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Experimental of alternative demulsifier formulation from corn oil in overcoming water–oil emulsion

Tomi Erfando *, Idham Khalid, Rizky Bahari

Department of Petroleum Engineering, Universitas Islam Riau, Kaharuddin Nasution 113, Pekanbaru 28284, Indonesia

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ABSTRACT

An emulsion is one of the problems that often occur in oil production activities. Emulsions happen when water is produced with oil. The presence of emulsions in crude oil makes it difficult for crude oil to be processed and the quality of the oil does not become good because it causes water to be contained in crude oil. An effort to overcome is to use a demulsifier. This study aims to test the demulsifier from corn oil. It will be processed with the saponification process to become a demulsifier. KOH and glycerin are used as additives in the saponification process. The substances found in corn oil are palmitic acid, linoleic acid, stearic acid, linolenic acid, and oleic acid. In the demulsification process used three various demulsifiers. There are commercial demulsifier (DK), green demulsifier 1 (DG1), green demulsifier 2 (DG2). Green demulsifier 1 and green demulsifier 2 are demulsifiers mixture by corn oil process, whereas the commercial demulsifier is chemical used to in the field. Demulsifier derived from corn oil are expected to have the ability to separate water from oil better than commercial demulsifiers. Demulsifier testing is done using the bottle test method. The test was carried out for 180 min and carried out observations every 30 min. The bottle test method was carried out using a water bath. Demulsifiers made from natural ingredients have better abilities than commercial demulsifiers. The best test results by the green demulsifier at 80 °C with a concentration of 5 ml separated 39 ml of water. While the commercial demulsifier with a concentration of 5 ml separates 32 ml of water. So demulsifier made from corn oil is more effective in separating water than commercial demulsifiers.

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1. Introduction

Oil produced from the wellhead will flow to the gathering station where in this process, several problems can occur. One of them is an emulsion in crude oil. Emulsions that occur cause oil to be difficult to process. A way to overcome the emulsion problem is to use commercial demulsifiers that are widely available in the market. Unfortunately, commercial demulsifiers still have weaknesses that have the potential to pollute the environment because of the chemicals they contain [1]. Then research will be conducted to determine the potential of natural ingredients as an alternative demulsifier. The natural material to be used is corn oil. Demulsifiers derived from natural ingredients are also known as the green demulsifier. Factors affecting the composition of emulsion in crude oil are the water–oil ratio, the presence of natural emulsifiers and secondary emulsion [2]. Efforts were made to overcome the emulsion in Nigeria by using local materials as a demulsifier formulation to break down the emulsion [3]. The study aimed to compare the formulation of demulsifiers with local materials and existing demulsifiers. Therefore, researchers also want to develop local materials available in Indonesia as demulsifier ingredients.

Environmental friendly demulsifier formulations will be developed to optimize oil production. This formulation must contain fewer poisons and have the same efficiency as demulsifiers made using chemical compositions [1]. Based on data obtained from data centers and agricultural information systems, the amount of corn production in 2016 was 23.19 tons [4]. This corn production is predicted to continue to increase to 29.05 tons in 2020. Therefore, the aim of this research made organic demulsifiers or green demulsifiers from corn oil. It is expected that this demulsifier can be used effectively and has better quality than commercial demulsifiers made from chemicals. The process of this research will be conducted at the Petroleum Engineering Laboratory of the Islamic

* Corresponding author.
E-mail address: tomierfando@eng.uir.ac.id (T. Erfando).

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Nomenclature

°C	degree of celcius	kg	kilogram
DK	commercial demulsifier	ml	milliliter
DG	green demulsifier		
g	gram		

University of Riau. This green demulsifier will be tested for its ability to separate oil and water using the bottle test method and to use crude oil samples from the wellhead. The parameters to be tested are the temperature and concentration of the emulsifier. The temperature tested will vary by conditioning the conditions in the field. Demulsifiers made from corn oil are expected to be able to overcome emulsions in crude oil better than commercial demulsifiers.

2. Materials and methods

Equipment and materials used in the manufacture of green demulsifier formulations are aquadest, KOH 90%, glycerin, lemon, orange juicer, knives, filters, beakers, heaters, magnetic stirrers. While the equipment used to carry out the bottle test is a water bath, digital balance, volumetric flask, 100 ml bottle, test tube, funnel, measuring cup. The raw materials used have met the requirements for making soap following SNI 06-4985-1996. The method used in manufacturing green demulsifier is saponification [5]. The detailed steps for making the demulsifier formulation are as follows: First of all, the experimental equipment and materials were prepared. Seventy-five milliliters of corn oil is heated at 70 °C for 30 min, then KOH that has been dissolved with aquadest is poured slowly into the oil being heated while continuing to stir as much as 29 ml. In the final step, ten milliliters of glycerin and few aquadest are added to form a demulsifier [6]. As for the characteristics of crude oil used in this experiment can be seen in Table 1.

The characteristics of the oil used in testing the bottle test are crude oil samples obtained from the wellhead. The type of oil used is heavy oil. This oil comes from one of the oil and gas fields located in Riau Province. Bottle test is one method that is very often used in testing demulsifiers in the laboratory. This experiment carried out using the bottle test method as well [7]. The research carried out by them aims to overcome the emulsion problem in oil and gas fields in southern Sumatra. Table 2 shows the characteristics of corn oil used in the experiment.

The citric acid content of the lemon used is 48.6 g/Kg [8]. Citric acid is beneficial for producing water and oil limit. Fatty acid from oil makes the green demulsifiers have clear color and viscosity level like commercial demulsifiers.

3. Results and discussion

Demulsifier made from corn oil is also called green demulsifier. Corn oil contains various substances that can separate water and oil. Corn oil contains palmitic acid, linoleic acid, stearic acid, linolenic acid, and oleic acid [9]. Every ingredient contained in corn oil has an impact on the demulsifier. Green demulsifier and commercial demulsifier have the highest water separation results at 80 °C.

Testing is done by adding each of the demulsifier formulas with different concentrations of 1 ml, 3 ml, and 5 ml. There are three demulsifier formulas tested on oil, namely DK, DG1, and DG2. DK is a commercial demulsifier commonly used in the field. While the formula DG1 and DG2 are demulsifiers made from corn oil. The difference between DG1 and DG2 is only a demulsifier made from corn oil with a saponification process, while DG2 is a formula DG1 added with lemon liquid. The highest water separation by DG2 at 80 °C with a total volume of water as much as 39 ml. Demulsifier concentration affects the results of separation in this experiment.

From Fig. 1, it can be seen that the demulsification process with a bottle test at 80 °C shows that demulsifiers with corn oil formulations have a higher degree of separation than commercial demulsifiers. The highest water separation occurs with a concentration of 5 ml. That is because of the increased concentration of the demulsifier reduces the interfacial tension [10]. Based on the opinion of [10], the higher the concentration of demulsifiers, the interfacial tension will decrease. If one of the liquid interfacial tension decreases, it will facilitate the fluid phase to separate. From the test parameters that have been done, the temperature has the biggest role in the emulsification process when compared with concentration and time of separation. Based on data obtained from software statistics, the separation that occurs due to temperature testing has the biggest role. The impact on the demulsification process is 37.5% and 62.5% is influenced by other factors. This demulsification process is a process that occurs in the breakdown of the emulsion into an integral fluid phase. The concentration of demulsifiers only affects 1% of the demulsification process, and 99% is influenced by factors other than concentration. This means that in the tests that have been carried out, the concentration of the demulsifier formula does not significantly affect the demulsification process. While the duration of testing only affects only 0.5% of the demulsification process. The three parameters tested only the temperature has a dominant influence on the demulsification process. Higher the concentration, better the separation test and longer the demulsification process occurs in the separation water bath that will be perfect. Based on one researched by [11], optimum concentration obtained 5 ml. The equal concentrations used in the test are 1 ml, 3 ml, and 5 ml. These show at condition test 60 °C, 70 °C, and 80 °C.

Table 1
The characteristics of crude oil tested in this research.

Parameter	Value
Density (ρ_{oil})	0.929 gr/ml
Specific gravity (SG)	0.929
°API	20.8

Table 2
The characteristics of corn oil used in this research.

Type	Saturated fat (%)	Not saturated fat (%)
Corn oil	Palmitic(13) Stearic(3)	Linoleic(52 Oleic(31) Linolenic(1)

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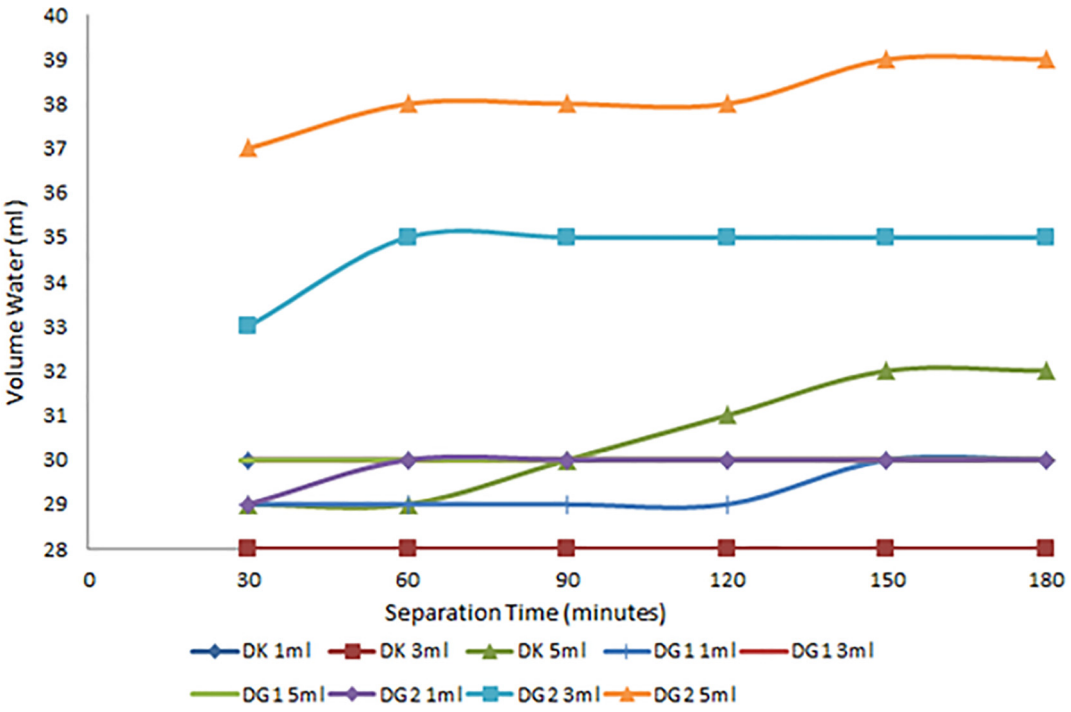

Fig. 1. The best result separations were at temperature of 80 °C.

The comparison of the separation between the commercial demulsifier formulation and the green demulsifier shows a significant value. All the parameters, the test temperature, concentration and time of separation, are dominated by the green demulsifier. These are seen from the 30th minute to the 180th minute. High concentrations of demulsifiers greatly affect the tension between fluid surfaces [12]. In the study of [12] also said that increasing concentration of demulsifiers resulted in a decrease in interfacial tension, viscosity, and increased water separation. So the surface elasticity of the liquid greatly determines the level of efficiency of the demulsifier. The best test results from each test condition can be seen in Table 3.

Based on the results of the testing of all conditions, it can be seen that the green demulsifier can separate water better than commercial demulsifiers. Demulsifiers made with corn oil better than the commercial demulsifier. Corn oil produced surfactant, as stated by previous research [13]. The surfactant changed the interfacial tension between oil and water. At a temperature of 40 °C, the separation was carried out by DG1 with a concentration of 5 ml. While the commercial demulsifier formula with a concentration of 5 ml does not occur separation. Tests carried out at a temperature of 50 °C also show that demulsifiers made from natural materials are better compared to commercial demulsifiers. It can be seen from the results of the separation that occurred because during the testing carried out 180 min; the commercial demulsifier was not able to separate water more than the green demulsifier. The best results of separation at the testing temperature of 60 °C have a lower yield compared to the temperature of 50 °C, which is 32 ml. These results obtained from the DG2 formula show that the demulsifier DG2 formula is better when compared to the commercial demulsifier green demulsifier formula made from corn oil. Separation at a temperature of 70 °C showed that the formula DG2 with concentration had the highest water separation of 32 ml. Water separated at temperatures of 60 °C and 70 °C lower than DG1 at a temperature of 50 °C. The peak of water volume separation was 39 ml at a temperature of 80 °C. This is the best result of all test conditions. This demulsifier formula made from natural ingredients has better separation ability when low temperatures and high temperatures. So the comparison between commercial demulsifier and green demulsifier has been proven from this research. All the testing conditions, the results of the separation obtained by the green demulsifier, were better than the commercial demulsifier. In [14], kaffir lime separates water more than commercial demulsifiers. These results increasingly indicate that the potential of natural materials can be used as a demulsifier used in the oil and gas industry to deal with emulsion problems. Demulsifiers also can applicate at the refinery unit, it will produce better crude oil to process become a product. Product of processing crude oil are kerosene, gasoline, and other product from crude oil. Temperature is the factor that most influences separation because higher temperature better the separation results. High temperatures cause the emulsion to break down between oil and water [15].

Table 3
The peak of separation based on concentrations and temperatures.

Results of separation (ml)	Formulation	Concentration (ml)	Temperature (°C)
26	DG1	5	40
33	DG1	5	50
30	DG2	5	60
32	DG2	5	70
39	DG2	5	80

4. Conclusion

This research showed that corn oil produced green demulsifiers which have better performance than commercial demulsifier. The addition of lemon also increased the performance of the demulsifier. The most influencing factor for emulsion separation

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was temperature conditions. In DG1 and DG2, the best result of the separation of water was at a concentration of 5 ml, and the best temperature of separation was 80 °C.

CRediT authorship contribution statement

Tomi Erfando: Conceptualization, Methodology, Investigation, Writing - review & editing. **Idham Khalid:** Data curation, Writing - original draft. **Rizky Bahari:** Data curation, Writing - original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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