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Evaluation of Demulsifier for *AGOCO, Nafoora* Oilfield, Liby*a*: Demulsifier Bottle Test

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Abstract

Continued advances in technology have increased the demand of crude oil. The most common types of problems encountered in oil and gas production operations is Emulsions (Normal or Reverse). The formation of water and oil emulsions is largely unavoidable in the petroleum industry. Break-up of these oil field emulsions is important either for recovery of crude oil or environmental cleanup in the oil field. The oil field emulsions, especially the water-in-oil type of emulsions, are very difficult to break. Chemicals products used to break emulsion and separate oil. Oil production companies contract with professional companies in chemical treatment. One of these companies is JOWF OIL TECHNOLGY COMPANY that product chemicals to break emulsion. One of these products is JOF BREAK 6266 that used in this study. **JOF BRAIK 6266N** is a blend of alkoxylated resins, epoxy compounds and high molecular weight polyols in an aromatic solvent. This class of chemicals is commonly used in oilfields for separation of oil and water from the emulsion. Several concentrations of JOWFE products coded *(BI 9,BI 12 and BI 26)* that used in this study were screened by using standard bottle test. **JOF BRAIK 6266N (BI 09)** is found to be suitable for demulsification of water and oil from the crude oil/water emulsion of Nafoora field gives better performance than the chemical used (NALCO) at present in the field at the lower and same concentration.

JOF BRAIK 6266N was tested in laboratory for the compatibility of other additives and was found to be compatible.

Keywords: *GOSP=Gas Oil Station Production, CPS: Collection Production Separators , AGOCO: Arabian Golf Oil Company*

1. Introduction

The treatment of crude oil emulsions is the very foundation of the present oil field chemical business. An examination of early crude oil production history will illuminate the true impact of the importance of the resolution of crude oil emulsions.

Emulsion breaking is one of the most complex processes in the oil industry. Breaking of water in crude oil[1] emulsions involves chemical, thermal, electrical, or a combination of these processes

depending on the characteristics and properties of the emulsion. The addition of chemical demulsifiers in small quantities can greatly facilitate oil-water separation. [2]

The main objective of the emulsion breaker/demulsifier is to displace the naturally occurring emulsifying agents from the oil-water interface . [1]

The efficiency of the emulsion breakers depends upon:

1. The efficiency of the product (emulsion breaker).
2. Oil characteristics.
3. Environmental conditions.
4. Application method.
5. Time of application. [7]

Lots of different emulsion breakers are available in the market and the choice of the most efficient one is a time consuming and difficult process. [3]Different emulsion breakers are generally tested through a bottle test method, which consist of adding the given emulsion breaker to the sample of the emulsion and observing the percentage of water as function of time. [4]

It is not a foolproof approach, but run by a competent person with sufficient care, it will give a good answer. There has been much criticism of the bottle test, but this stems mostly from a lack of understanding of the test and of result interpretation[5]. A good understanding of the treating plant, its contribution to the treatment and the chemical requirements to match it, are necessary before chemical selection can be made. [5]

The bottle test is performed to assist in selecting the treating compound which will most effectively break the emulsion from a given well or lease. The bottle test is used to select the best compound for treating a given emulsion and will aid in determination of the smallest volume of chemical which can be used to treat an emulsion to pipeline specifications. Therefore, testing must be realistic, reliable, and reproducible. [1]

In conjunction with determining objectives, you can note precisely what is going on in a system to prepare for testing. It is important to know the number and location of all chemical injection points. Measure the rates to insure that the correct ratio is known. Check

the system flow to select a proper sample point. Check treating vessels to observe present performance. [4]

Emulsion breaking, or demulsification is the separation of a dispersed liquid from the liquid in which it is suspended. All chemical and mechanical methods of emulsion breaking conform to Stoke's Law. Stoke's Law states that when a small sphere is under the influence of gravity in a viscous fluid it obtains a constant velocity. The following equation is the basis for most of the discussion presented: [7]

$$V = \frac{2g\,r^2(d_1 - d_2)}{9n_2}$$

where:

g = 980 cm/sec^2

d_1 = density of dispersed phase (water) in gm/cc

d_2 = density of continuous phase (oil) in gm/cc

n^2 = viscosity in poises of continuous phase (oil) at settling temperature

r = radius of dispersed phase (water droplet) in cm

v = rate of fall of dispersed phase in cm/sec (if negative the dispersed phase is lighter than the continuous phase and will rise).

The objective of demulsification is to destroy the interface and drive the surfactant to either the oil side or the water side, allowing the oil particles and sediments to coalesce and rise to the surface, as in creaming Demulsification can be enhanced by decreasing water-phase viscosity or increasing oil viscosity[7]. Increasing the diameter of oil droplets and lowering the density of oil to water also works.

JOWFE OIL TECHNOLOGY COMPANY one of companies that product chemicals to break emulsion. JOF break 6266 one of these products that used in this study. It is a blend of alkoxylated resins and high molecular weight polyols in an aromatic solvent. [7]

It has been formulated to give good demulsification and water separation in a range of medium to high API gravity crudes. Three concentrations were used to evaluation with NALCO chemical that used in NAFORA field (AGOCO).

Nafoora oil field is producing 72.000-77.000 bbl. of a 36 API waxy crude oil per day . 8 GOSP are separating water down to 0,05-0,15% further desalting is done in the CSP by settling tanks. The installed electrical desalters are not used. Every GOSP has a similar layout. Wells are collected in a manifold followed by two 300bbl 3 phase separator. One of these separator is used as test separator. Demusifier is injected 30cm upstream the separator inlet. After a residence time of about 10-15min the oil goes to a gas boot and a 20.000bbl tank were final separation takes place within ~8 hrs. The oil leaves with the above mentioned water cut and approx. 50ptb salt the GOSP and is pumped to the CPS. Most wells are gas lift or free flow only some have ESP. GOSP 3 crude oil emulsion is regarded as most difficult to treat mainly due to the low temperature of the incoming oil of about 30-45°C in winter time. Field trials are usually done at GOSP 3 on no cure no pay basis and in addition in GOSP 6 which is not producing to the CPS but to another oil company. Incumbent demulsifier is Nalcos ES2281A which is treating the crude with 36-45ppm at GOSP 3. Total demulsifier consumption in Nafoora oil field is 1400 drums per year. Demusifier testing is usually done with at GOSP 3 were out of the 15 producing wells, well G46, G110 and G79 are known to produce difficult emulsion.

2. Experimental Work

2.1 Materials;

2.2.1 Oil sample; The GOSP 3 manifold has no sample point for a composite sample but every well got separate sample points so a fresh emulsion sample was taken twice a day from min 5 wells including min one of the “difficult” emulsion wells. Samples were taken only from producing wells.

The crude oil sample from GOSP 6 was also a mixture of 6 individual wells.

2.2.2 Chemicals; All demulsifier blends were diluted 10% in Xylene. [8]

2.3 Laboratory Procedures; [9]

2.3.1 Bottle Test;

Test Equipment;

Emulsion:	see 2.2.1
Bottles	100ml graduated test tubes with screw top
Demulsifier Injection	Brand 10-100 ml digital pipette
Injection Rate	30-200ppm (on total fluids)
Injection Temperature	45° (30°C) GOSP 3, 50°C GOSP 6
Demulsifier Mixture	100-200shakes by hand
Test Temperature	water bath at 45°C/ (30°C) GOSP 3, 50°C GOSP 6
Test Duration	up to 6 hr.

1. Test Procedure;

1. Fill the separation bottles up to 100ml with crude oil emulsion.
2. Place the bottles in a 45°C water bath to reach temperature.
3. Inject the required demulsifier.
4. After dosing all bottles put them into the shaking rack and shake for the required time.
5. Place the bottles again in the water bath and monitor the water drop for the test duration.
6. Apply coalescence shakes during the water separation to simulate separator dynamics.
7. Observe separation behavior after coalescence shakes and make notes on the interface and water quality.

2.3.1 Residual Emulsion, Top cut; [10]

This test is used to monitor the complete demulsification after a bottle test. The residual water and emulsion is measured in the top oil of the separation bottles. With an adjustable needle top oil can be taken from different levels.

Test Equipment;

Syringe	Socorex 0-10ml with adjustable needle
Tubes	CMS 12.5ml graduated centrifuge tubes
Chemicals	F46 knock out drops, White Spirit
Dosage	1 drop
Centrifuge	modified heated 8 place Hettich centrifuge
Duration/Speed	10min at full speed

Test Procedure;

1. Fill the Centrifuge tubes with solvent to 50%.
2. Take out top oil at a 80% or 60% level and fill centrifuge tubes to 100%.
3. Shake tubes to solve the oil completely.
4. Heat the tubes in a water bath (50°C) for about 1min.
5. Centrifuge.
6. Write down emulsion and water (BS&W).
7. Heat the tubes in a water bath (50°C) for about 1min.
8. Add 1 drop of F46 and shake again (in case of though emulsion use a stirrer to resolve it).
9. Heat the tubes in a water bath (50°C) for about 1min.
10. Centrifuge.
11. Write down centrifuged water.

2.3.2 Residual Emulsion, Mixed Cut;[10]

This test is used to monitor the demulsification for the whole oil after a bottle test. The separated water is removed, the oil is mixed and grind out for residual emulsion.

Test Equipment;

- Syringe BRAND Transferpetor 0-10ml
  50ml glass syringe with 20cm-drain tube
- Tubes CMS 12.5ml graduated centrifuge tubes

- Chemicals F46 knock out drops, White Spirit
- Dosage 1 drop
- Centrifuge modified heated 8 Place Hettich centrifuge
- Duration/Speed 10min at full speed

Test Procedure;

1. Remove water layer form the test tubes.
2. Shake the test tube 20 times.
3. Fill the Centrifuge tubes with solvent to 50%.
4. Fill centrifuge tubes with mixed oil to 100%.
5. Shake tubes to solve the oil completely.
6. Heat the tubes in a water bath (50°C) for about 1min.
7. Centrifuge.
8. Write down emulsion and water (BS&W).
9. Heat the tubes in a water bath (50°C) for about 1min.
10. Centrifuge.
11. Add 1 drop of F46 and shake again (in case of though emulsion use a stirrer to resolve it).
12. Heat the tubes in a water bath (50°C) for about1min
13. Write down centrifuged water.

3. Results and Discussion

The main problem at GOSP 3 in Nafoora is the low temperature in winter time. The Nafoora crude oil has a pour point of 24°C and the start of the wax crystallization is in the range of the winter temperatures. This is stabilizing the emulsion. In addition low temperature means a higher viscosity which slows down the water separation but also makes it more difficult to have a proper mixing of the demulsifier into the crude oil

emulsion. This shows the following diagram. Any additional mixing of the Demulsifier with a changed injection point compared to the one just at the entrance of the separators will improve demulsification.

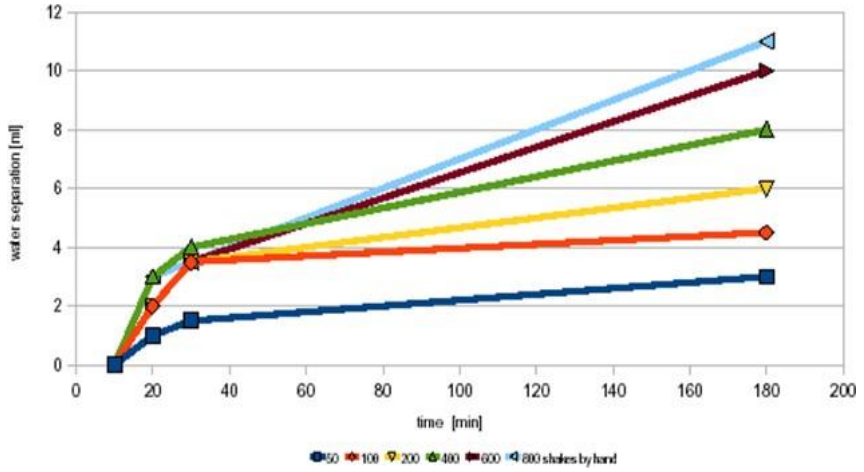
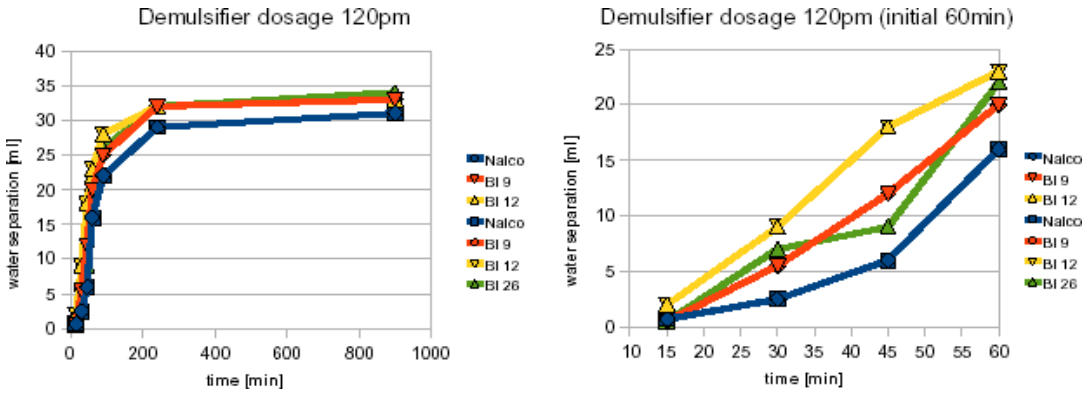


Figure 1. Influence of the mixing intensity on the separation 100 ppm demulsifier, temp. 40^{0}C

The first diagrams show the performance of the recommended blend in comparison to the incumbent product at the different dosage rates on the water separation for the whole time and for the initial 60 min.



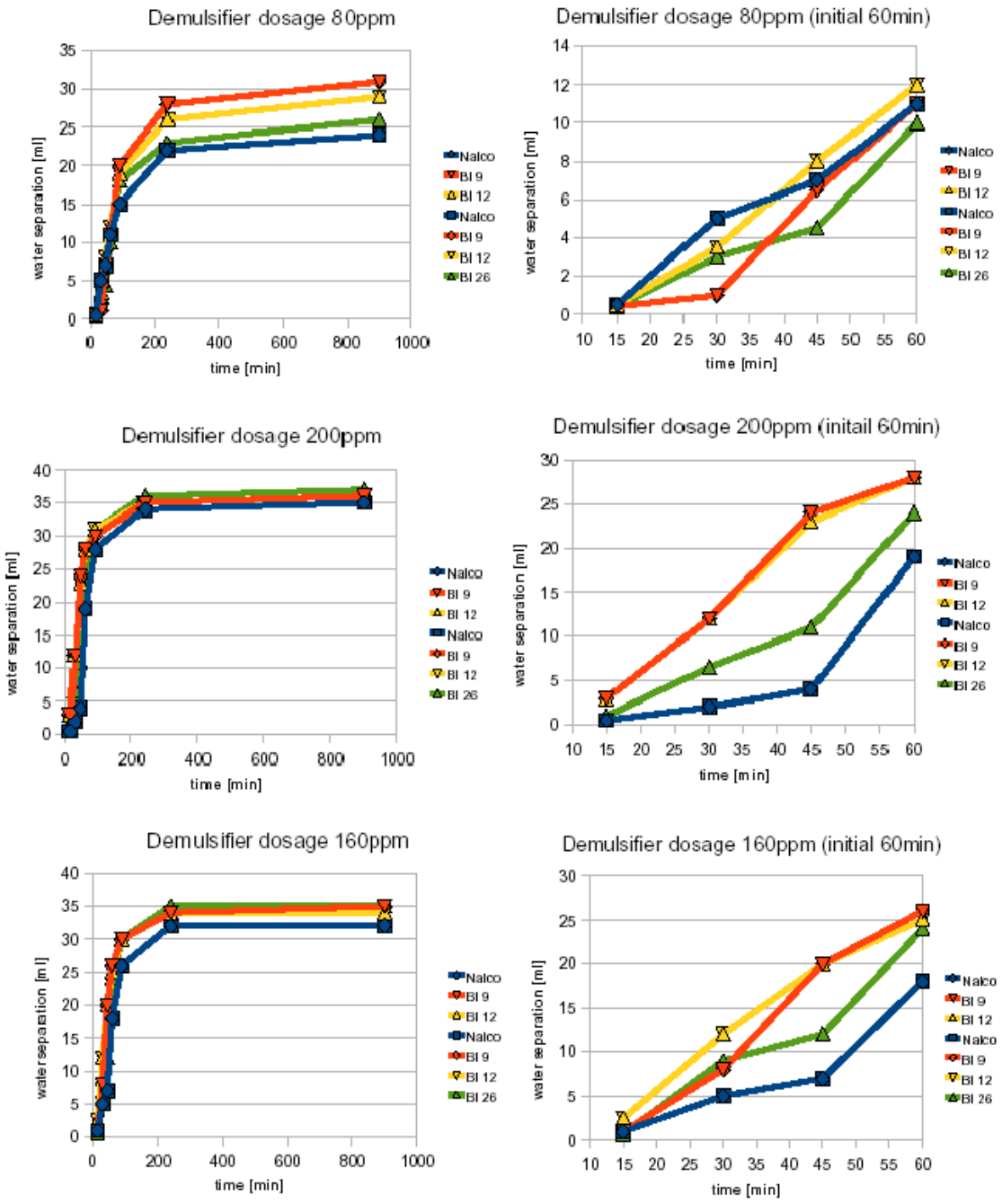


Figure 2. Demulsifier dosage with different ppm values

Top cuts were done after 4 and 15 hours the following diagrams show the excellent performance of the new Demulsifier blends.

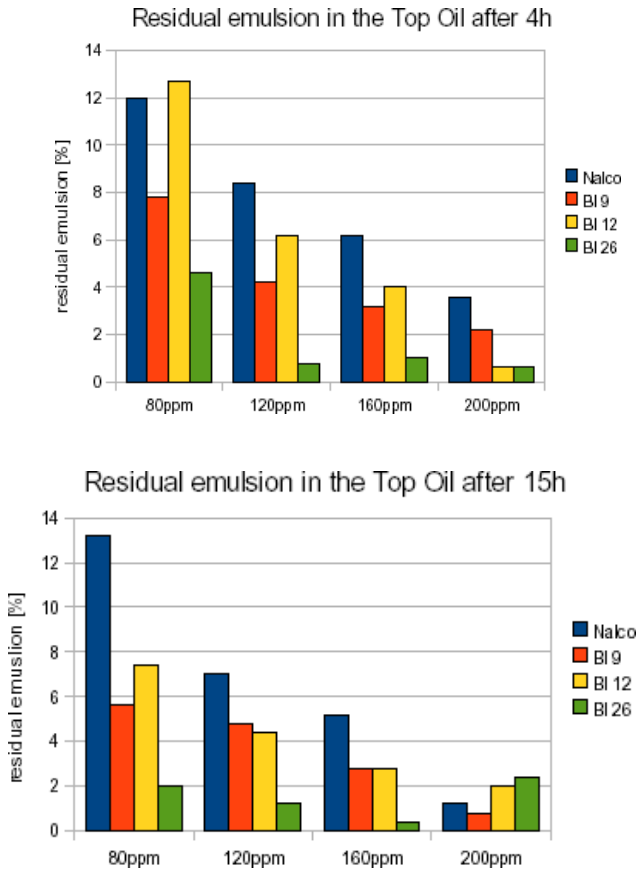


Figure 3. Residual emulsion in the top oil with time variation

The high residual emulsion in the 200ppm BI12 and BI26 might be due to water dripping

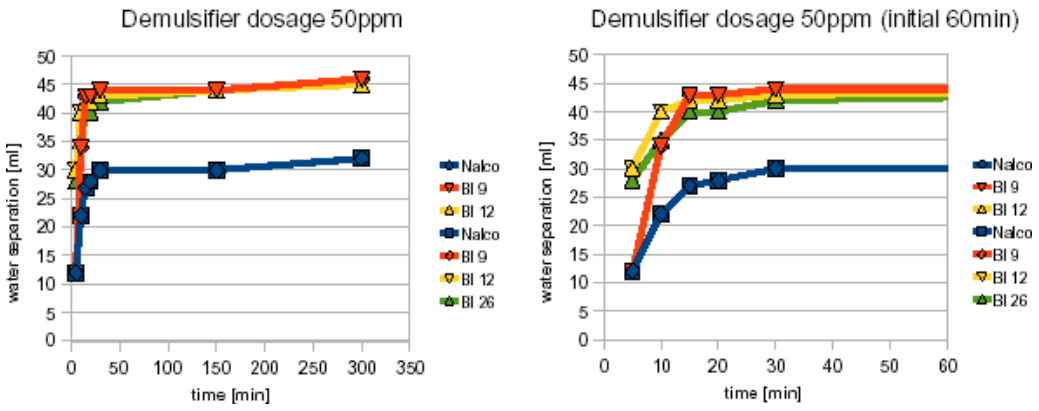


Figure 4. Demulsifier dosage with 50 ppm

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from the water bath lid! In all tests before BI 26 showed the best top cut in all dosages.

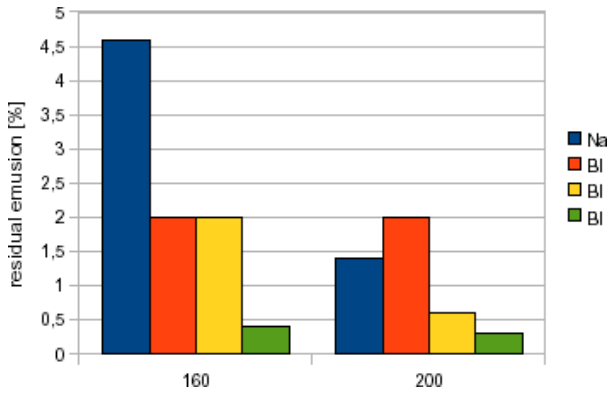

Figure 5. Residual emulsion in the oil (mixed cut) after 15 h.

The same products were also tested with crude oil emulsion from GOSP 6. Here are the results as example for the water separation data of the 50ppm dosage is shown. The final performance of a Demulsifier can only be rated after a field trial.

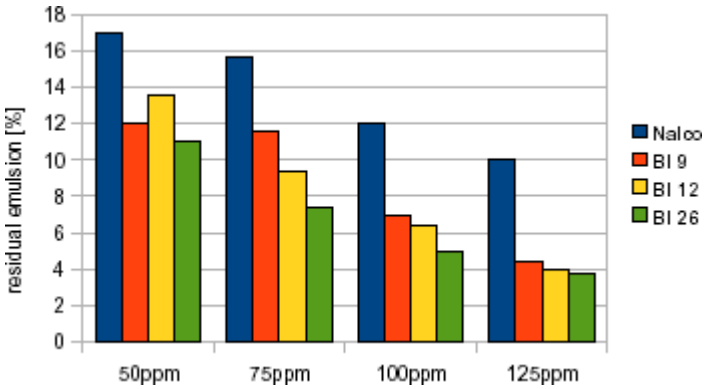

Figure 6. Residual emulsion in the top oil after 5h.

Blend 9 and 12 are best in water separation, blend 26 is best in residual emulsion followed by blend 9.

Recommendation for treating Nafoora crude oil emulsion is blend 9 (**JOF BRAIK6266N).**

4. Conclusion and Recommendation

1. The tests indicate that the **JOF BRAIK6266N** provides at lower dosage rate, faster water separation, top oil quality with lower residual emulsion in the treat crude oil, better interface, and better water quality than product currently being used.

2. **JOF BRAIK6266N** is recommended chemical for demulsification of water and oil from the emulsion produced in Nafoora field.
3. The actual dosing rate can be recommended during field trial since no bottle test ever totally duplicate plant conditions of agitation and surface effects.
4. Bottle test results shows **JOF BRAIK 6266N** gives better performance than the chemical used (NALCO) at present in the field at the lower and same concentration.

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