price is in the composition of 15000 ppm NaCl 1.5% NaLS with code CF 7. It's influenced by the IFT value which is the lowest value of another composition which proves true that the smallest IFT value can increase the recovery factor [20] and it can see that the stability of the CF 7 emulsion has begun to stabilize at 48 hours, faster than the other two compositions. It shows that faster stable emulsions produce greater performance so that the recovery factor is greater. Better emulsification with a lower index of instability [18]. The instability index is a qualitative relationship with interface tension and recovery factors.

The biggest emulsion formed in the composition of 4000 ppm NaCl 1.5% NaLS with code CF 1, but the value of the recovery factor is the smallest when compared to the other two compositions. It shows that the emulsion that is too large can inhibit the pushing process due to the occurrence of plugging [16]. The optimization of the recovery factor shown by increasing salinity and surfactant concentration, so the recovery factor also increases.

Table 2. Core flooding results.

Code	Primary			Secondary		Tertiary		Recovery Factor	
	OOIP (ml)	so (%)	Swir (%)	RF (%)	Sowf (%)	RF (%)	Sosf (%)	Total Rf (%)	RR (%)
CF 1	1.9	50.39	49.61	27.37	36.60	3.24	34.96	30.61	69.39
CF 5	2.4	64.80	35.20	36.25	41.31	3.62	38.96	39.87	60.13
CF 7	1.9	52.04	47.96	37.37	32.59	5.34	29.82	42.71	57.29

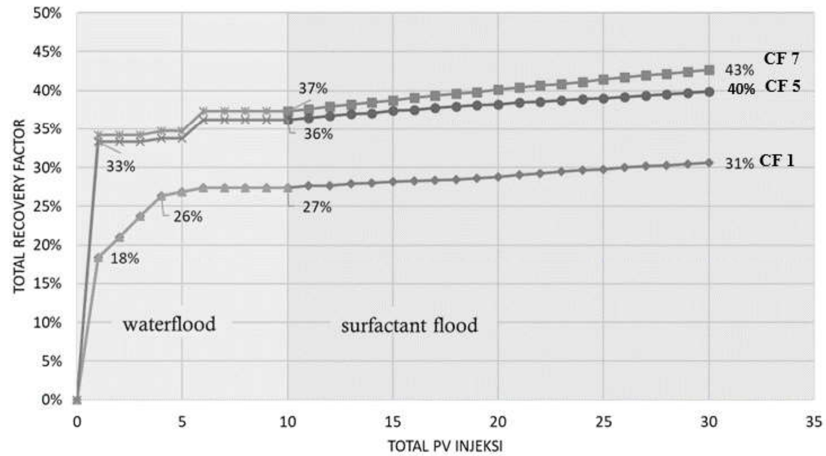

Figure 2. Recovery factor.

Figure 2 shows an increase in the total injection factor of the three compositions where it can see that the comparison of the recovery factors for CF 1, CF 5 and CF 7 which produced the highest injection factor for surfactant was CF 7 with a composition of 1.5% NaLS 15000 ppm NaCl.

4. Conclusions

Bagasse can be used as an injection liquid to increase oil production at low salinity by optimizing the composition of 1.5% NaLS 15000 ppm NaCl. The efficiency of the recovery factor is not the result of a single factor but is a representation of multi-factor surfactants, such as lower IFT and better emulsification so that it can cause a greater recovery factor.

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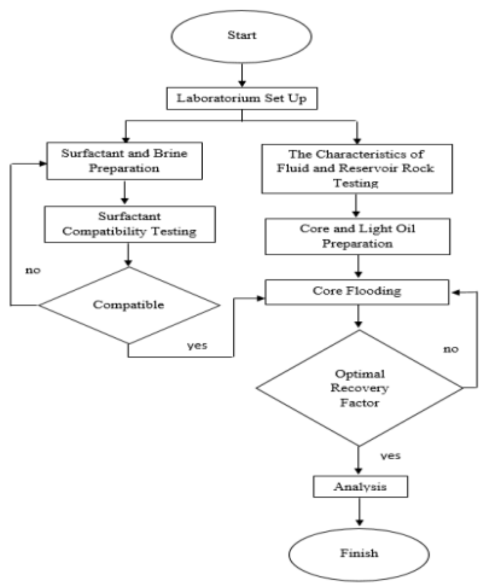

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CF 7	1.5	15000	transparent	middle phase	48	3.75	stable	2.11

Table 2 and Figure 2 are summaries of the results of core flooding, where the objective is to obtain the value of the recovery factor from surfactant injection. In the CF 1 code, the recovery factor (RF) is 3.24% with a total recovery of 30.61%. While for CF 5, the RF price is 3.62% with a total RF of 39.87%; and also for CF 7, the RF is 5.34% with a total RF of 42.7%.

The highest RF price is in the composition of 15000 ppm NaCl 1.5% NaLS with code CF 7. It's influenced by the IFT value which is the lowest value of another composition which proves true that the smallest IFT value can increase the recovery factor [20] and it can see that the stability of the CF 7 emulsion has begun to stabilize at 48 hours, faster than the other two compositions. It shows that faster stable emulsions produce greater performance so that the recovery factor is greater. Better emulsification with a lower index of instability [18]. The instability index is a qualitative relationship with interface tension and recovery factors.

The biggest emulsion formed in the composition of 4000 ppm NaCl 1.5% NaLS with code CF 1, but the value of the recovery factor is the smallest when compared to the other two compositions. It shows that the emulsion that is too large can inhibit the pushing process due to the occurrence of plugging [16]. The optimization of the recovery factor shown by increasing salinity and surfactant concentration, so the recovery factor also increases.

Table 2. Core flooding results.

Code	Primary			Secondary		Tertiary		Recovery Factor	
	OOIP (ml)	so (%)	Swir (%)	RF (%)	Sowf (%)	RF (%)	Sosf (%)	Total Rf (%)	RR (%)
CF 1	1.9	50.39	49.61	27.37	36.60	3.24	34.96	30.61	69.39
CF 5	2.4	64.80	35.20	36.25	41.31	3.62	38.96	39.87	60.13
CF 7	1.9	52.04	47.96	37.37	32.59	5.34	29.82	42.71	57.29

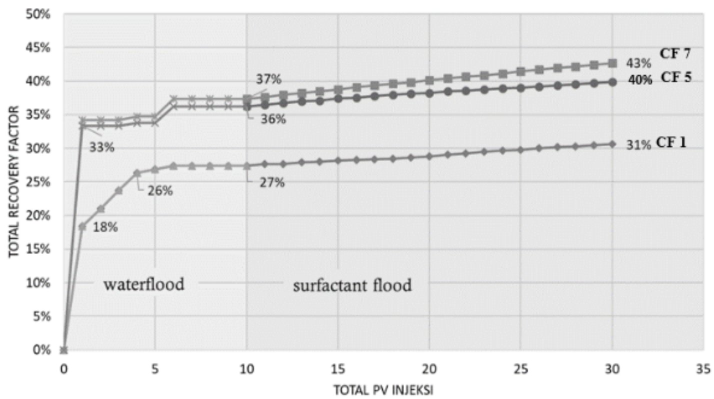

Figure 2. Recovery factor.

Figure 2 shows an increase in the total injection factor of the three compositions where it can see that the comparison of the recovery factors for CF 1, CF 5 and CF 7 which produced the highest injection factor for surfactant was CF 7 with a composition of 1.5% NaLS 15000 ppm NaCl.

4. Conclusions

Bagasse can be used as an injection liquid to increase oil production at low salinity by optimizing the composition of 1.5% NaLS 15000 ppm NaCl. The efficiency of the recovery factor is not the result of a single factor but is a representation of multi-factor surfactants, such as lower IFT and better emulsification so that it can cause a greater recovery factor.

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