NEW LOGIC RESEARCH

Case Study

Using V✧SEP to Treat Produced Water

An effective and economical solution

An Offshore Oil Drilling Platform

Introduction

Every few years, Oil companies will re-evaluate new technologies on the market for oily wastewater treatment. Technological improvements have been especially significant in the area of membrane filtration. New Logic Research has developed a proprietary membrane filtration system that is uniquely suited for treatment of Produced Water, Barge and Bilge Water, and Drilling Mud.

The use of a vibrating membrane mechanism to avoid membrane fouling is new and is just the kind of improvement needed to make the use of membrane filtration an effective and economical treatment solution for Oil Drilling operations. New Logic has completed several treatment facility installations using this vibrating membrane system for treating all kinds of petrochemical wastewater. The results have demonstrated many advantages of this new membrane technology when compared to the conventional crossflow filtration techniques and other methods of treatment. This new membrane system is know as V✧SEP which is an acronym for Vibratory Shear Enhanced Process and is manufactured by New Logic Research at its factory in Emeryville California near San Francisco.

What is Produced Water?

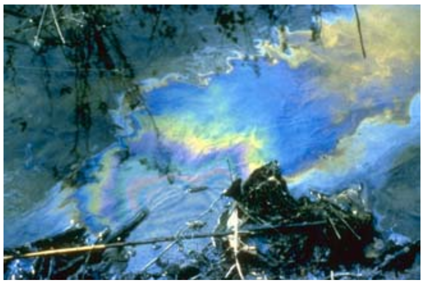
Oil drilling operations can create large quantities of contaminated water known as “Produced Water”, or water that is produced from the well. Most underground oil reservoirs have a natural water layer called Formation Water, which lies underneath the hydrocarbons.

As a well ages and oil becomes difficult to remove, water or steam is injected into the reservoirs to help force the oil to the surface. Both formation and injected water eventually make their way to the top and are produced at the well head along with the hydrocarbons.

As the oil/water mixture is pumped out of the well, it is separated yielding the hydrocarbon product and the Produced Water. As the oil level drops in the reservoir, the amount of water injected increases to fill the void. In the United States, Produced Water coming from Oil wells is 8 times the volume of the oil produced. These volumes represent huge amounts of contaminated water that require economical and environmentally freindly methods of treatment so it can be re-used or disposed of safely.

Produced Water Regulation

International conventions have set provisional targets of 40 ppm for hydrocarbons in offshore operation discharge. This 40 ppm number is a target and is voluntary in most areas. In offshore environments, anything above 100 ppm is considered an oil spill. At onshore installations, the oil companies have more space for large heavy equipment, sand filters, settlement ponds, and long process times to reduce the oil in water concentration of bilge water and other effluents to as low as 4ppm. In US coastal waters, the EPA set limits in 1993 at 29 ppm monthly average “oil and grease” content for produced water, with a daily maximum of 42 ppm. Offshore, discharges of produced water containing oil cannot be compared with large oil spills because the small amounts of oil are dispersed within the sea and do not form a surface slick. But, nearly all offshore installations usually have faint but visible streaks of sheen extending for hundreds of meters downwind of them, even when their water treatment plants are the best available. On calm water a visible sheen can form at 25ppm.



Produced water volumes tend to increase dramatically as older oilfields pass their peak production It is important to note that the reporting and monitoring system for discharges of produced water is based almost entirely on self-reporting. Unannounced visits by government inspectors to platforms are almost unheard of and, because helicopter access to the installations is controlled by the oil industry, almost impossible to arrange. Inspectors may be stationed on individual platforms for periods of time, but permanent on-site inspection does not happen.

Produce Water Re-use and Discharge

To mitigate the problem of Produced Water, four approaches can be used:

1]Avoid water production from the well.
2]Inject back into the same well
3] Inject the water into discharge wells
4] Treat the water for disposal

During the early stages of oil production from a well, injection water is not needed. In this case, the produced water presents a disposal problem. To account for this other wells are drilled where voids exist for injection and disposal of this water. This method of disposal can be quite expensive, especially offshore. Also the disposal well must be located a significant distance from the oil producing well and must be pumped or hauled to the injection point. Very often the void can be a porous area and so re-injected water must be managed so that the injected water does not plug the pores of the formation.

In the later stages of the life cycle of a well, water is injected underneath the oil layer, very often through a porous formation. The injection of water produces the pressure needed to bring oil to the top. Because this water will need to filter through the soils and rock structure, it must be treated so that plugging of the formation does not occur. The content of oil and scaling minerals must be controlled in this water to achieve maximum results. Scale forming anions like carbonates and sulfates must be within a required minimum to prevent precipitation with earth metals in the injection area that would limit effectiveness of the injection water.

Disposal wells are particularly expensive and problematic at sea. Also, the quantity of produced water is often higher than the quantity of injection water leaving water requiring disposal. No matter how good the treatment, produced water still contains traces of oil and, because of this, discharge is strictly controlled. In arid areas this treated water can be viewed as a natural resource. In order to be used safely, an appropriate treatment method must be designed based on the water quality that is needed.

Onshore vs. Offshore Treatment

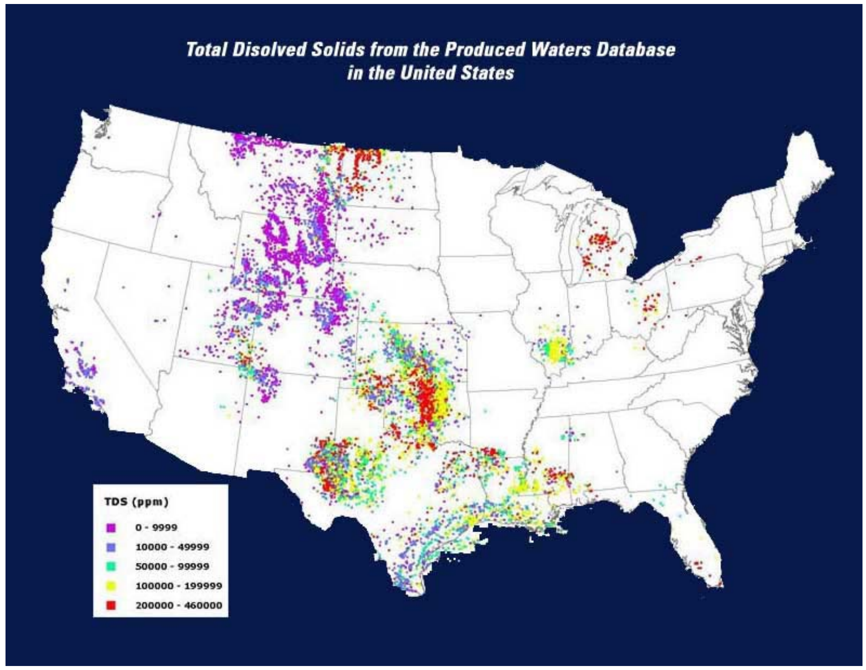
Offshore, there hasn't been time or space for the best treatment methods, whereas at onshore installations, oily water treatment can be intermittent allowing batch treatment and recirculation. Offshore water treatment must rely on equipment such as electrostatic precipitators, plate separators, gas flotation units, centrifuges, hydrocyclones, filter membranes and skim piles to get as much oil as possible out of the water. Offshore platforms are also limited to a maximum weight capacity of approximately 250 lbs per square foot. North Sea platforms are generally larger and have more space but the restrictions are still real. In offshore platforms, there is neither space nor time to allow treated water to lie for days in settlement ponds where oil can be skimmed off and purified using biological agents. Produced water discharged offshore may therefore be up to 10 times oilier than the discharges from onshore facilities. Some offshore facilities rely on floating water treatment by ships known as Storage and Offloading vessels (FSOs or FPSOs).

The movement of the anchored ship in a swell can upset water treatment processes and lead to discharges considerably above the average levels. This problem is particularly acute when storms generate very large waves, which happen on average at least 60 days a year in the northern North Sea.

Problems with Discharge

In produced water, there are also elevated concentrations of heavy metals including barium, beryllium, cadmium, chromium, copper, iron, lead, nickel, silver and zinc. There are also small amounts of the natural radionucleides, radium226 and radium228 and up to several hundred ppm of volatile dissolved organic material.

When diluted and mixed with seawater, treated produced water does not pose an environmental hazard. However, in shallow turbid waters near the shore or for onshore discharges to land based water bodies, elevated concentrations of hydrocarbons and metals in produced water can be toxic.



Survey of TDS Levels in Domestic Produced Water

As more information has become available on the possible long-term environmental effects of pouring large quantities of even mildly polluted water into the waterways every day, industry has continued the search for solutions. These include ways to reduce the volume of produced water, to re-inject it into the rocks below ground, and to make it as clean as possible when there is no alternative to discharge. The oil industry was able to achieve an average for 1998 of 22ppm.

One treatment method of reducing the oil in water number has been to increase the use of flocculating polymers and chemicals. This brings with it other environmental issues, as a result of the creation and disposal of the chemical materials.In addition to the added environmental threat, these chemicals must be stored and handled as part of the ongoing treatment process adding to liability and to operating costs. Use of these chemicals adds millions of tons of additional waste to the ecosystem.

The map above shows the relative concentrations of total dissolved solids in produced waters throughout the United States. In order to safely be discharged, these dissolved solids must first be removed from the water. Becasue of this, the normal produced water treatment process is complex.

Calcium Sulfate Crystals

Amoung the difficulties in treating produced water are the toxic ingredients often associated with hydrocarbon products. Heavy metals, radioactive particles, and volatile organic carbon represent the most significant threats.

In addition, produced water contains many other unwanted chemicals that must be removed prior to discharge or even prior to re-use in the drilling operations. High levels of dissolved solids are difficult for conventional gravity separation devices to handle. DAF, centrifuge, clarifiers, hydrocyclones and other similar settling and separating equipment is ineffective at removing dissolved solids.

Treatment Method	Advantages	Disadvantages	Cost
Carbon Adsorption Modular granular activated carbon systems.	Removes hydrocarbons and acid, base and neutral compounds; low energy requirements; higher through-put than other treatments (except biological); treats a broad range of contaminants; very efficient at re-moving high MW Organics	Fouling of carbon granules is a problem; produces waste stream of carbon and backwash; requires some pre-treatment of produced water stream.	Moderate
Air stripping Packed tower with air bubbling through the produced water stream.	Removes 95% of VOCs as well as benzene, toluene, naphthalene, and phenols; H2S and ammonia can be stripped with pH adjusting; higher temperature improves removal of semi-volatiles; small size; low weight and low energy requirements	Can be fouled by oil; risk of iron and calcium scales forming; gen-erates an off-gas waste stream that may require treatment; requires some pre-treatment of produced water stream.	Low capital and operating costs; treatment cost up to $0.10/1,000 gal plus $1.50/k gal if off-gas control by activated carbon
Membrane Filtration Nanofiltration and Reverse Osmosis polymeric membranes.	Effective removal of particles and dispersed and emulsified oil; small footprint size, low weight and low energy requirements; high through-put rates.	Doesn't remove volatiles or low molecular weight compounds. Oil, sulfides or bacteria may foul membrane, which requires daily cleaning; reject may contain radioactive material; requires pre-treatment of feed stream	Low Operating Costs
Ultra-violet light Irradiation by UV lamps	Destroys dissolved organics and both volatile and non-volatile organic compounds, including organic biocides; does not generate add-itional waste stream; handles upset or high loading conditions.	Will not treat ammonia, dispersed oil, heavy metals, or salinity; rel-atively high energy requirements; UV lamps may become fouled; residues may be toxic if peroxide used; requires some pre-treatment of produced water stream.	Similar capital costs to chemical oxid-ation with ozone but operating costs lower because no waste streams.
Chemical Oxidation Ozone and/or hydrogen peroxide oxidation	Removes H2S and particulates; treats hydrocarbons, acid, base and neutral organics, volatiles and non-volatiles; low energy requirements if peroxide system used; straightforward to operate.	High energy inputs for ozone system; oil may foul catalyst; may produce sludge and toxic residues; requires some pre-treatment of produced water stream.	Moderate Operating Costs
Biological Treatment Aerobic system with fixed film biotower or suspended growth (e.g. deep shaft)	Treats biodegradable hydrocarbons and organic compounds, H2S, some metals and, in some conditions, ammonia; "fairly low" energy requirements; handles variable loadings, if acclimated.	Large, heavy plant required for long residence times; build-up of oil and iron hinders biological activity; aeration causes calcium scale to form; produces gas and sludge requiring treatment; requires pre-treatment of feed.	Similar capital costs to chemical oxid-ation with ozone but operating costs lower because no waste streams.

Conclusions of the 1995 American Petroleum Institute's report on the Best Available Technology for Produced Water Management and Treatment

Produced Water Treatment Methods

In 1995 the American Petroleum Institute, (API), made its recommendation on the Best Available Technology for Produced Water Management on Offshore Gas and Oil Installations. The report identified the following factors as contributing to the toxicity of produced water: very small particles, salinity (9% or greater), volatile compounds, extractable organics (acidic, basic, neutral), ammonia and hydrogen sulfide. Six water treatment technologies already proven onshore were evaluated and costed for offshore use. The report made it clear that, by using combinations of different technologies, it is possible to reduce the pollutants in produced waster to almost undetectable levels. The accompanying table shows the technologies assessed by the group. It should be noted that significant technological advances have been made since 1995 including the introduction of V✧SEP.

Membrane Filtration

The advantages of the pure ionic separation that membranes can give has always held the interest of those wishing to treat Produced Water. Many studies have been done attempting to optimize the use of conventional membranes. In the past, the limitations of conventional spiral membrane systems have prevented widespread use for Produced Water treatment because of rapid fouling due to colloidal scale formation. Colloidal fouling obstructs the pores of the membrane and greatly reduces the throughput and increases the frequency and amount of cleaning required. To combat this problem, elaborate pretreatment is used to prevent scale formation inside the membrane system by the use of anti-scalant dosing. In addition, spiral membrane companies have developed new membranes that are extremely hydrophilic so that the free oil is repelled. Even with these improvements, the limitations of conventional spiral membranes have not allowed their widespread use in

Produced Water treatment. Some of the disadvantages of conventional spiral crossflow membranes in treating Produced Water include the following:

Fouling from colloidal scale formation

Elaborate pretreatment requiring a long train of multi-stage treatment

Large foot print area and complex treatment system design

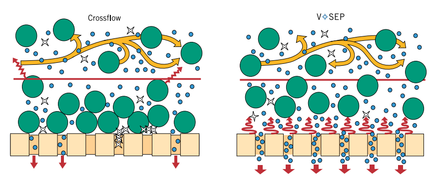
High energy usage as in horsepower per square foot of membrane

Antiscalants and other pretreatment chemicals require handling and storage

VSEP Advantages to Conventional Membranes

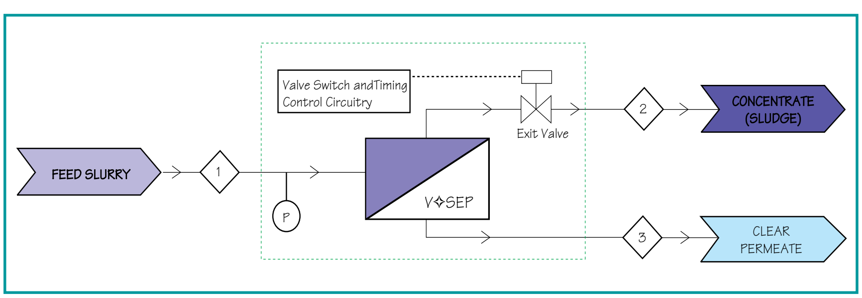
A new membrane system know as V✧SEP, (vibratory shear enhanced process) employs torsional vibration of the membrane surface, which creates very high shearing energy at the surface and near the pores. The result is that colloidal fouling and polarization of the membrane due to concentration of rejected materials are greatly reduced. Since colloidal scale fouling is avoided due to the vibration, the use of pretreatment to prevent scale formation is not required. In addition, the throughput rates of V✧SEP are 5-15 times higher in terms of GFD (gallons per square foot per day). The sinusoidal shear waves propagating from the membrane surface act to hold suspended particles above the membrane surface allowing free transport of the liquid media through the membrane. This accounts for the increased performance of V✧SEP membrane filtration when compared to conventional spiral crossflow membrane filtration.

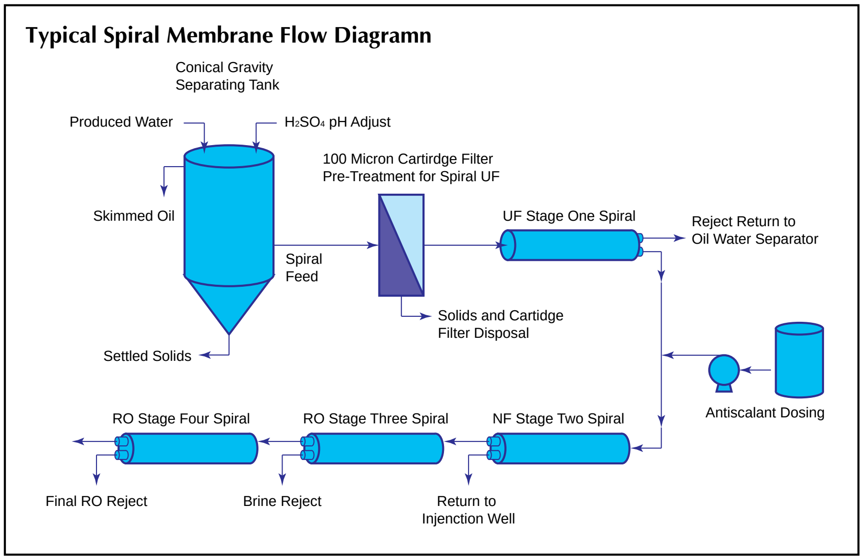
The V✧SEP membrane system is a vertical plate and frame type of construction where membrane leafs are stacked by the hundreds on top of each other. The result of this is that the horizontal footprint of the unit is very small. As much as 2000 square feet (185 m2) of membrane is contained in one V✧SEP module with a footprint of only 4' x 4'. This combined with the very low energy consumption, makes V✧SEP a very attractive alternative especially for offshore installations where space is a premium. Recent studies conducted using V✧SEP for treatment of produced water have shown the benefits of vibration.



When scaling occurs in a membrane system, colloids of insoluble mineral salts are formed. While some scaling can occur on the membrane itself, most of it will occur at other more efficient locations and then will become suspended colloids, which will act as any other suspended solid during the filtration process. Conventional membranes are subject to colloidal fouling as suspended matter can become attached to the membrane surface and obstruct filtration.

Crossflow is used to reduce the effects of this accumulation. The main problem with scaling for membrane systems is that the process introduces a large amount of potential foulants into the system, which can reduce flux. Just as





Multistage process used with Spiral Wound Modules to prevent fouling and mineral scale formation from slightly soluble salts

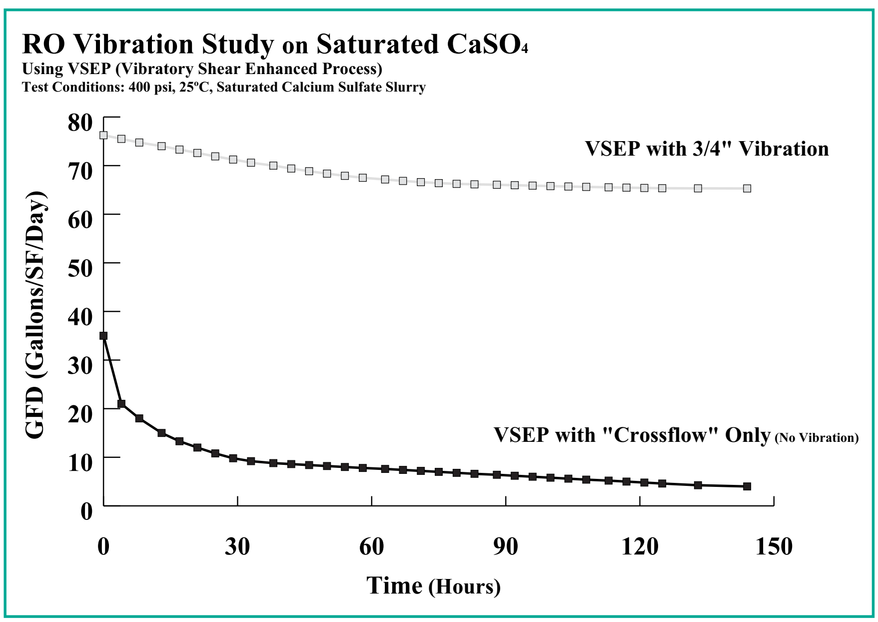
documented by other studies, V✧SEP is not limited when it comes to TSS concentrations as conventional membrane systems are. Conventional membrane systems could develop cakes of colloids that would grow large enough to completely blind the conventional membrane. In V✧SEP, no matter how many arriving colloids there are, an equal number are removed as the diffusion layer is limited in size and cannot grow large enough to blind the system. In fact V✧SEP is capable of filtration of any liquid solution as long as it remains a liquid. At a certain point, as water or solvent is removed, the solution will reach a gel point. This is the limitation of V✧SEP.

conventional membranes have limits on TDS due to the solubility limits of the various constituents, they also have limits on TSS, as colloidal fouling will occur if these levels are too high.

V✧SEP employs torsional oscillation at a rate of 50 Hz at the membrane surface to inhibit diffusion polarization of suspended colloids. This is a very effective method of colloid repulsion as sinusoidal shear waves from the membrane surface help to repel oncoming particles. The result is that suspended solids are held in suspension hovering above the membrane as a parallel layer where they can be washed away by tangential crossflow.

This washing away process occurs at equilibrium. Pressure and filtration rate will determine the thickness and mass of the suspended layer. Particles of suspended colloids will be washed away by crossflow and at the same time new particles will arrive. The removal and arrival rate will be different at first until parody is reached and a state of equilibrium is reached with respect to the diffusion layer. (Also known as a boundary layer) This layer is permeable and is not attached to the membrane and is actually suspended above it. In V✧SEP, this layer acts as a nucleation site for mineral scaling. Mineral scale that precipitates will act in just the same way as any other arriving colloid. If too many of the scale colloids are formed, more will be removed to maintain the equilibrium of the diffusion layer. As

In the V✧SEP membrane system, scaling will occur in the bulk liquid and become just another suspended colloid. One other significant advantage is that the vibration and oscillation of the membrane surface itself inhibits crystal formation. Just as a stirred pot won't boil, lateral displacement of the membrane helps to lower the available surface energy for nucleation. Free



Comparison of Flux with and without Vibration energy is available at perturbations and non-uniform features of liquid/solid interfaces. With the movement of the membrane back and forth at a speed of 50 times per second, any valleys, peaks, ridges, or other micro imperfections become more uniform and less prominent. The smoother and more uniform a surface, the less free energy is available for crystallization. In the absence of any other nucleation sites, this would lead to a super-saturated solution. In actual fact, what happens is that nucleation occurs first and primarily at other nucleation sites not being on the membrane, which present much more favorable conditions for nucleation. Crystals and scale also take time to form. The moving target of the membrane surface does not allow sufficient time for proper germination and development. Other stationary features within V✧SEP present a much more favorable nucleation site. Whereas, with conventional membranes that are static, scale formation on the membrane is possible and has plenty of time to develop and grow. Another feature of V✧SEP is that filtration occurs at a dramatically higher rate per m2 than with conventional membranes due to the suspension of colloids above the membrane. Studies have shown as much as a 15x improvement in flux per area. The result of this is that as much as 1/15th of the membrane area is required to do the same job as a conventional crossflow membrane. This is beneficial for many reasons one of which is hold up volume of feed waters. Because of this, the use of membrane separation for treatment of Produced Water is now an effective economical alternative. The advantages of V✧SEP include:

Higher throughput per square foot of membrane when compared to other membrane systems
No pretreatment chemicals are required to prevent scale formation
Extremely energy efficient (.27 kW per 1000 gal of filtrate)
Small footprint and simple design
Wide range of membranes from Microfiltration to Reverse Osmosis

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Case Study

Nanofiltration

Produced water that is treated for re-injection into the producing well or a disposal well must be at the very least softened with scale forming anions and cations removed. In addition, oil and other organics must be removed. Nanofiltration membranes are capable of removing virtually all oil and are very effective at rejecting divalent and multivalent ions. Most membranes are negatively charged. Anions with two or more exposed electrons are easily repelled by the nano-filtration membrane structure.

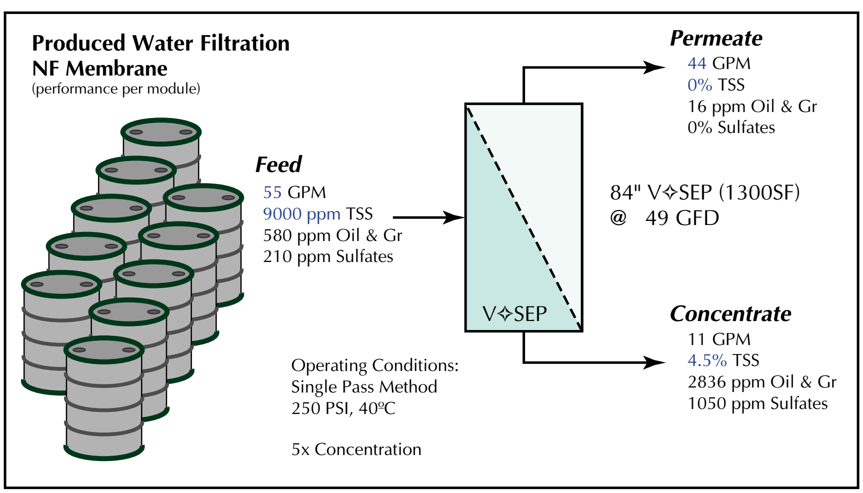
Nanofiltration and reverse osmosis membranes both act by diffusing liquids through their molecular structure. Ultrafiltration membranes have actual pores or small openings in the media and rejection is based on size classification. NF and RO membranes have a more sophisticated method of rejecting substances. It can be very difficult for multi-valent anions with a minus two charge to diffuse its way through the negatively charge membrane matrix structure. Monovalent anions are able to pass more easily because of the lower electrical potential and the fact that they are generally smaller than divalent or multivalent ions.

Typical V✧SEP Results:	Untreated	NF Filtrate	RO Filtrate
Total Organic Carbon, TOC	810 mg/L	120 mg/L	20 mg/L
Total Suspended Solids, TSS	9000 mg/L	ND	ND
Chemical Oxygen Demand, COD	2600 mg/L	270 mg/L	71 mg/L
Oil & Grease	580 mg/L	16 mg/L	ND
Chlorides, (Cl)	4700 mg/L	2900 mg/L	15 mg/L
Sulfates, (SO_4)	210 mg/L	ND	ND
Calcium, (Ca)	400 mg/L	8 mg/L	ND
Magnesium, (Mg)	50 mg/L	ND	ND
Zinc, (Zn)	100 mg/L	5 mg/L	ND

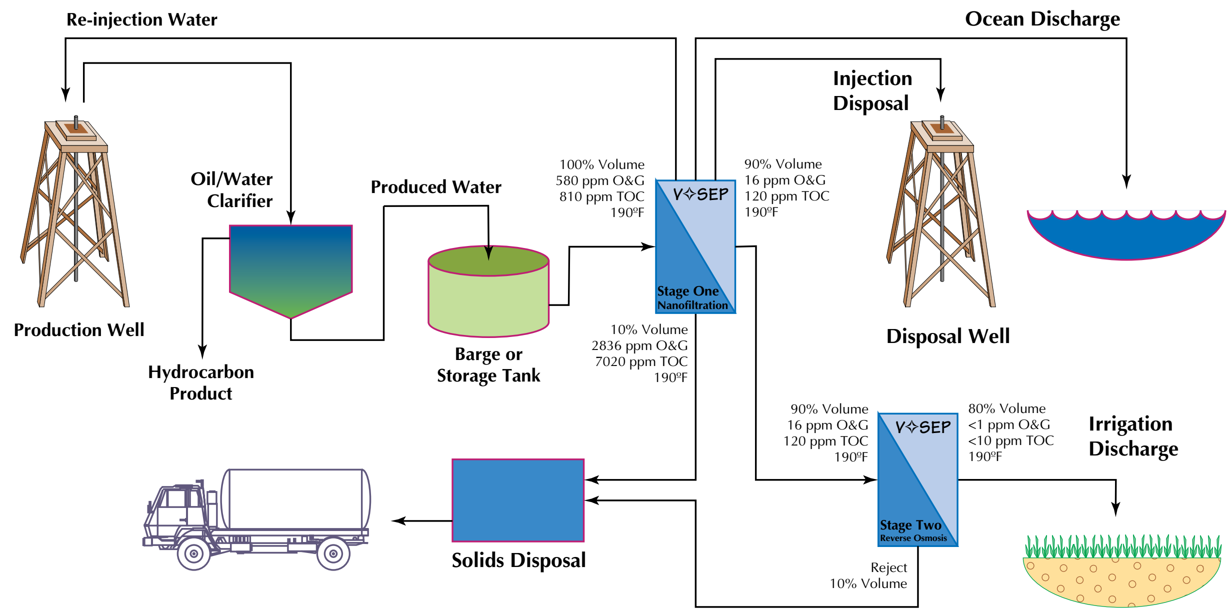
Results that are possible using V✧SEP membrane filtration. The choice of membrane would depend on the filtrate quality desired.

As the multi-valent anions are held back, positively charged cations are needed to maintain electrical balance. Because of this, divalent metal ions remain on the reject side of the membrane in proportion to the rejected anionic species. Ions such as Calcium, Barium, Strontium, Magnesium, Copper, Zinc, and Iron are held back quite effectively by nano-filtration membranes. Holding back metals, sulfates, carbonates, and phosphates produces "softened" permeate, which is water low in scale forming species. Because the filtration occurs by diffusion, nano-filtration membranes are able to reject very small non-charged particles. NF membranes have a specific size rejection capability known as "molecular weight cut off" (mwco). The value of this is measured as Daltons. This means that even very small organic molecules can be rejected. NF membranes have good rejection characteristics of benzene, tolulene, and other volatile organic carbons. The use of NF permeate for re-injection water is ideal as the water has many of the same characteristics of the natural water except that it has been softened. Re-injection of water that is also the same temperature as the naturally occurring water will also reduce the possibility of scale formation and plugging of the porous areas of the formation.

V✧SEP nano-filtration can be followed by a number of other treatment methods to further treat the filtrate or the reject. Reverse Osmosis membranes can be used to make the NF filtrate nearly as good as drinking water suitable for almost any use. It can be used where discharge to local waterways has strict regulations and tight criteria for discharge. Air Stripping can be used to



Produced Water Management using V✧SEP



remove volatile organic carbons beyond thecapabilities of the nano-filtration membrane. UV Radiation, Ion Exchange Resins, and EDI are other water purification methods that can also be utilized.

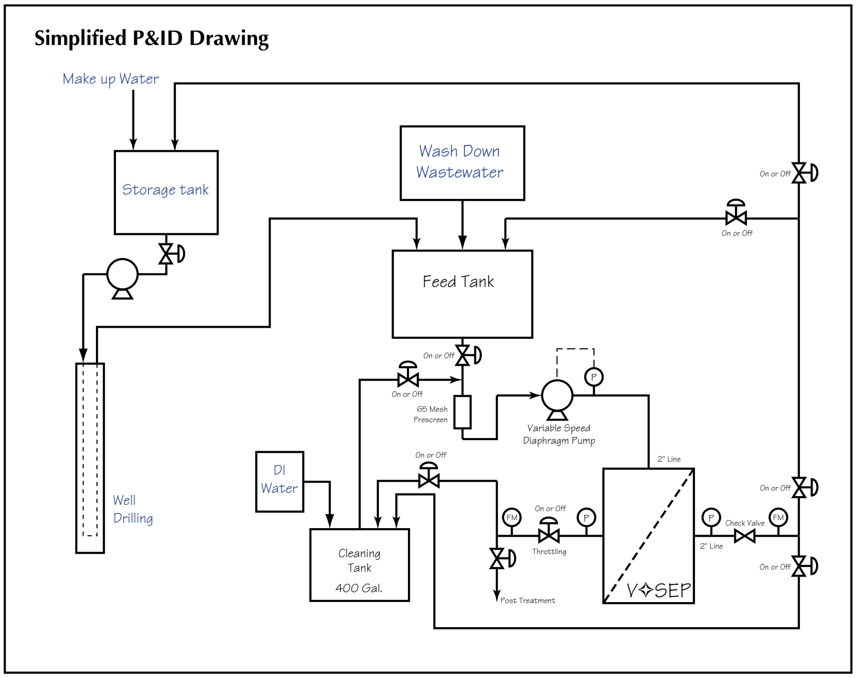
VSEP Membrane Treatment of Produced Water

VSEP can be employed for all sorts of oil water separation processes including produced water, bilge water, drilling mud, wash down water, tank rinse, and any other oily wastewater project. The illustration shows several scenarios for the filtration of produced water. As the oil is produced from the well, the water that comes with it is separated from the oil using gravity separators. Oil and water will separate fairly easily unless they exist as an emulsion. In which case chemicals can be used to break the emulsion. Water is removed from the bottom of the settling tank as it is heavier than oil. This water is known as produced water and is the feed material to the VSEP in this case study. When treating produced water it is important to determine how the treated water will be used and what requirements there are for levels of contaminents like oil and scale forming compounds. Water that will be injected into a well must simply not create any scale formation as it is introduced to the geological porous area. The injected water will need to percolate to fill small voids and because of this fouling and plugging of the porous structure will impede results. Oil and grease must also be reduced in the injection water as these are also capable of plugging.

In the diagram above, there are three options for the produced water which has been treated using nano-filtration. The water can be used back into the same well to bring up the oil below, or it can be disposed of in another well drilled for the purpose of getting rid of unwanted produced water. The third option is disposal at sea once certain criteria is met to meet discharge limits. In order to be used for land based discharge or for clean water re-use, the NF filtrate would require further treatment. In the case above, V✧SEP RO membrane filtration is shown. The water from this would be suitable for irrigation, process water, waterway discharge, or any other water needs. Other treatment methods can be used depending on the situation. Ion exchange resins, air strippers, carbon filters, electro-deionization, UV radiation, or other similar treatment can be employed. Each of these would target specific ionic species which are targeted for removal. In both cases above the reject from the V✧SEP system would need further treatment for land application as a sludge. Another option not shown is a third stage V✧SEP for additional volume redcution.

Process Conditions

A process schematic for treatment of a typical oily wastewater process using a V✧SEP system is presented in the figure to the right. When the residual oily wastewater has been settled so that oil and water can separate naturally, the result is a process effluent, at 1 to 2% by weight total solids (TS). This process effluent is normally sent to a multi-step train of chemical treatment equipment in order to dewater the wastewater. The addition of V✧SEP to concentrate the process effluent improves the process efficiency. The permeate can be reused in the process or discharged.



Simplified P&ID Drawing

For one V✧SEP module, the oily wastewater is fed to the V✧SEP treatment system at a rate of 55 gpm and a pressure of 250 psig. One industrial scale V✧SEP unit, using nano-filtration membranes is installed to treat the process effluent. The produced concentrated stream at a flow rate of 11 gpm and a solids concentration of 5% TS is sent to a coalescer and stored for hauling or disposal. V✧SEP generates a permeate stream of about 44 gpm which is recycled to the process or discharged to an injection well or to the ocean. The permeate concentration is reduced to ~ 1 mg/L of total suspended solids (TSS), and a low level of total dissolved solids (TDS), all well below the design requirements for process recycling or discharge. Membrane selection is based on material compatibility, flux rates (capacity) and concentration requirements. In this example, the TSS reduction is over 99% while the oily waste is concentrated from a starting feed of 1-2% to a final concentrate of 5% by weight. The permeate quality from the V✧SEP can be controlled though laboratory selection of membrane materials available to fit the application parameters.

Successful pilot tests have been conducted at New Logic for many kinds of oily wastewater treatment. Depending on process temperatures, membrane selection and the requirement for solids concentration or BOD/COD removal for effluent streams, the permeate flux rate in the V✧SEP can range from 15 to over 150 gallons per day per square foot (GFD).

Compact Design

The V✧SEP Machine incorporates a modular design which makes it compact. Because the basic design is vertical rather than horizontal, the needed floor space per unit is inherently less than other types of separations systems. The V✧SEP does require up to 17' in ceiling clearance. In most industrial applications ceiling clearance is ample, it is floor space which is limited. This is especially true with offshore drilling platforms where space is extremely valuable and the subject of great scrutiny.

Benefits of V✧SEP Compact Design:

1] Easily added into an existing system to enhance performance
2] Can be installed in areas where space is at a premium
3] Is easily portable and can be moved from plant to plant
4] Can be installed as multiple stage system or as single pass
5] Can be "chain linked" to an any number depending on demand.
6] More units can be installed as production grows.

Very often floor space is so limited, or the system being designed is so large that a separate structure is built to accommodate the treatment system. In such cases, the fact that the V✧SEP units are vertical and compact, it may be able to fit into an existing area of the building or it will reduce new building costs by requiring less space. Construction costs of $80 to $120 / square foot for new industrial buildings can add up and are a consideration when figuring the overall cost burden of a completed system. In addition to the limited space required for the mechanical components, the actual filter area has been designed in such a way as to be extremely compact and energy efficient. In the largest model, the "Filter Pack" contains 2000 Square Feet of membrane surface area, about the size of a medium size house. This 2000 SF of membrane has been installed into a container with a volume of about 15 Cubic Feet!!

Produced Water/Bilge Water

Description	Description
V✧SEP System Power Consumption*	$ 7,180
System Maintenance & Cleaning	$ 8,640
Annual Production (at 49 gfd)	23,250,500 gal./yr

*based on 0.05 $/kW electricity cost

Economic Value

New Logic's V✧SEP system provides an alternative approach for oily wastewater treatment applications. In a single operation step, V✧SEP will provide concentrated oil sludge and also reduce BOD, COD, TSS, TDS and color to provide a high quality permeate stream for discharge or reuse in the process. In many applications, the addition of V✧SEP can eliminate conventional treatment equipment including the need for chemical treatments. The justification for the use of V✧SEP treatment system in your process is determined through analysis of the system cost and benefits including:

Reduction of solids from discharge stream & associated treatment cost.
Reduction of BOD, COD, TSS, TDS and color from the effluent stream.
Provision of high quality water for re-introduction into the process.
Offset fresh water demand and pretreatment cost.
Retain heat in recycled process water as a possible method to reduce energy requirements.
Elimination of biological growth and odor in effluent.
Simplify effluent treatment with a compact, low energy system.

Your New Logic Sales engineer can assist with economics analysis for your project and can demonstrate operating cost savings and Return on Investment calculations. The Table above shows the typical operating costs associated with the installation of one V✧SEP module. The units are modular, so the operating costs are proportional to the number of V✧SEPs installed.

Summary

New Logic Research has supplied V✧SEP separation technology successfully into many industrial processes. The availability of new membrane materials and V✧SEP technology make it possible to economically treat produced water and other petro-chemical wastewaters.

Contact a New Logic representative to develop an economic analysis and justification for the V✧SEP in your system. For additional information and potential application of this technology to your process, visit New Logic's Website @ http:/www.vsep.com or contact New Logic Research.

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V✧SEP NF Membrane System installed at a major manufacturing facility for oily water filtration.