

Full Length Research Paper

Polyaluminum chloride as oil-water emulsions destabilizer

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The potential use of polyaluminum chloride (PAC) on destabilizing oil-water emulsions was investigated. The phase separation for emulsions with different water cuts ranging from (10 to 60) % was studied. A wide range of PAC doses (0.5 and 8.0) mg/L was tested. A 30 % hexane and 70 % ethanol solvent was used for PAC dose preparation. PAC was found to perform well for samples with water cut between (30 and 60) %. For 60 % water cut the phase separation reached 79 %. For samples with water cut of less than 20 %, PAC is found to have absolutely no influence on emulsion destabilization.

Keywords: Polyaluminum chloride, oil-water emulsions, bottle test.

INTRODUCTION

Water is commonly present in crude oil in different forms as free, emulsified or dissolved. The presence of water in crude oil is undesired because it lessens the commercial value of the crude and increases the refining operations costs. Emulsions usually have significantly high viscosities than that of the crude oil thus increasing the energy input required for transport in pipeline (Pena, 2005). The free water is removed by gravity. The removal of water emulsion remained the challenge.

The removal of emulsified water from oil is generally occurs in three steps as destabilization (emulsion breaking) of emulsion followed by coalescence and gravity separation. The destabilizing of emulsion is made either by heat or use of chemicals. The coalescence is the process in which small particles fuse together forming larger particle thus increasing its settling velocity. The gravity separation is the process in which the coalescence particles settle down. In this process the retention time and flow pattern are the main controlling parameters (Bradly, 1987).

There are many methods of emulsion breaking. These include thermal, mechanical, electrical and chemical methods. In thermal methods heating will reduce the viscosity of both oil and oil hence enhances emulsion breaking. However, the main drawbacks of the thermal method are the loss of light ends and scale formation.

Mechanical methods such as centrifugation and filtration relay on increasing the collision rate of droplets and applying an additional force driving coalescence (Schramm, 2005). In electrostatic methods the separation is based on the attraction of the opposite charges, in an electric field the droplets orient in chains along the direction of the field (Gosh, 2009).

The addition of chemicals will break emulsions and allow coagulation by neutralizing repulsive charges between particles, and then precipitate or settle out the emulsifying agent or weaken the interfacial film between the oil and water. Chemical is the most common method of emulsion treatment. Toluene based chemicals are most widely used (Fenchi, 2006). The main parameters that influence chemical treatment include type of chemical, water cut, and retention time, degree of mixing and chemical dose.

This work presents the result of study on the potential use of PAC as an oil-water emulsion breaking agent. The parameters of retention time, PAC dose and water cut are studied. The study is conducted for constant temperate and mixing rate.

MATERIALS AND METHODS

Emulsion Preparation

Crude oil used in this work was obtained from Khartoum

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Table 1. Properties of Nile Blend Petroleum (PAC, 2012).

Property	Test Method	Unit	Value
Salt Content	ASTM D 3230	mgNaCl/L	7.4
Density at 15°C	ASTM D 5002	Kg/m ³	867.2
Pour Point	ASTM D97	°C	+33.0
Kinematic Viscosity at 100°C	ASTM D 445	mm ² /s	8.231
Water Content	ASTM D 4006	%m	0.5
Asphaltene Content	IP 143	wt%	0.69
Sulfur Content	ASTM D4294	wt%	0.059

Table 2. PAC specification.

Item	Value
Al ₂ O ₃	17%
Cl	21%
Solid content	39%
Specific gravity	1.37
pH	3

Refinery, Sudan. Table 1 shows the specification of the crude oil. To create crude oil with water emulsion, the obtained crude oil is mixed with 35 g/L NaCl brine. The mixer used for this purpose was a five shaft high speed mixer, with 5 cups each of 500 mL volume. The desired amount of crude oil was poured into mixing cup and the mixer was run at 10,000 rpm. Then the desired amount of brine was added drop by drop. The sample was left for 1 h at 60 °C in the oven to test its stability. The sample that its emulsion exhibited instability is rejected. In this process 6 samples of water cut between 10 to 60 % were prepared.

Emulsifier Preparation

Commercially available PAC [Al₂Cl(OH)₅] was used. Table 2 shows the specification of PAC. Commercially available Hexane and Ethanol of 85.5 and 99.9% purity respectively were used as a solvent for PAC solution. For the preparation of PAC solution, different trails were attempted by varying hexane - ethanol ratio. The best ratio in which PAC is completely dissolved is found to be 30% hexane and 70% ethanol.

Bottle test

The bottle test is performed at constant temperature of 60 °C. The temperature is maintained using a thermostat (Scott Science LDO) with a temperature range of - 50 °C to 250 °C. In this test a known PAC dose is added to a sample of known water cut. The oil and water is expected to separate in two phase; oil phase and water phase. The hexane and ethanol added with PAC dose are expected

to be separated with water phase. The thickness of water phase was observed against time. The run is considered complete if the thickness of the water phase remained unchanged for three consecutive readings with 10 min intervals.

RESULTS AND DISCUSSIONS

PAC Dose range

Prior to the test the applicable range of dose is determined. Starting with a PAC dose of 0.5 mg/L and marching up; it was found that the emulsion started breaking up only at a PAC dose of 4 mg/L. The upper limit of the dose is set by economical factors. The literature indicated that the cost of chemicals used in emulsion destabilization ranged \$ 0.1 to \$ 0.35 per BBL of oil (PAC, 2012). The commercial value of PAC used in this work is \$ 190 to \$ 250 per ton. For 8 mg/L PAC dose the cost will be \$0.216 per BBL. Hence a dose of more than 8% is not recommended for application. Hence PAC dose of 4 to 8 mg/L is used throughout.

Influence of retention time on phase separation

Figure 1 shows the influence of retention time on emulsion breaking at a constant PAC dose for a 60 % water cut sample at different PAC doses. The data is presented as phase separation versus retention time. The phase separation is defined as

$$\eta = \frac{L_o - L_t}{L_o} 100\% \quad (1)$$

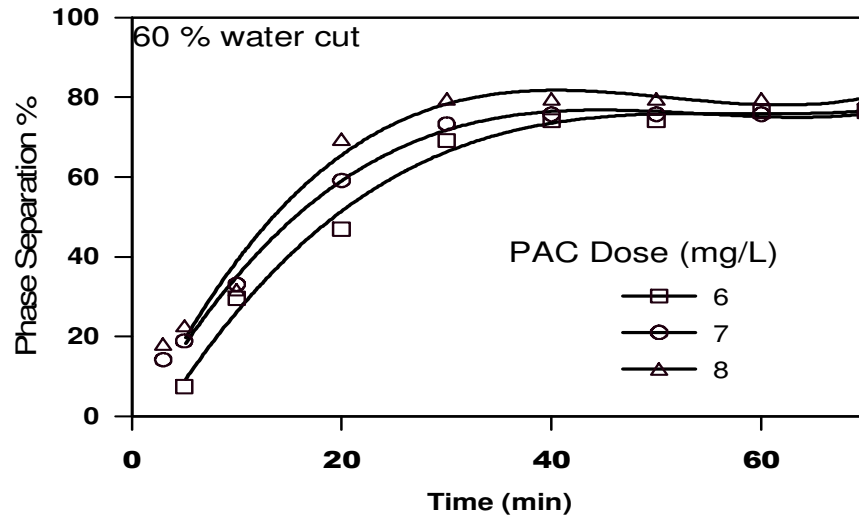


Figure 1. Influence of retention time on phase.

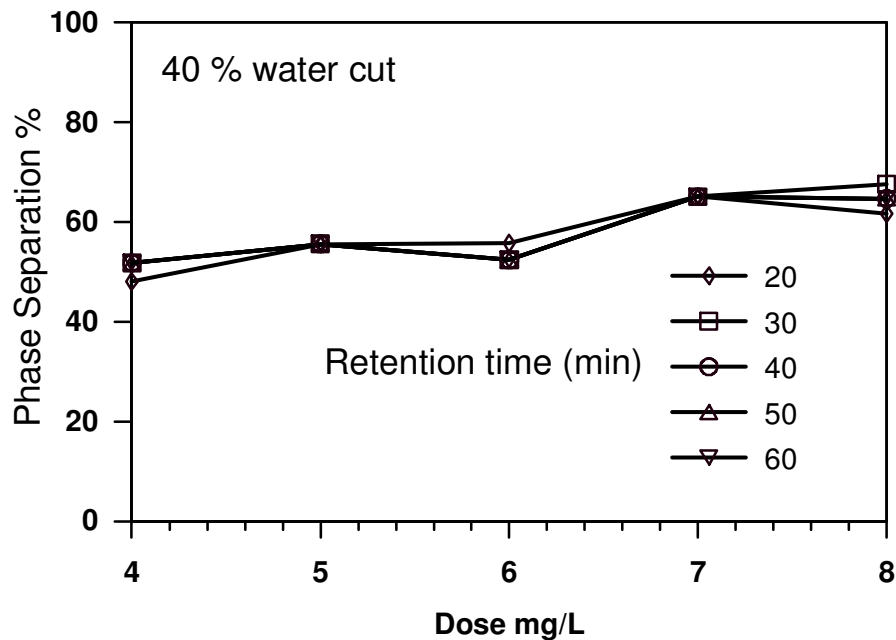


Figure 2. Influence of PAC dose on phase separation.

Where L_o is the total volume water cut plus hexane and ethanol added with PAC dose and L_t is water phase volume at time t .

It can be seen that the phase separation increases with retention time exponentially.

Influence of PAC dose on emulsion destabilization

Figure 2 shows the influence of PAC dose on emulsion destabilization. The result is presented as phase

separation versus PAC dose at different retention time for a sample of 40 % water cut. It is clear that as the PAC dose increases the phase separation increases.

Figure 3 shows the phase separation for a certain PAC dose applied to samples of different water cuts. It can be seen that the PAC dose of 4 mg/L when applied to samples of 40, 50 and 60 % water cuts it found that the phase separation efficiency increase with water cut. The highest separation efficiency is obtained for 60% water cut. On the contrary it is expected that the sample of 30% water cut yields higher separation efficiency than 60 % water cut of the same dose. Hence it can be concluded

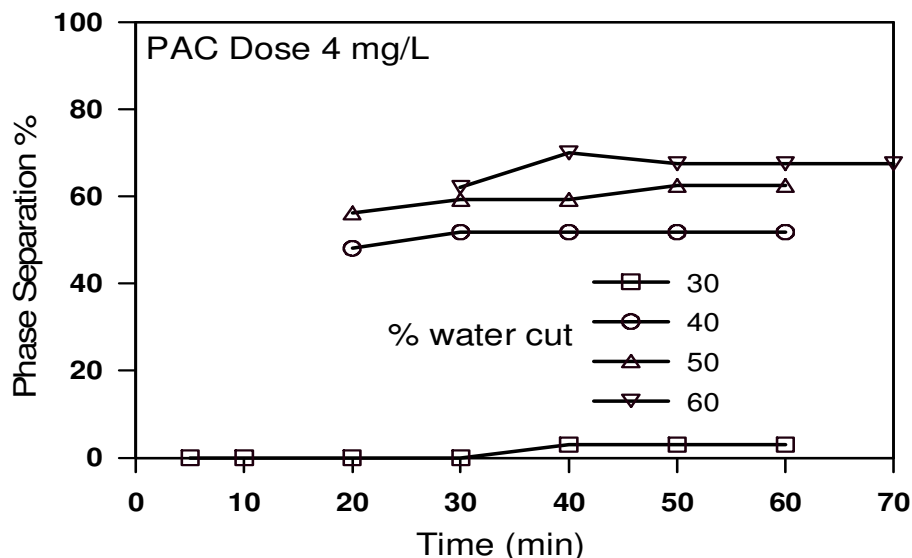


Figure 3. Influence of PAC dose on water cut.

that PAC works well for samples with high water cuts. On the other hand high dose yield high phase separation efficiency than lower PAC dose.

Produced water

The water produced (effluent) by emulsion breaking was subjected to chemical analysis in particular for Al and pH. It is found that most of Al element is produced with water not with oil. This is expected as its solubility in water is higher than in oil. However, the pH is found to be high. This may cause serious problem by produced water handling otherwise neutralization is necessary.

CONCLUSION

The research results concluded that PAC can be used effectively (phase separation efficiency exceeding 79 %)

as an emulsion destabilization agent in particular for high water cut (30 to 60 %). It also concluded that the economic value of PAC make it potential candidate as demulsifying agent.

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