

New BioBreak NX Chemical Technologies for Oil Field Treatment

NEW CATIONIC BIOPOLYMERS REVERSE EMULSION BREAKER – NX OILFLOC REB-30 / NX OILFLOC REB-31

NEW CATIONIC BIOPOLYMER COAGULANT IS BIODEGRADABLE, VERSATILE AND EFFICIENT, IT IS INTENDED FOR THE CLARIFICATION OF PRODUCTION WATER WITH HIGH CONTENT OF HYDROCARBONS AND SOLIDS. 100% COMPATIBLE WITH EMULSION BREAKER. IT NOT GENERATE SLUDGES OR INTERFACE PROBLEMS IN SURFACE FACILITIES (GUN BARRELS, FWKOS, 3 PHASE SPs).

Challenge:

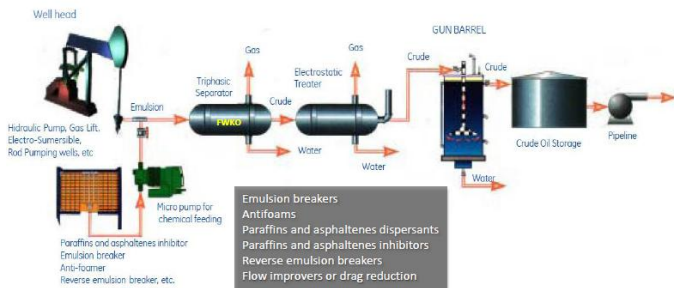
Oil production in mature fields is associated with secondary recovery or disposal, through the injection of production water. Injection water quality is essential to keep the facilities in good condition and minimize the negative impact of contaminants that contribute to faults in surface and downhole installations.

Typically, in mature oil-producing fields, the problems associated with the high oil content in the injection water present two main drawbacks.

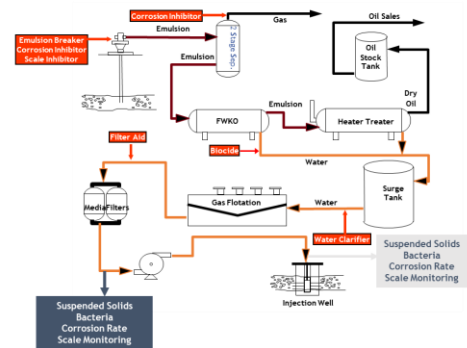
The first one is related to a loss of oil production that is reinjected back into the formation. This oil content can be high since a high volume of production water is injected per day. On the other hand, the presence of oil in water is transformed into a source of carbon, hydrogen and other micronutrients used by bacteria, which, in turn, can cause MIC (Microbiologically Induced Corrosion) on surface and injection well installations. The generation of iron sulfide from the metabolism of sulfate-reducing bacteria causes fouling and clogging of the formation.

In a dehydration plant the production of the batteries distributed in the deposit is received. The received mixture enters a "Free Water Knock Out" (FWKO), Surge Tank, Gun Barrel, which act as three-phase separators and is where the dehydration process begins. The water that is evacuated from the bottom of these surface facilities is sent to a Skimming Tank, where a second separation is made. Flow diagrams typical of a dehydration process are attached:

Crude Oil Chemical Treatments - Onshore

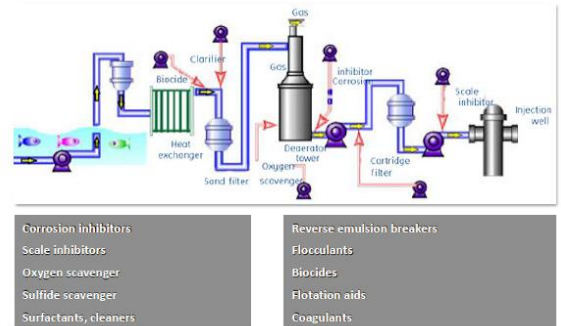


Typical Produced Water System - Onshore



Typical flow diagram for offshore dehydration and clarification.

Water Injection Systems Treatment - Offshore

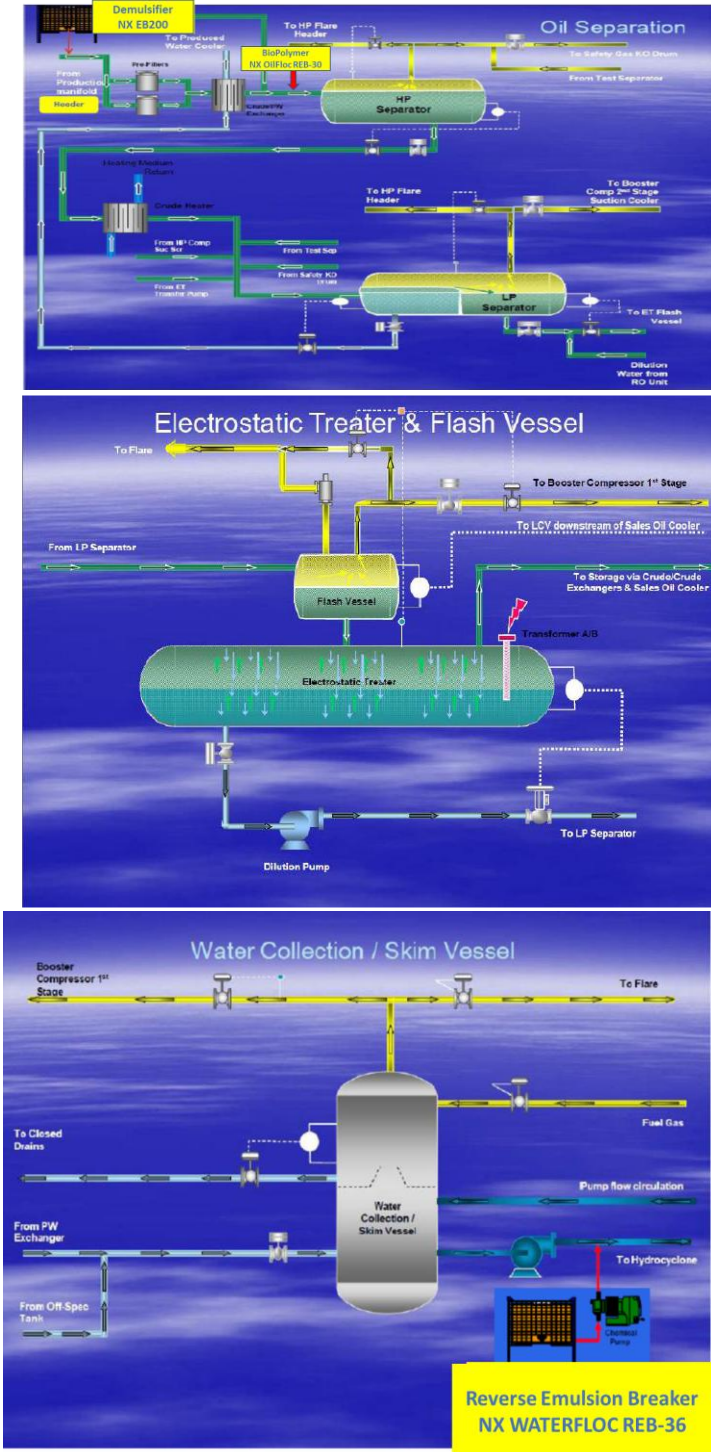


In spite of the majority of dehydration plants having two stages of separation, the water separated and sent to the injection water plant, can contain high contents of oil and solids. Values can range between 50 and 1000 ppm of suspended oils and grease and solids.

Given the large amounts of water injected or discarded, the lost oil is considerable.

NX Chemical has an adequate treatment, applying the direct emulsion breaker together with the reverse emulsion breaker at the entrance of the process.

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Alternative solutions to the problems caused by reverse emulsions:

The alternative solution to these problems was to study at the laboratory level and then apply in the field a product capable of reducing the oil content in water in the first phase of separation, minimizing the drag of hydrocarbons and solids to the water treatment plant residuals, notably improving the interfaces, the quality of the separation water and the non-generation of sludge.

New Technology for the Clarification of Formation Water – NX OilFloc REB-30 / OilFloc REB-31:

In addition to the treatment with primary de-emulsification technology, the use of biodegradable organic cationic polymers has been shown to contribute significantly to the improvement of the oil-in-water separation process.

Unique Characteristics and Main Benefits:

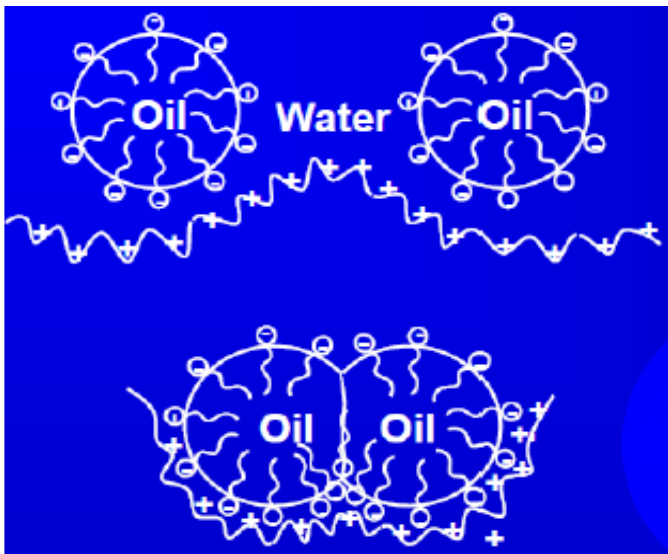
- Cationic coagulant Biopolymer and/or reverse emulsion breaker, indicated for the clarification of production waters with high hydrocarbon content
- Better performance than flocculants of the same chemical nature
- Prevents environmental impacts by being free of oils and greases
- Easy handling and simplicity in the dosing and injection system
- Best cost-benefit for the treatment of production water clarification
- 100% compatible with the Demulsifier
- Acts as a flotation aid and does not contain metallic salts, avoiding the formation of deposits
- Polymer without inclusion of heavy metals in its formulation; helps to avoid stabilization of emulsions when the separated crude is reprocessed.

The new advances in polymer technology developed by **NX Chemical**, have led to the creation of the new product **NX OILFLOC REB-30/NX OILFLOC REB-31** that presents excellent results in operations of dewatering and clarification of produced waters.

Figure No.1, shows the mechanism of operation of the new polymer **NX OILFLOC REB-30 / NX OILFLOC REB-31**.

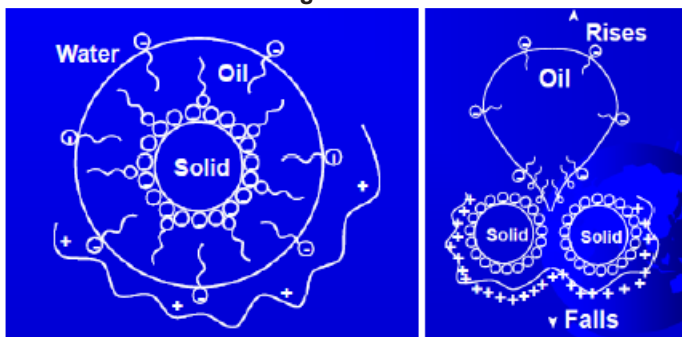
Figure No. 1

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This same mechanism is fulfilled for the case of solid particles where the distribution of charges on the surface of the extended polymer attracts the particles of charged solids and again when neutralizing the polymer charges that keep it extended, the molecule contracts causing the particles solid ones join forming a larger one that precipitates more easily and draining the oil retained between them as illustrated in **Figure No. 2**.

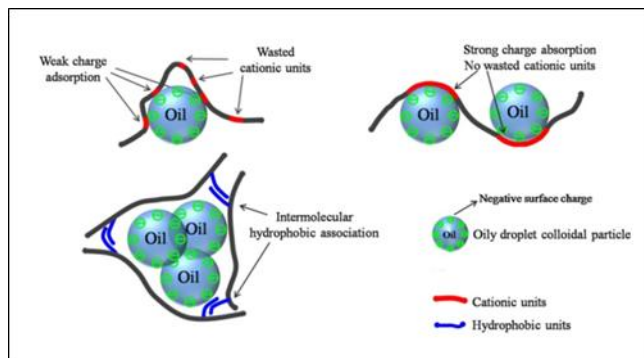
Figure No. 2



How the Physical Reaction of **NX OILFLOC REB-30** Biopolymer Works:

The coagulation process destabilizes the colloid (-), by the action of neutralization of its charge (avoids electrostatic repulsion) by an active of opposite charge (+) (Organic Bio-Polymer **NX OILFLOC REB-30**). These typical reactions of the **NX OILFLOC REB-30** Biopolymer with the inverse emulsion of a formation water with high Hydrocarbon content are described in Figure 3:

Figure No. 3



The application of the new organic polymer **NX OILFLOC REB-30/REB-31** has been proven with excellent results in a large number of oil production fields:

Case Study No. 1:

Location: Latin America

Used Products:

- Emulsion Breaker: **NX BREAK EB-200**
- Reverse Emulsion Breaker Oil Phase: **NX OILFLOC REB-30 / NX OILFLOC REB-31**
- Reverse Emulsion Breaker Water Phase: **NX WATERFLOC REB-36 / NX WATERFLOC REB-37**



Problem:

With the current water clarification treatment, the reaction byproducts generated sludge (see Image 1), which interfere in the dehydration process, causing additional costs for its treatment and final disposal.

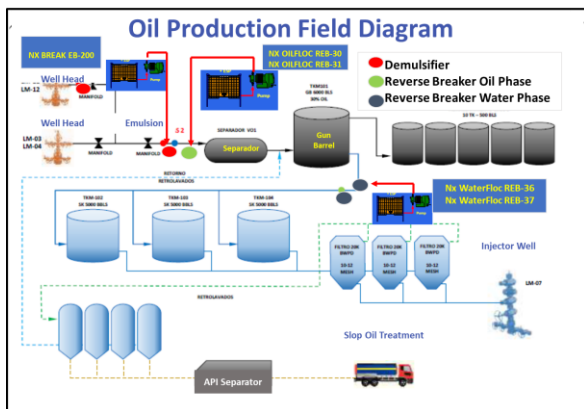


Solution:

NX Chemical

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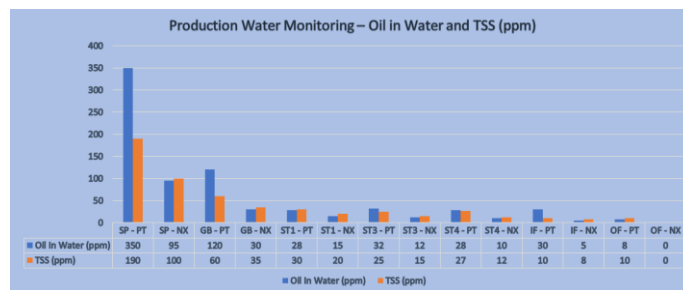
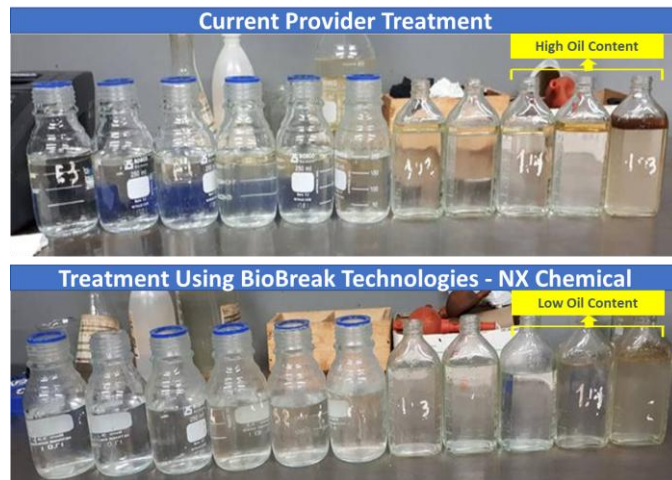
With our treatment of cationic biopolymers, complemented with the addition of the emulsion breaker, these sludges were completely eliminated, since they are technologies that do not generate this type of by-products, leaving the system completely clean. The flow diagram with the application of the recommended chemical products is attached below:



With these recommended products, it was possible to obtain the following results:

- ✓ With the **NX BREAK EB-200** emulsion breaking product, it was possible to maintain an oil quality of 0.05% BSW in a considerably less time than currently used. This product can be dosed together with the **NX OILFLOC REB-30/31** inverse emulsion breaker, as they are compatible and do not generate solids, nor problems of interfaces in the Gun Barrels, Skimming Tanks and Filtration Units.
- ✓ A completely clear water quality is/was obtained, when the direct breaker is dosed together with the inverse breaker at the entrance of the Gun Barrel or in the general manifold of production.
- ✓ The **NX OILFLOC REB-30/31** reverse emulsion breaker was used to minimize the dragging of hydrocarbons and solids to the injection water plant. It is a cationic polymer with low molecular weight and high load.
- ✓ The objective of this treatment was to reduce the drag of solids and hydrocarbons to the injection water plant, allowing to avoid accelerated saturation of solids and oils in the flotation and filtration units. It also avoided the generation of waste and poor effluent quality, which, when returning to normal operation, can cause dehydration problems.
- ✓ It was possible to reduce the emulsion height of the Gun Barrel interface from 60 cm to 0 cm at the end of the field test.
- ✓ Based on the results obtained during the field test, the oil company, Awarded NX Chemical the contract for the integral chemical treatment (Dehydration, Clarification of formation waters, integrity control of surface and bottom

equipment and corrosion control for the gas plant), for all production fields.



Saving Achieved – Case Study No. 1:

- With the application of the Bio-Polymers **NX OILFLOC REB-30/REB-31** and the use of the Emulsion Breaker **NX BREAK EB-200**, the formation of sludge was completely eliminated, optimizing the use of treatments for slop oil and the discarding of 2 trucks weeks of Lees/Sludges that added up to around **US\$500,000/year**.
- It was possible to improve the quality of the injection water, attending values of oil in water (O/W) and suspended solids of 0 ppm.
- It was possible to maintain constant injection pressure in the injection wells
- It was possible to optimize the use of chemical cleaning (Workovers), to restore the injection pressure of the injection wells, twice a year. An estimated savings of **US\$200,000/year** per well.
- It was also possible to avoid production losses, which amounted to around 20% of the field's production. In other words, a saving of 40 barrels of oil/day, an approximate saving of **US\$1,000,000/year**.
- Once all these benefits and savings were obtained, the client awarded NX Chemical the account for a period of 2 years to supply and control all the variables of the chemical treatment in the dehydration process,

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clarification of the injection water and the integrity of the wells and surface facilities. Estimated value of **US\$650,000/year**.

Case Study No. 2:

Location: Latin America

Used Products:

- Emulsion Breaker: **NX BREAK EB-200**
- Reverse Breaker Oil Phase: **NX OILFLOC REB-30/31**
- Reverse Breaker Water Phase: **NX WATERFLOC REB-36**



With these recommended products, it was possible to obtain the following results:

- ✓ With the **NX BREAKPLUS EB-200** emulsion breaking product, it was possible to maintain an oil quality controlled by 0.0% of BSW in a considerably shorter time than currently used. This product can be dosed together with the **NX OILFLOC REB-30/REB-31** reverse emulsion breaker, as they are compatible and do not generate solids, nor problems of interfaces in the Gun Barrels, Skimming Tanks and Filtration Units.
- ✓ A completely clear water quality was obtained (Excellent), when the direct breaker is dosed together with the inverse breaker at the entrance of the Gun Barrel or in the general manifold of production.
- ✓ The **NX OILFLOC REB-30/REB-31** reverse emulsion breaker was used to minimize the dragging of hydrocarbons and solids to the injection water plant. It is a cationic biopolymer of low molecular weight and high load.

API Separator with **NX Chemical** Treatment



Skimming Tank with 50% level with NX Chemical Treatment

Sampling Points	TSS (ppm)	O/W (ppm)
Outlet Gun Barrel	100	120
Inlet Filter Unit – 1	60	70
Outlet Filter Unit - 1	0.5	0.0
Inlet Filter Unit - 2	61	75
Outlet Filter Unit - 2	0.4	0.0
Inlet Filter Unit – 3	60	90
Outlet Filter Unit - 3	0.8	0.5

Visualization of water quality in the Production Field:



Saving Achieved – Case Study No. 2:

- The client gained an additional 20 bbl/day production by optimizing the Gun Barrel interface, generating an additional value of US\$500,000/year in revenue
- It was also possible to reduce the formation of sludge, due to reaction by-products of inappropriate chemical treatments.

Case Study No. 3:

Location: Latin America

Fields: Field-1, Field-2

Used Products:

- Emulsion Breaker: **NX BREAK EB-200 (Field-1)**
- Emulsion Breaker: **NX BREAK EB-203 (Field-2)**
- Reverse Breaker Oil Phase: **NX OILFLOC REB-30**
- Reverse Breaker Water Phase: **NX WATERFLOC REB-37**

Field Conditions Case Study No. 3:

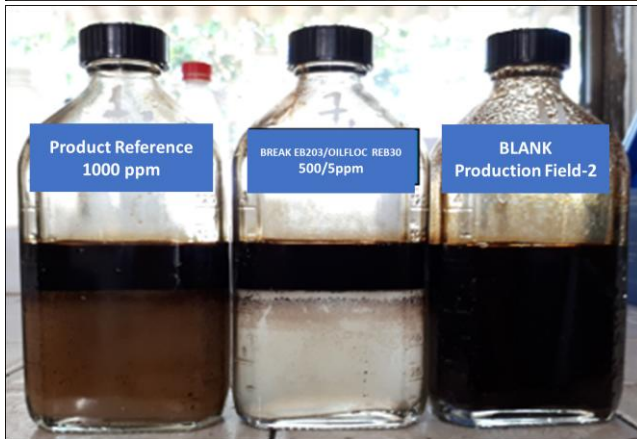
NX Chemical

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- %BSW: 98%
- API: 22 (Field-1)
- API: 30 (Field -2)
- Temp: 50°C – 60°C
- ESP pumping – Hydraulic Pumping
- Presence sludge or slop oil
- Water quality problem for both fields.

- With the **NX BREAK EB-200** emulsion breaking product for Field -1 and **NX BREAK EB-203** for Field-2, was possible to maintain an oil quality controlled by 0.0% of BSW in a considerably shorter time than currently used. This product can be dosed together with the **NX OILFLOC REB-30** reverse emulsion breaker, as they are compatible and do not generate solids, nor problems of interfaces in the Gun Barrels, Skimming Tanks and Filtration Units.

Bottle Test Results:



- A completely clear water quality was obtained (Excellent), when the direct breaker is dosed together with the inverse breaker at the entrance of the Gun Barrel or in the general manifold of production.
- The **NX OILFLOC REB-30** reverse emulsion breaker was used to minimize the dragging of hydrocarbons and solids to the injection water plant. It is a cationic polymer of low molecular weight and high load.
- As a complement for the clarification of the water at the outlet of the FWKOS, the biopolymer **NX WATERFLOC REB-37** was applied, managing to bring values lower than 5 ppm both the suspended solids and the oil in water.
- It was possible to drain excellent quality water, which was injected directly into the injection well, and in this way, the crude oil was sent directly to the dehydration plant (150 km away).
- This allowed an energy saving of avoiding the transport of water of approximately 25,000 barrels per day and reducing the load of the flow line with only clean oil towards the main station.
- For both production fields, excellent crude oil quality and excellent water quality were achieved, with a 40% lower dosage of products than previously used.
- Savings of approximately **US\$150,000/year** were achieved.

Bio Polymer Clarification Tests:



With these recommended products we can guarantee the following benefits:

Case Study No. 4:

Location: Latin America

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Field: Heavy crude production battery

optimizing the formation of lees or sludge in the different production facilities.

Used Products:

- Emulsion Breaker: **NX BREAK EB-200**
- Reverse Breaker Oil Phase: **NX OILFLOC REB-30/31**

Heavy Crude Oil Production Battery



Synergy of the Emulsion Breaker with Reverse Breaker NX OILFLOC REB-30/31



With these recommended products we can guarantee the following benefits:

- With the **NX BREAKPLUS EB-200** emulsion breaking product, it was possible to maintain an oil quality controlled by 0.2% of BSW in a considerably shorter time than currently used. This product can be dosed together with the Bio-Polymer **NX OILFLOC REB-30/REB-31** reverse emulsion breaker, as they are compatible and do not generate solids, nor problems of interfaces in the Gun Barrels, Skimming Tanks and Filtration Units.
- A completely clear water quality was obtained (Excellent), when the direct breaker is dosed together with the reverse emulsion breaker at the entrance of the Gun Barrel or in the general manifold of production.
- The **NX OILFLOC REB-30/REB-31** reverse emulsion breaker was used to minimize the dragging of hydrocarbons and solids to the injection water plant. It is a cationic polymer of low molecular weight and high load.
- The quality of the separation water improved by 100%, reducing the carryover of suspended solids and hydrocarbons (Oil in Water) to the water treatment plant,

Case Study No. 5:

Company: **Medium oil production field in LAM**
Field: **Oil Production Field in LAM**

Used Products:

- Emulsion Breaker: **NX BREAK EB-202**
- Reverse Breaker Oil Phase: **NX OILFLOC REB-30**
- Reverse Breaker Water Phase: **NX WATERFLOC REB-36**
- Reverse Breaker Water Phase: **NX WATERFLOC REB-37**

Medium Oil Production Field in Latin America



Current Treatment – Sludge Generation into the API Separator



Synergy of the Emulsion Breaker with Bio-Polymer NX OILFLOC REB-30

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Location: Latin America
Field: Light oil production field with high paraffin content.

Used Products:

- Emulsion Breaker: **NX BREAK EB-202**
- Reverse Breaker Oil Phase: **NX OILFLOC REB-30**
- Reverse Breaker Water Phase: **NX WATERFLOC REB-36**

With these recommended products we can guarantee the following benefits:

- With the **NX BREAKPLUS EB-202** emulsion breaking product, it was possible to maintain an oil quality controlled by 0.1 to 0.2% of BSW in a considerably shorter time than currently used. This product can be dosed together with the Bio-Polymer **NX OILFLOC REB-30** reverse emulsion breaker, as they are compatible and do not generate solids, nor problems of interfaces in the Gun Barrels, Skimming Tanks and Filtration Units.
- A completely clear water quality was obtained (Excellent), when the direct breaker is dosed together with the reverse emulsion breaker at the entrance of the Gun Barrel or in the general manifold of production.
- The **NX OILFLOC REB-30** reverse emulsion breaker was used to minimize the dragging of hydrocarbons and solids to the injection water plant. It is a cationic polymer of low molecular weight and high load.

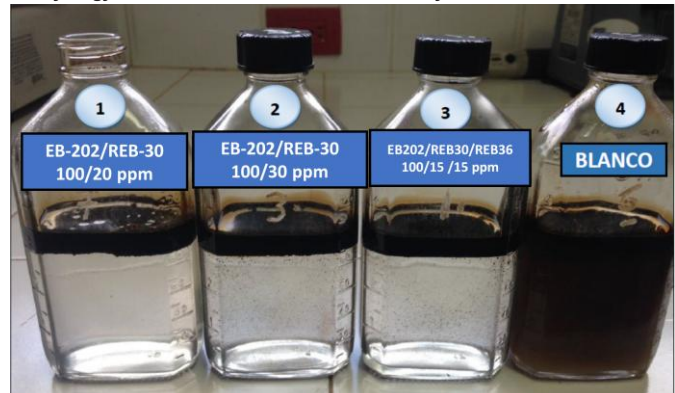
Saving Achieved – Case Study No. 5:

- The client managed to gain more production, only the improvement of the reduction in the Gun Barrel interface. This meant an additional benefit of 45 barrels/day, generating an additional value of more than **US\$1,000,000/year**.
- It was also possible to reduce the formation of lees or sludge, due to reaction by-products of inappropriate chemical treatments.
- Previously, the customer incurred many additional expenses and services related to the treatment and preparation for the discharge of slop oil.
- Once the operation was stabilized with the **NX Chemical** products, no more slop oil was generated, resulting in the signing of a new 2-year contract. Estimated value in **US\$800,000/year**

Case Study No. 6:



Synergy of the Emulsion Breaker with Bio Polymer NX OILFLOC REB-30



Confirmation Test – Room Temperature

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As we can see that the synergy of the direct breakers is 100% compatible with the reverse breakers **NX OILFLOC REB-30** (applied in the oil phase) and the reverse breakers **NX WATERFLOC REB-36** and/or **NX WATERFLOC REB-37** (applied in the water phase - output of Gun Barrels, Wash Tanks, Skimming Tanks, Entry Flotation Units, and Inlet Filters).

Benefits and Saving Achieved – Case Study No 6:

- With the **NX BREAKPLUS EB-202** emulsion breaking product, it was possible to maintain an oil quality controlled by 0.1 to 0.2% of BSW in a considerably shorter time than currently used. This product can be dosed together with the Bio-Polymer **NX OILFLOC REB-30** reverse emulsion breaker, as they are compatible and do not generate solids, nor problems of interfaces in the Gun Barrels, Skimming Tanks and Filtration Units.
- A completely clear water quality was obtained (Excellent), when the direct breaker is dosed together with the reverse emulsion breaker at the entrance of the Gun Barrel or in the general manifold of production.
- The **NX OILFLOC REB-30** reverse emulsion breaker was used to minimize the dragging of hydrocarbons and solids to the injection water plant. It is a cationic polymer of low molecular weight and high load.
- As a complement for the clarification of the water at the outlet of the FWKOS, the biopolymer **NX WATERFLOC REB-36** was applied, managing to bring values lower than 2 ppm both the suspended solids and the oil in water.
- The client managed to gain more production, only the improvement of the optimization of 100% reduction in the Gun Barrel interface. This meant an additional benefit of 30 barrels/day, generating an additional value of **US\$750,000/year**.
- It was also possible to reduce the formation of lees or sludge, due to reaction by-products of inappropriate chemical treatments.
- The value of the contract was signed for one year, with a value of **US\$400,000/year**

Location: Latin America

Field: Light Crude Oil with high paraffin content.

Used Products:

- Emulsion Breaker: **NX BREAK EB-201**
- Reverse Breaker Oil Phase: **NX OILFLOC REB-30**



Benefits and Saving Achieved – Case Study No 7:

- With the **NX BREAKPLUS EB-201** emulsion breaking product, it was possible to maintain an oil quality controlled by 0.0 to 0.1% of BSW in a considerably shorter time than currently used. This product can be dosed together with the Bio-Polymer **NX OILFLOC REB-30** reverse emulsion breaker, as they are compatible and do not generate solids, nor problems of interfaces in the Gun Barrels, Skimming Tanks and Filtration Units.
- A completely clear water quality was obtained (Excellent), when the direct breaker is dosed together with the reverse emulsion breaker at the entrance of the Gun Barrel or in the general manifold of production.
- The **NX OILFLOC REB-30** reverse emulsion breaker was used to minimize the dragging of hydrocarbons and solids

Case Study No. 7:

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to the injection water plant. It is a cationic polymer of low molecular weight and high load.

- The client managed to gain more production, only the improvement of the optimization of 100% reduction in the Gun Barrel interface. This meant an additional benefit of 10 barrels/day, generating an additional value of **US\$250,000/year**.
- It was also possible to reduce the formation of lees or sludge, due to reaction by-products of inappropriate chemical treatments. (Inorganic Polymers).
- The value of the contract was signed for one year, with a value of US\$200,000/year

Conclusions of the BioBreak - Biopolymers "NX Chemical":

- **NX OILFLOC REB-30**
- **NX OILFLOC REB-31**
- **NX WATERFLOC REB-36**
- **NX WATERFLOC REB-37**
- **NX WATERFLOC REB-38**

- ✓ All the fields of production evaluated, for the process of dehydration, it is possible to maintain a quality of controlled crude less than or equal to 0,0% to 0.5% of BS&W and in a considerable time less than currently used.
- ✓ The emulsion breaker can be dosed together with the reverse emulsion breaker **NX OILFLOC REB-30/NX OILFLOC REB-31**, as they are compatible and do not generate interface problems in the FWKO, Gun Barrels, Skimming Tanks and Filtration Units.
- ✓ With this synergy of treatment, a completely clear and clear water quality is obtained (Excellent), when the direct breaker is dosed together with the inverse breaker at the entrance of the FWKO, Gun Barrel or production manifold.
- ✓ The **NX OILFLOC REB-30/NX OILFLOC REB-31** reverse emulsion breaker is used to minimize the drag of hydrocarbons and solids to the injection water plant. It is a cationic polymer of low molecular weight and high cationic charge, 100% compatible with the direct breaker.

- ✓ The aim of the proposed treatment, with the new **NX OILFLOC REB-30/REB-31** technology, is to be able to reduce the dragging of solids and hydrocarbons to the injection water treatment plant, this allows to avoid accelerated saturation of solids and oils in the filtration units (Gauge Tank), avoiding as far as possible the generation of waste and effluents of poor quality, which, when returning to the operation, can cause dehydration problems.
- ✓ With the previous water clarification treatment, in most of the production fields evaluated, the reaction byproducts are generating sludge, which interfere in the dehydration process and generate additional costs for their treatment and final disposal.
- ✓ With our treatment of cationic polymers, these slicks would be eliminated completely, since they are technologies that do not generate this type of by-products, leaving the system completely clean and without the presence of them.
- ✓ As a complement for the clarification of the water at the outlet of the FWKOS, the biopolymers **NX WATERFLOC REB-36, NX WATERFLOC REB-37 or NX WATERFLOC REB-38** can be applied, providing excellent water quality in skimming tanks, flotation units, inlet to filtration units, and ensuring 0 ppm of oil in water and 0 ppm of suspended solids at the filter outlet.
- ✓ This makes it possible to keep the injection pressure constant, avoiding as far as possible losses of injectivity or increases in injection pressure.
- ✓ In general, the use of these new biopolymers (**NX Chemical**) in all production fields has reduced the formation of lees or sludge at interfaces and other surface facilities by 100%, obtaining great value for customers by reducing handling and disposal of these sludge due to inappropriate treatments, always looking for the best cost benefit of the process at truly competitive costs.
- ✓ For additional details and information, please visit our website at www.nxchemical.com or contact us at Telephone: +1 (832) 510 8191 or via email jorge.paredes@nxchemical.com, or david.engel@nxchemical.com