Application of bio-surfactants as an effort to enhanced oil recovery (EOR) in Kawengan oil field

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Abstract. Kawengan Field has reached the peak of its production and currently is being developed an Enhanced Oil Recovery (EOR). In this research bio-surfactants will be used as substance that will be injected into reservoir. Bio-surfactants are as surfactant from microorganisms and can work to reduce interfacial tension (IFT) so that it can be applied in EOR. The other advantages of bio-surfactant are being able to reduce oil viscosity in reservoir temperatures, higher biodegradation rates and low toxicity. This research used Kawengan Field oil samples before and after being given bio-surfactants. In laboratory test, the viscosity and IFT will be measured. Viscosity shows the phase changes and IFT shows bio-surfactants can reduce IFT between water and oil.The aim of this research is to provide an overview of the application of bio-surfactants as a good and viable alternative to expensive chemical surfactants in increasing oil recovery. The addition of bio-surfactants can reduce oil viscosity from from 2,7 cp at 30°C to 0,37 cp at 80°C and IFT 3,91 at 2,5% bio-surfactants concentration.

Keywords: Bio-surfactant, EOR, IFT.

INTRODUCTION

Until now, petroleum is still the main energy source and its needs continue to increase. Most petroleum reserves in producer countries is decreasing. Therefore, there needs to be an effort to increase the acquisition of petroleum by using technology that is often called *Enhanced Oil Recovery* (EOR). This method is done by injecting some material into the reservoir that can increase the recovery factor until 40-45% [1].

This study focuses on the application of bio-surfactants to oil fields. Where is now the EOR technology developement leads to biotechnology that is more environmentally friendly or often called as *Microbial Enhanced Oil Recovery* (MEOR) [2].

Bioproduct injection is the most effective technique in Microbial Enhanced Oil Recovery (MEOR), one example of bioproduct injection is bio-surfactants. Bio-surfactants use to reduce interfacial tension between oil and water and can mobilize trapped oil in rock by increasing the number of capillaries [3].

In this study, probability the surfactant injection using bio-surfactants considered with laboratory test involve the viscosity and IFT measurements. The measurement is doing to the oil sample before and after injected with bio-surfactants.

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Bio-surfactants

Bio-surfactants are surfactants synthesized by microorganisms, especially if they are grown on substrates that are not soluble in water. Unlike oil-based surfactants which are classified according to their natural polar group, bio-surfactants are categorized according to their chemical structure and producing bacteria. In general, the bio-surfactants chemical structure consists of hydrophilic groups containing amino acids or anions and cations of peptides, mono-, di-, or polysaccharides; and hydrophobic groups containing saturated and unsaturated fatty acids.

Based on its molecular size, bio-surfactants can be divided into bio-surfactants with low molecular weight and high molecular weight. Glycolipids such as rhamnosa and sophorolipid, and lipopeptides such as surfactin and polymyxin are low molecular weight bio-surfactants, which function to reduce surface tension and tension between surfaces.

While high molecular weight bio-surfactants such as lipoproteins, lipopolysaccharides, and amphipatic polysaccharides are very effective for stabilizing oil emulsions in water. Based on its chemical structure, bio-surfactants are classified as glycolipids; lipopeptide or lipoprotein; fatty acids, phospholipids, polymeric bio-surfactants; and particulate bio-surfactants.

METHODOLOGY

This study is doing at Enhanced Oil Recovery Laboratory in Universitas Pembanguan Nasional "Veteran" Yogyakarta. The product used in this study is Biosurfactant. Biosurfactant obtainet from Laboratory test for environmental, chemical and biotechnology. Oil sample that use in the viscosity and IFT measurement obtained from Cepu field from well KW-55. With the addition of biosurfactant 1%, 2.5%, 5%, 10%.

Density and Viscosity Measurement

Crude oil density is measured using a pycnometer. Measurements were made at each concentration. Brookfield Viscometer was used for viscosity measurement. The procedure is put the solution into the silinder tube and put the silinder tube into the Spindel. Spindel ULA was used for this measurement. When the tube and spindel is installed put the parameter into the console and the measurement can be started. Do the measurement in several temperature to test the durability of the biosurfactant resistant to the temperature. In this study the measure temperature is 30-60^{o}C. After Viscosity Measurement, the same sample.

Interfacial Tension (IFT) Measurement

Spinning drop tensioner was used for IFT measurement. The procedure is to measure the contact angle between 2 liquid phase, in this measurement is oil and water. Where $\pm$10-20 µL of oil sample is injected into $\pm$2 ml of formation water in the capillary tube. An image is aquired and analyzed by the associated software in the computer and the contact angle is measure to get the IFT value. Do the measurement in temperature range between 30-80 ^{o}C.

Material

In the viscosity and IFT measurement in every product from Biosurfactant, some material is needed. And there some material that use in this study:

Oil and Formation water sample

Crude oil sample obtained from Cepu field from well KW-55 and formation water obtained from the same well with the oil sample.

TABLE 1. Crude Oil Characteristic KW-55

No	Oil Sample	Biochem Volume	Empty Pigno weight	Empty Pigno weight	Density		Viscosity	
		(ml)	(10 ml)	(10 ml)	gr/cc	Suhu (°C)	cp	Suhu (°C)
1	KW-55	0	15,530	24,2017	0,8672	60	3,88	30,4

RESULT AND DISCUSSION

Density and Viscosity Measurement

KW-55 Oil Density continues to increase with the addition of bio-surfactants concentration. Bio-surfactants injection into the medium oil sample from cepu field is not too influental, where is the bio-surfactants use to reduce the viscosity, but not too significant, because the viscosity in mediun oil sample is already low, and allow oil to flow.

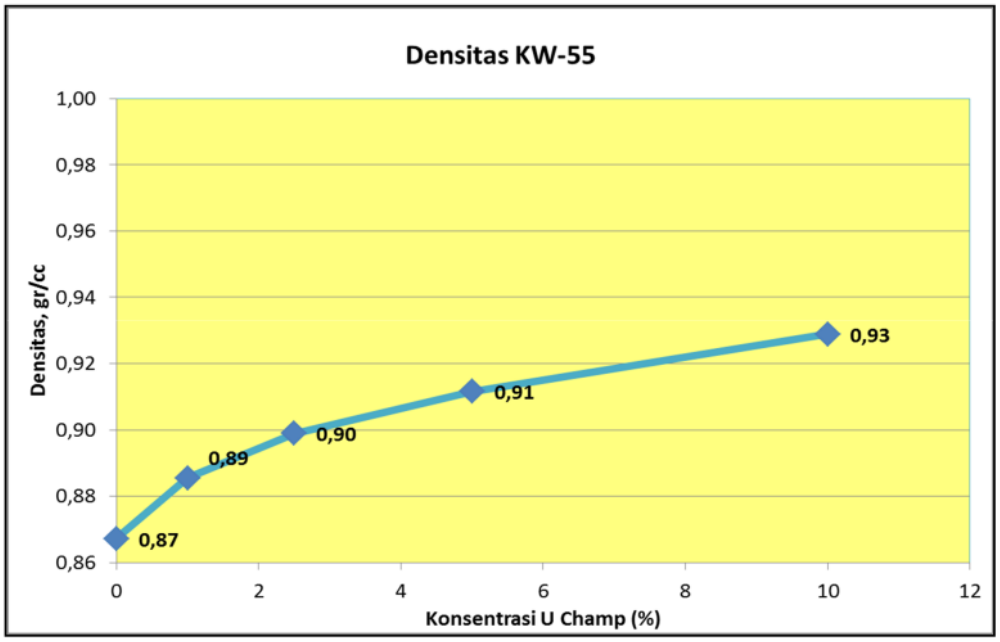

FIGURE 1. Plot Density Vs Temperature Plot

Oil viscosity (μo) defined as oil resistance to flow and shear. Unit of viscosity is centipoises (cp) or gr/100 s/1cm. There is some several factor that affect the oil viscosity: That is, temperature, where is the higher temperature, the smaller viscosity of oil.

The second is Pressure, where is the higher pressure, the higher viscosity because the higher pressure will decrease the oil mobility. And oil composition, more complexity of oil composition affect the higher of oil viscosity.

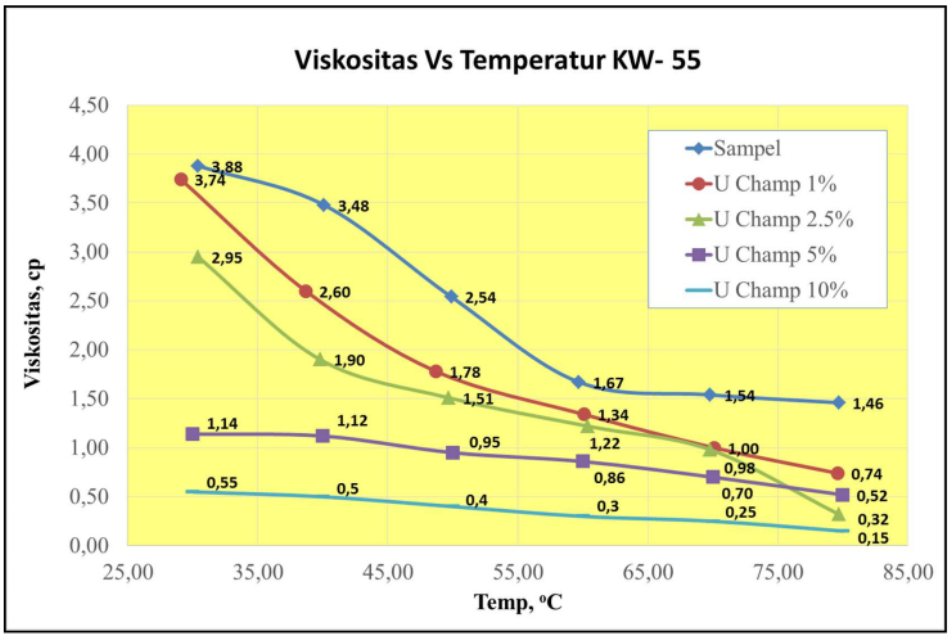

FIGURE 2. Plot Viscosity Vs Temperature Plot

From oil sample that obtained from well KW-55, made some oil solution (oil sample, oil sample + 5% biosurfactant, and oil sample + 10% biosurfactant) that measure with viscometer. Viscosity measurement is doing at temperature 30-80°C. Solution with 5% biosurfactant reduce the viscosity from 2,7cp pada 30°C to 0,367 cp at 80°C. Solution with 10% biosurfactant reduce viscosity below 10 cp at the temperature that higer than 80°C.

Interfacial Tension (IFT) Measurement

Bio-surfactants can decrease Interfacial Tension (IFT) between oil and formation water. In the case of K-55 samples the concentration that produces the lowest IFT is at a concentration of 2.5%.(**FIGURE 3**.)

CONCLUSION AND RECOMMENDATION

1. The addition of biosurfactant product into the medium oil sample is not too influented, where is the bio-surfactants use to reduce the viscosity, but not too significant.
2. Viscosity measurement is doing in temperature 30-80oC. Solution with 5% bio-surfactants can reduce viscosity from 2,7 cp at 30oC to 0,37 cp at 80oC.
3. With the viscosity reduction can affect the flow of oil and can increase the recovery factor of oil from reservoir.
4. The higher temperature affect the lower viscosity of oil.

Recommendation

1. It is recommended to conduct further studies to prove that the addition of biosurfactant is the economical way to enhance the recovery of oil.

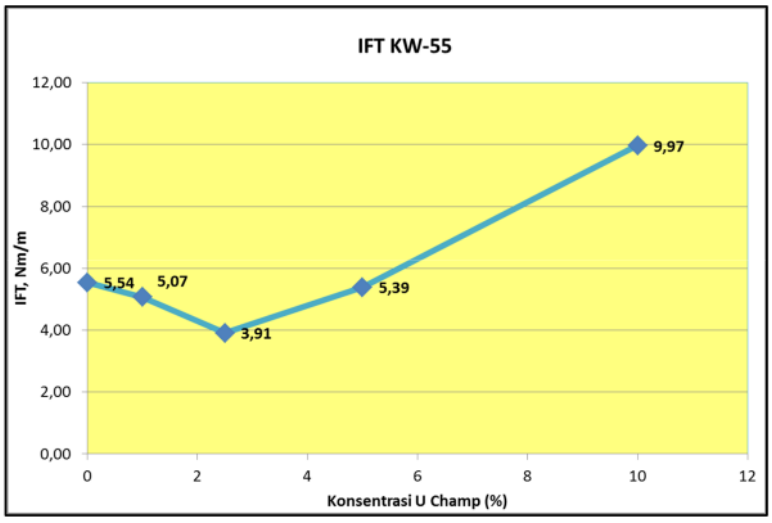

FIGURE 3. Plot IFT Vs Temperature Plot

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