The Use Of Sodium

by Sekar

Submission date: 24-Aug-2024 02:22PM (UTC+0700)
Submission ID: 2413396210
File name: eeset_The_Use_of_Sodium_Polyacrylate_for_oil_water_demulsisi.pdf (527.53K)
Word count: 3002
Character count: 15930

Journal of Earth Energy Science, Engineering, and Technology, Vol. 5, No. 1, 2022
URL: https://trijurnal.lemlit.trisakti.ac.id/jeeset, DOI: http://dx.doi.org/10.25105/jeeset.v%vi%i.9959
Received: 2 August 2021, Accepted: 17 January 2022, Published: 24 January 2022

The Use of Sodium Polyacrylate for Oil-Water Demulsification Process

(Penggunaan Sodium Polyacrylate untuk Proses Demulsifikasi Minyak-Air)

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Abstract

Oil-water emulsion formation is common in oil fields. The emulsion is a problem which causes an increase in production costs and a decrease in oil quality. Therefore, a demulsifier formulation is needed to overcome these problems. The use of household waste, particularly disposable diapers, is a promising alternative. One of the substances contained in diapers is sodium polyacrylate super absorbent polymer, known as sodium polyacrylate. The substance takes 450 years and 500 years to decompose in the sea and on land. Sodium polyacrylate has inert and hydrophilic properties with the working principle of absorbing and trapping water which is expected to reduce the water content in oil-water emulsions which are mostly produced from old oil wells. In this experiment, diapers were used to separate the emulsion in light crude oil samples which were tested with brine with 20% and 70% salinity at 50°C. Centrifuge was used to speed up the demulsification process within 1 to 3 minutes. It can be concluded that sodium polyacrylate contained in diaper waste can reduce the water content of the emulsion. In addition, the demulsification process by sodium polyacrylae was more stable and higher in brine with a salinity of 70% compared to brine with a salinity of 20%.

Keywords: Sodium Polyacrylate; Super Absorbent Polymer; Demulsifier; Chemical; Oilfield

Sari

Pembentukan emulsi minyak-air biasa terjadi di ladang minyak. Emulsi merupakan masalah yang menyebabkan kenaikan biaya produksi dan penurunan kualitas minyak. Oleh karena itu diperlukan formulasi demulsifier untuk mengatasi permasalahan tersebut. Penggunaan limbah rumah tangga, khususnya popok sekali pakai, adalah alternatif yang menjanjikan. salah satu zat yang dikandung popok adalah sodium polyacrylate super absorbent polymer, dikenal sebagai sodium polyacrylate. Zat tersebut membutuhkan waktu 450 tahun dan 500 tahun untuk terurai di laut dan di darat. Sodium polyacrylate memiliki sifat inert dan hidrofilik dengan prinsip kerja menyerap dan menjebak air yang diharapkan dapat mengurangi kadar air pada emulsi minyak-air yang banyak diproduksi dari sumur-sumur minyak tua. Pada percobaan ini popok digunakan untuk memisahkan emulsi pada sampel light crude oil yang diuji dengan brine dengan salinitas 20% dan 70% pada suhu 50°C. Alat sentrifugal digunakan untuk mempercepat proses demulsifikasi dalam jangka waktu 1 hingga 3 menit. Dapat disimpulkan bahwa sodium polyacrylate yang dikandung dalam limbah popok dapat mengurangi kandungan air pada emulsi. Di samping itu proses demulsifikasi oleh sodium polyacrylae lebih stabil dan lebih tinggi pada brine dengan salinitas 70% dibandingkan brine dengan salinitas 20%.

Kata-kata kunci: Sodium Polyacrylate; Polimer Penyerap Super; Demulsifier; Bahan Kimia; Ladang Minyak

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I. INTRODUCTION

During the immigration process, water and oil from the pores of the reservoir rock can form an emulsion because the oil contains natural surfactants in the form of asphaltene, resin, naphthenic acid, porphyrin amines, micro-crystals of paraffin, clay, and sand, with an average concentration of asphaltene interface of 3 – 70%, resin 7 – 55% and paraffin 20 – 90%. Some polar substances include naphthenic acid and porphyrin amines, while non-polar substances such as asphaltene, resins, and other solids serve as emulsion stabilizers [1-2]. In addition, emulsions contain salts such as $NaCl$, KCL, $MgCl_2$, and $CaCl_2$, which can trigger corrosion of equipment in the oil field [3]. To overcome the formation problem due to water-in-oil emulsions, the organic compound is added for the demulsification process divided into three methods: thermal, electrical, and chemical. Generally, the demulsifier process used is a chemical method. The chemical that usually disperses water is a surfactant; besides that, there are solvents such as xylene, toluene, cosolvents such as methanol and Ethylene Glycol Mono Butyl Ether (EGMBE), which are often used for demulsifier formulations [2-3]. However, the use of chemical solutions such as surfactants is quite expensive. In addition, many chemicals are not suitable for the environment. Surfactants take a long time to degrade and disappear from the surface of the water completely. The waste if not handled properly can endanger the environment and human survival. The waste can cause the death of river organisms if the water quality standard is more than 1000 mg/l [4]. In addition, it can cause living things such as fish in rivers to migrate. However, because some types of fish have territorial characteristics,

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some types of fish can return to the area, even though the river has been contaminated with hazardous and toxic materials. In addition, people living around rivers can also be affected [5-6].

To reduce the environmental impact and the amount of diaper waste that is disposed of carelessly, diaper waste can be used as a demulsifier. The main ingredient for making diapers is using sodium polyacrylate super absorbent polymer gel, which has hydrophilic properties, can lower the interfacial tension, disperse evenly and facilitate uniform dispersion of crosslinked polymers containing sodium atoms. It absorbs water and distributes between the textures and water molecules evenly, and swaps the position of the sodium atoms so that the water is filled and trapped with the polymer texture. In addition, diapers made from sodium polyracrylate are not easily biodegradable; The effect is that diapers take 450 years to degrade at sea and 500 years on land [7]. Besides being able to recycle household waste, sodium polyacrylate contained in diaper waste can be used repeatedly, making it much more economical than other chemical oil fields.

II. THEORETICAL FRAMEWORK

The characteristics of each oil have different levels of emulsion stability and various elements of the oil, and before determining the demulsification method, firstly know the characteristics of the oil [3]. The emulsion is a droplet suspension with a diameter of 0.1, which occurs because two solutions, namely an immiscible solution and a dispersed solution, mix with the entire solution. This is due to the absorption of water by the oil so that it can increase the viscosity of the substance formed by the occurrence of the emulsion, the viscosity level of the substance is higher than the oil and water itself, supported by the emulsion stabilization process so that it can make the demulsification process take longer. Emulsion stabilization can be caused by the film layer trapping water droplets, making it challenging to carry out the coalescence process, and it is characterized by high viscosity and stiff film layers [1-2]. Types of emulsions based on the size of the dispersed emulsions are divided into three types, namely: macroemulsion (0.4, microemulsion (0.1 and nanoemulsion (0.1 – 0.4), besides that, the colour of the emulsion can be a benchmark for the content of the emulsion). If the colour is dark red, grey, brown, and black-brown, the lighter the emulsion colour, the surface area value is the larger and vice versa; if the emulsion is dark, the surface area value is smaller. If based on the condition of the dispersed phase, the emulsion is divided into four types, namely: oil-in-water (W/O) emulsion, water-in-oil (O/W) emulsion, water-in-oil-in-water emulsion (W/O/W), and oil-in-water-in- oil emulsion (O/W/O) [3]. The process of demulsification consists of several stages, namely the occurrence of flocculation. This flocculation process occurs because the speed of the falling water droplets is directly proportional to the diameter of the water droplets so that they can form agglomerations and aggregates. The flocculation rate can increase if there is an increase in temperature so that it can reduce the level of oil viscosity, and the higher the difference in density of oil and water [8-9]. Next is the creaming & sedimentation stage occurs if the difference in density between the two kinds of solutions where sedimentation is formed if while creaming is formed at [10], the sedimentation and creaming rate will produce larger water droplets if the dispersed particles are large [11]. Then, coalescence occurs where the water droplets combine to become larger at this stage, but some factors influence this stage, namely an increase in flocculation collisions, a film layer that is too strong, high interfacial tension, and low interphase viscosity [8]. At the last stage is the settling time, namely, the condition where after the water droplets get bigger so they can separate themselves from the oil.

Diapers are made of polyacrylate granule and fiber made from hydrocarbon plastic, synthetic pulp, polychlorinated dibenzodioxins, and sodium polyacrylate gel. Sodium polyacrylate gel absorbs water and develops when it comes in contact with water like a sponge. The fiber in the diaper helps to spread the sodium polyacrylate gel and liquid. Sodium polyacrylate can easily absorb up to 800 times its weight in water. Sodium polyacrylate is used as a thickening agent in industrial processes and to dissolve the soap. A thickener increases the viscosity of hydro-based systems, improves stability.

III. METHODOLOGY

The procedure of the research is shown in Figure 1. The materials and tools used in the research are shown in Figure 2. The following is the steps to perform the research:

1. Prepare tools and materials. The tools needed are centrifuge, spinner/heater, test tube, thermometer. And the materials needed are sodium chloride of 20 g for 20% salinity solution and 70 g for 70%, 100 mL aqua dest for each solution, light crude oil (P # 441), sodium polyacrylate from diaper waste.
2. Make 20% and 70% salinity solutions by inputting 20 g and 70 g in each beaker filled with 100 mL aquadest. Then make the solution homogeneous by stirring using a spinner until no sodium chloride settles at the bottom of the beaker.
3. After that, enter 5 mL of P #441, 5 mL of 20% salinity solution, and put 1 mL of diaper waste into a beaker, then shake until P #441 has already mixed with water to form an emulsion, do the

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same steps with a solution of 70% salinity.

4. Then, two samples were put into a centrifuge with a period of 1, 2, and 3 minutes at speeds 500, 1000, and 1500 RPM, at a temperature of 50ºC. Then note any changes in the volume gain of water from each sample.

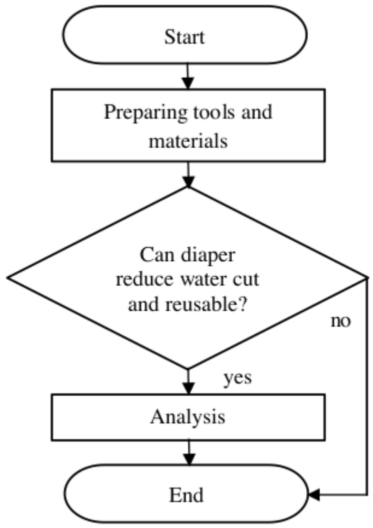

Figure 1. Research Flow Chart

Figure 2. Materials and Tools

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IV. RESULTS AND DISCUSSION

The crude oil sample P#441, which is classified as light crude oil, has a high API gravity so that the viscosity measurement obtained is low. As explained in the theory that the lower the viscosity can facilitate the demulsification process, it can be concluded that the sample is relatively easy to separate from the aqueous phase. The properties of P#441 crude oil are given in Table 1.

Experiments to observe the effect of salinity on demulsification are shown in Figures 3 and 4. Table 2 shows the content of sodium chloride particles for 20% and 70% salinity concentrations. The table shows that the solid particle content is above 1000 mg/l. The value in the table is the value before the demulsification process. Diaper waste is not only to reduce water cut but also to reduce the content of solid particles, so that in addition to not forming substances that can stabilize the emulsion, this salt content can also trigger electrostatic interactions between droplets so that it can make the emulsion more difficult to separate.

After knowing the classification of crude oil samples and the content of solids in the salinity solution, the diaper waste was tested. Then the two samples were tested at a temperature of 50°C. The value of the water volume obtained is shown in Figures 5 and 6.

Figure 5 shows that at 70% water salinity, the graph shows a consistent separated water volume at the 2nd and 3rd minutes. However, in samples that did not use sodium polyacrylate as a demulsifier at a speed of 500 RPM, the separated water volume decreased. Separated water volume varies between 4.58 ml to 5.62 ml. Figure 6 shows that at 20% water salinity, the separated water volume varies between 4.00 ml to 5.41 ml. Based on the sample salinity comparison, it can be stated that higher salinity can reduce the stability of the emulsion so that a higher separated water volume is obtained. The use of sodium polyacrylate can increase the separated water volume until 10.6% and 4.2% for salinity of 70% and 20%, respectively. This shows that the sodium polyacrylate contained in the diaper can be used as an emulsifier. The effect of sodium polyacrylate on separated water volume is more stable and greater at 70% salinity than at 20% salinity.

Table 1. Crude Oil P #441 Properties

Parameter	Crude Oil
Specific Gravity	0.8254
°API	38.55
Viscosity, cp	2.25

Table 2. Reservoir Properties of CW-A wells and CW-B wells

Salinity, %	Solid Particle Content, ppm
20	10060
70	15080

(a) (b)

Figure 3. Demulsification Test at 70% Salinity Water
a). Without Diaper Waste b). With Diaper Waste

(a) (b)

Figure 4. Demulsification Test at 20% Salinity Water
a). Without Diaper Waste b). With Diaper Waste

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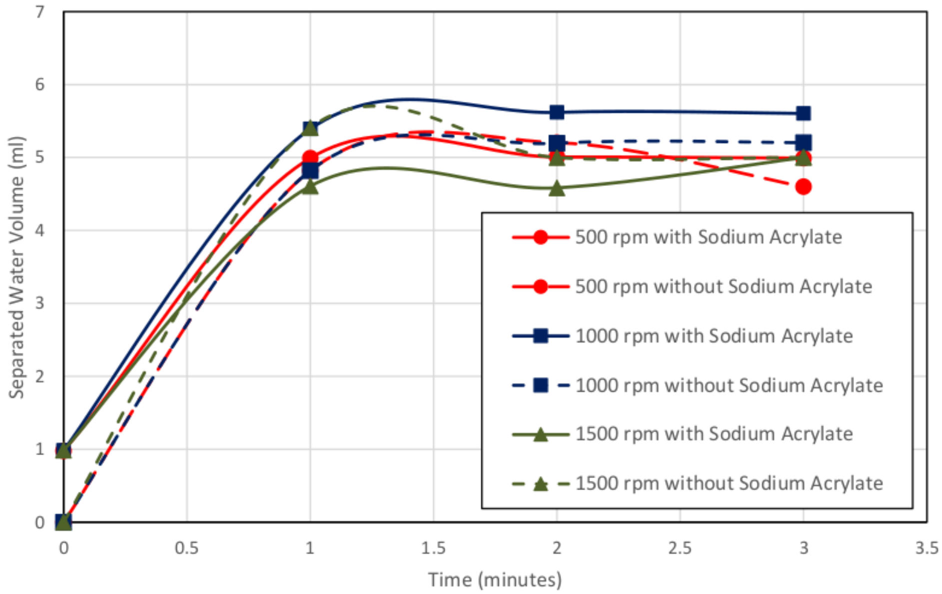

Figure 5. Separated Water Volume at 70% Salinity

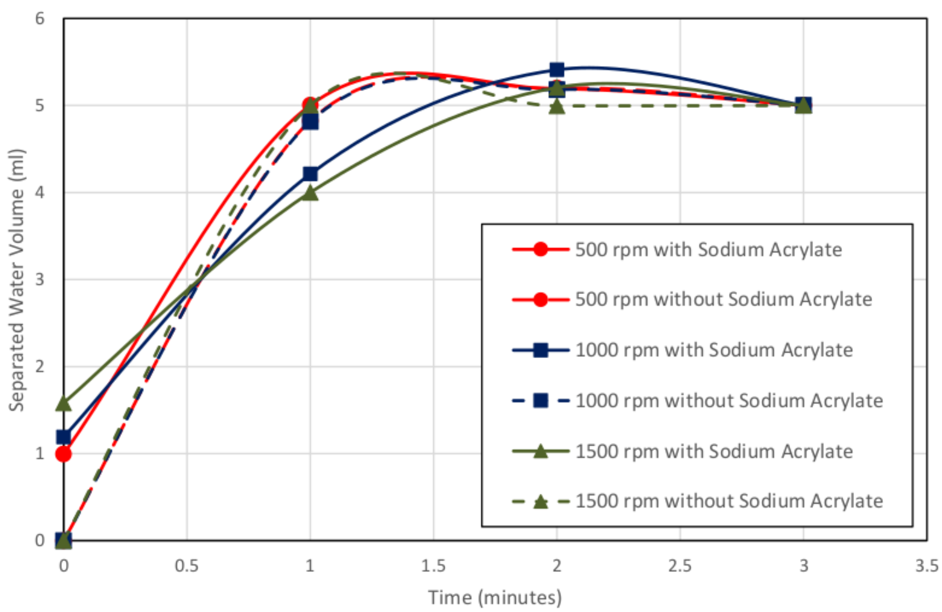

Figure 6. Separated Water Volume at 20% Salinity

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URL: https://trijurnal.lemlit.trisakti.ac.id/jeeset, DOI: http://dx.doi.org/10.25105/jeeset.v5i1.12600
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VI. CONCLUSION

From the discussion above, several conclusions can be stated, as follows. Salinity affects the volume of water separated. 70% water salinity produces more separated water volume than 20% water salinity. The use of sodium polyacrylate can increase the separated water volume until 10.6% and 4.2% for salinity of 70% and 20%, respectively.

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