



is published for the benefit of our friends and clients. If you have any questions about this article please contact us at 281-398-5781
info@gatellc.com

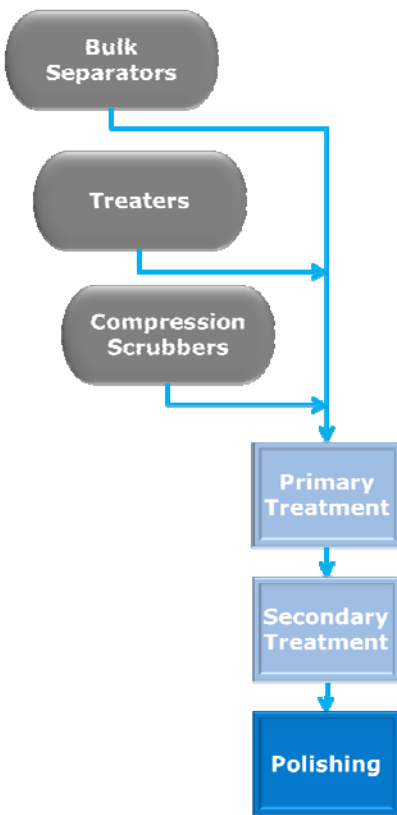


Figure 1: Produced Water System Schematic



Produced Water Polishing

Produced water systems can be divided into 3 parts including primary, secondary, and polishing, as shown in Figure 1. In earlier GATEKEEPERS, the primary and secondary stages were discussed. Primary treatment is typically done via hydrocyclones or sometimes skim tanks. Secondary treatment is typically done via flotation units. Effluent from the second stage generally meets overboard discharge requirements and the polishing stage is typically not needed.

There are several other circumstances in which a polishing stage may be installed. These include:

- Water deoiling, which is particularly difficult if the oil density is very high.
- Platform is in an environmentally sensitive area and the operator is required to or chooses to exceed typical regulatory requirements and have lower oil and grease (O&G) targets.
- Water is to be re-injected and the re-injection spec is tighter than the overboard discharge spec.
- Polishing is added to handle upset conditions or is added to handle non-steady state conditions, such as startup.
- Removal of water soluble organics (WSOs).
- Polishing equipment is installed to handle well flowback fluids.

Because polishing is infrequently used, there is no industry consensus on the preferred method. For this GATEKEEPER, the different equipment and methods for polishing produced water are explored.

Flotation Unit—Coalescer—Flotation Unit Operated in Series

Secondary treatment is typically a flotation unit in the GoM. Produced water leaving secondary treatment generally has very low O&G concentrations and very fine oil droplets. A coalescer and second flotation unit may be added in series with the first to improve oil removal.

This scheme works best if a coalescer is installed upstream of the second unit. Without the coalescer, the second flotation unit will not remove much of the oil that made it through the first flotation unit because the oil droplets will be very small.

Deep Bed Multimedia Filters

Deep bed media filtration removes suspended solids and oil from the water phase by passing the water through a deep bed of granular material. Backwashing is then used to clean the media bed and remove the impurities.

There are different types of deep bed multimedia filter materials including sand and nut shells. Although typically not used offshore due to their size and weight, nut shell filters are becoming more popular due to recent advances in making them smaller and lighter. Nut shell filters offer higher inlet stream concentration abilities, often limited to between 100-150 mg/l where other deep bed multimedia bed filters are limited to 30-50 mg/l.

Oil characteristics must also be considered when recommending deep bed multimedia filters. Heavy oils are more likely to plug media beds quicker and thus affect the length of the filtration cycle. Waxy or other fouling oils will reduce filtration cycles as well as media life. Deep bed multimedia filters should not be operated above the maximum rated flow as this increases the velocity of the water through the media bed and may cause the attached oil droplets to detach and move into the outlet stream.

Deep bed multimedia filters offer up to 95% removal efficiency of oil droplet sizes down to 2 µm and 98% efficient at removing up to 5 µm or greater oil droplets.



Figure 2: Centrifuge Skid



Figure 3: Carbon Filter

Upstream engineering for offshore oil and gas specializing in:

- Chemical Systems Engineering
- Materials & Corrosion
- Flow Assurance
- Waterflood
- Commissioning & Startup



Activated Carbon Filters & Other Absorption Technologies

Activated carbon filters are very effective for removal of low levels of hydrocarbons including dissolved hydrocarbons (WSOs). However, they are large and heavy, and require relatively frequent carbon replacement. They are occasionally used offshore to rescue underperforming systems.

Various other proprietary absorption technologies exist in the market which may be as or more effective than activated charcoal. These include some polymers including Macro Porous Polymer Extraction (MPPE).

Centrifuges

Centrifuges have been tried offshore for produced water treatment on several occasions. Theoretically, centrifuges could be among the most effective separation technologies available. GATE is aware of 18 offshore centrifuge applications (beginning in the 1990's). With two possible exceptions (Tyra East and West), centrifuge applications have largely been unsuccessful. Centrifuges have been successfully used on low flowrate streams such as treatment of flowback fluids and treatment of wet oil reject streams.

The reasons for the failure of centrifuge installations is difficult to determine specifically in most cases. Identified issues include:

- Unfamiliarity of oilfield design firms with centrifuge technology resulting in inadequate auxiliary facilities including utilities supply.
- Unfamiliarity of offshore operators and maintenance personnel with centrifuge technology.
- Inadequate preservation of centrifuges during construction and installation.
- Solids deposition within centrifuges.
- Water chemistry issues including scale deposition.

Water Soluble Organics

WSOs are counted in the O&G overboard limits, but are not removed by most deoiling technologies discussed above, a major exception being activated carbon.

In the GoM, O&G is legally defined as those compounds which extract into n-hexane from water at a pH less than 2 and which remain after the solvent has been boiled away. Hence, it includes only relatively non-volatile compounds; volatile compounds will be vaporized in the boiling step.

Adjustment of the pH to 2 prior to extraction is an important feature of this test. All hydrocarbons will partition to some extent to the water phase. Some species, notably aromatics such as benzene, partition to the water in measurable quantities, but the solubility of most substances is not very sensitive to pH. An exception to this are some polar hydrocarbons, in particular carboxylic acids (fatty acids), which partition mainly to the oil phase at low pH, but are soluble in water at higher pH's.

Because of the measurement method, it is fatty acids which constitute the bulk of WSO's in the GoM, whereas light aromatics constitute much of the WSO concentration in the North Sea.

Because of the composition difference, different technologies are required for removal. In the GoM, polar organics are typically removed via pH adjustment (down to about 5.5) upstream of bulk oil/water separation.

Proprietary technologies, such as CTour™ or MPPE, may be required to remove BTEXs.