NX Chemical BioBreak Technology

NX OilFloc & NX WaterFloc Biopolymers for Emulsion Breaking

NX Chemical

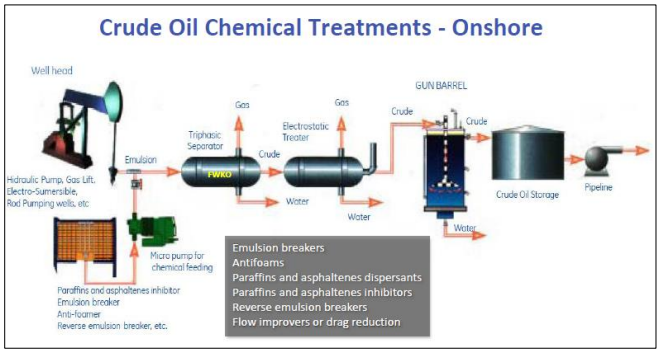
Novel Biopolymers for Hydrocarbons and Suspended Solids Control in Water

The Challenge:

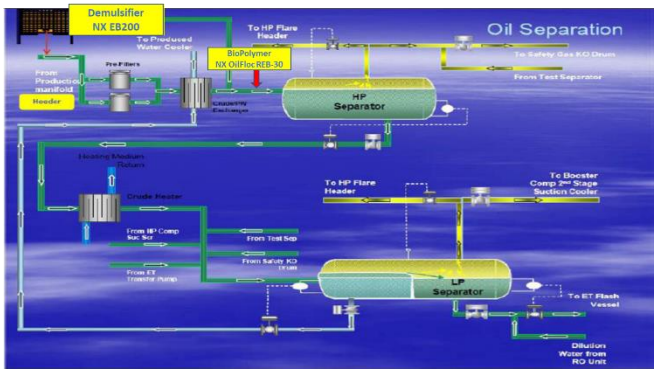
Oil production in mature production fields is associated with secondary recovery or disposal, through the injection of production water. Injection water quality is essential to keep the facilities in good condition and minimize the negative impact of contaminants that contribute to disposal in surface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

Normally in mature fields of oil production, the problems associated with the high oil content in the injection water present two main drawbacks. The first one is loss of oil production that is reinjected back into the formation. This oil content can be high since a significant volume of production water is injected per day. Secondly, the presence of oil in water is transformed into a source of carbon, hydrogen and other micro-elements used by bacteria that can cause MIC (Microbiologically Induced Corrosion) on surface and well installations Injectors. The generation of iron sulfide from the catabolism by sulfate-reducing bacteria causes fouling and clogging of the formation.

In a dehydration facility, the crude oil/water mixture from the production batteries is received and treated for water and solids removal. The received mixture enters a "Free Water Knock Out" drum (FWKO), Surge Tank or Gun Barrel vessel, which act as 3-phase separators where the dehydration process begins. The water that is removed these vessels and sent to a skimmer tank, where a second separation of the oil and water is performed. A simplified flow diagram of a general dehydration facility and process is shown below (both for offshore and offshore):



Crude Oil Chemical Treatments - Offshore



Despite the fact that the majority of dehydration facilities have 2-stages of separation. The separated water sent to the produced water injection plant can contain high levels of residual oil and solids. Values can range between 100 and 5,000 ppm of oils, grease and solids. Given the large amount of produced water injected or discarded during oil production, the oil losses can be considerable.

The Solution:

NX Chemical has a highly effective technology to address these detrimental effects. The solution considers applying a direct emulsion breaker together with the reverse emulsion breaker at the entrance of the process (down hole, well head, manifold, cluster, and others).

The improved solution to address the lack of efficiency in oil-water separation was determined at the NX Chemical laboratories and then applied in the field. NX Chemical technologies were capable of reducing the oil content in water in the first phase of separation, minimizing the carryover of oil and solids to the water treatment plant. In addition to significantly improving the oil-water interfaces, water quality and minimal generation of residual sludge inside vessels. The following discuss the NX Chemical technologies in more detail.

New BioBreak Technology for the Water-Oil Separation

NX OilFloc REB-30 & NX OilFloc REB-31

In addition to the treatment with primary emulsion breaker technology, the use of NX Chemical BioBreak biopolymers has shown to significantly improve the oil-water separation process duding crude oil production.

Unique Characteristics and Main Benefits:

- Bio-Break biopolymers reverse emulsion breaker resulted in excellent clarification and separation of produced water with high hydrocarbon content.
- Superior performance compared to conventional flocculants of the same use.
- Prevents environmental impacts by delivering produced water free of oil and grease.
- Easy handling and simple dosage using existing chemical injection systems.
- Best cost-benefit for treating and clarifying produced water.
- 100% compatible with other NX Chemical emulsion brakers.
- Acts as a flotation aid and does not contain metal-based salts, hence, avoiding the formation of sludges, scale of deposits.
- BioBreak biopolymers by NX Chemical do not contain heavy metals in its formulation, therefore helps to avoid stabilization of emulsions when the separated crude is reprocessed.

Advances in biopolymer technology developed by NX Chemical, have led to the creation of the new product line called BioBreak. The full BioBreak product line include: **NX OilFloc REB-30, NX OilFloc REB-31, NX WaterFloc REB-36 and NX WaterFloc REB-37.** This biopolymer technology proved to deliver excellent results in operations of dewatering and clarification of produced water in both onshore and offshore operations.

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Figure 1, shows the schematic oil and solids coagulation mechanism for the new BioBreak biopolymers **NX OilFloc REB-30 & NX OilFloc REB-31:**

Figure 1 Figure 2

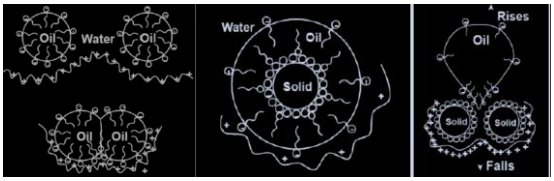
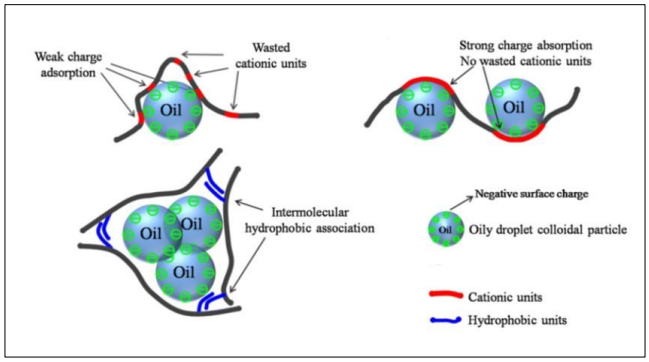


Figure 2 shows how the biopolymer product eliminates solid particles by a mechanism where the distribution of charges on the surface of the polymer attracts the charged solid particles. As the polymer is neutralized it contracts, causing the solid particles to join forming a larger particle that precipitates easier and faster as residual oil drains from between particles.

How the Physical Reaction of NX OilFloc REB-30 Biopolymer works:

The coagulation process destabilizes the negatively-charged colloids by neutralization of charges by adsorption of oppositely charged (+) biopolymer **(NX OilFloc REB-30 & NX OilFloc REB-31).** Essentially avoiding electrostatic repulsion of the colloids. The typical reactions of the **NX OilFloc REB-30 & NX OilFloc REB-31** biopolymers with the emulsion from formation, formation water or produced water with high oil contents are illustrated in Figure 3. The application of **NX OilFloc REB-30 & NX OilFloc REB-31** has proven to deliver excellent results in a number of oil production fields.

Figure 3



Root Cause Analysis | Proposed Solution | How We Solved the Challenge

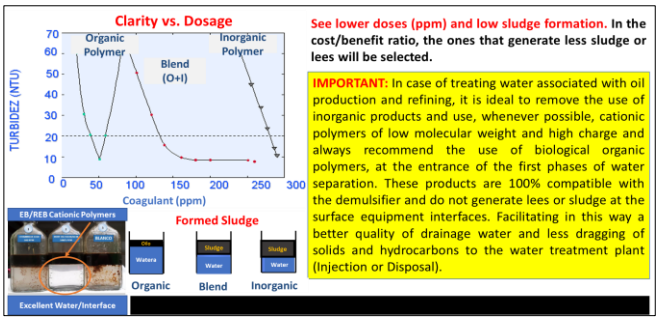
Oil production fields and water treatment facilities encounter a number of problems caused by chemical additives used not suitable for produced water clarification. Whether water is used for disposal, secondary recovery or tertiary recovery the issues can lead to significant costs. Most of these problems are associated with reaction byproducts of inorganic polymers, nonionic polymers, anionic polyacrylamides used in water treatment generating sludges and deposits, which is cumulative in surface equipment, such as free water knock outs (FWKOS), gun barrels, 3-phase separators, skimming tanks, flotation units, filtration systems and others. This affects considerable the quality of the injection water, causing an increase in the injection pressure, plugging of the injection wells, problems in the dehydration process, oil production losses caused by the slop oil generated and high treatment costs associated with sludge formation. A photographic description of the sludges commonly formed in these processes, because of unsuitable chemical treatments is shown below. Figure 4 displays the formation of sludges and how to NX Chemical evaluated the use of BioBreak biopolymers for its elimination.

Figure 4

The BioBreak biopolymer technology must always be evaluated through bottle tests, to select effective emulsion breakers. The emulsion breaker is added to each bottle together with the BioBreak biopolymer, with the objective of verifying the synergy between both materials and for confirming the quality of the separated water, quality of the interface and separation of the emulsion in the oil-water mixture.

Figure 5

Figure 5 shows the dosage curve of a direct emulsion breaker with given NX Chemical biopolymer product in comparison with a direct emulsion breaker with a conventional inorganic polymer.



To illustrate the effectiveness of the synergy between the direct emulsion breaker and the **NX OilFloc REB-30 & OilFloc REB-31** biopolymers, the following historical case is illustrated next. The work was carried out onsite at a production field. The production facility was experiencing a number of issues such as leakage and sludge formation caused by the use of inappropriate synthetic and/or inorganic polymers in the primary treatment for oil-water separation and also for solids control.

The Challenge:

Obtain oil in water (O/W) concentration <10 ppm at the filter inlet and near zero concentration O/W at the filter outlet.

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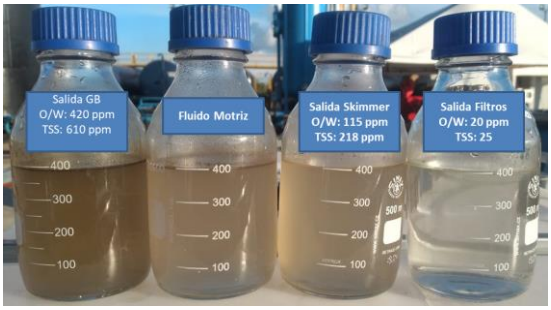
Previous Treatment

Point	O/W (ppm)	TSS (ppm)
Outlet Gun Barrel	**420**	**610**
Outlet Skim/EF	**115**	**218**
Outlet Filters	**20**	**25**

Results with NX Chemical Biopolymers

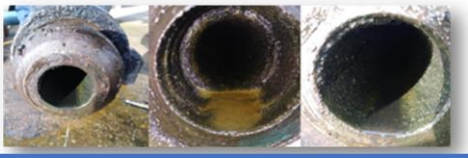
Point	O/W (ppm)	TSS (ppm)
Outlet Gun Barrel	20	**22**
Outlet Skim/EF	5	**5**
Outlet Filters	0	**0**



Skimmer during filling | Pool with high content O/W

Skimmer during filling - Clean | Pool with low content O/W

Paraffin Plugged Flow Lines



Flow lines completely free of paraffins

The Solution:

In order to improve performance at the production facility testing protocols were carried out considering the use of a combination of the new NX Chemical direct emulsion breaker **(NX Break EB-201)** together with the biopolymer **(NX OilFloc REB-31)**. The combination chemical was applied to the entrance of the Gun Barrel separator. In addition, to further improve performance of the overall process, the NX Chemical BioBreak biopolymer **NX WaterFloc REB-37** was used at the entrance of the skimmer vessel.

In addition to **NX OilFloc REB-30 & OilFloc REB-31** used, a few other NX Chemical BioBreak biopolymers were applied at the exit of the first separation phase. These additional BioBreak biopolymers were:

- **NX WaterFloc REB-36**
- **NX WaterFloc REB-37**
- **NX WaterFloc REB-38**

The above 3 biopolymers are complementary and synergistically applied to the inlet of the skimmers, flotation units or filtration systems for polishing the process to achieve the stringent water specifications prior to it being injected or discarded. The synergistic effect was most effective when maintained in a 1:1 ratio of the biopolymers used at the entrance to the first separation stage. Finally, it is critical to point out that none of the NX Chemical BioBreak biopolymer products generated any sludge in the process.

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