Treating Fuel Storage Tank Bottom Water With VSEP

Overview

Fuel storage tank bottom water (FSTBW) is one of several types of petroleum contaminated wastewater sources that can be treated using V✧SEP technology. The source of FSTBW, as suggested by its name, is simply water that separates from petroleum products that are being stored and transported in large quantities. This water that is periodically removed from the storage tanks in order to be treated will contain petroleum product such as gasoline and other fuels. The water will also contain suspended solids due to biological growth and other solids contamination that occurs during transportation and storage of the fuel products.

Fuel Storage Tank Farm

FSTBW is considered hazardous material due to the high levels of Benzene that are typically present. Prior to the EPA's inclusion of Benzene as a toxic constituent under the Toxicity Characteristic Leaching Procedure (TCLP) in 1990, FSTBW was not typically considered hazardous. Due to the classification of FSTBW as hazardous material, companies dealing with the storage and transportation of fuels such as gasoline and jet fuel must develop more stringent methods to deal with the water. The best way for companies to avoid having their material classified as hazardous is to recover the product from the water for reuse in the refinery, and generating a water stream that is non-hazardous. V✧SEP can be used to carry out the separation of fuel products from FSTBW.

Background

The amount of refined petroleum products transported in the United States by pipeline in 1999 as estimated by The Bureau of Transportation was 296.6 billion ton-miles, or 60% of all transported refined petroleum products. At the beginning and end of each of these pipelines, and at regular intervals in between the beginning and end of these pipelines are terminals that store the product in tanks after receiving it and prior to pumping it to its next destination. The remaining 40% of refined petroleum product transportation is primarily handled by waterways, though small amounts are carried via motorways and railroads as well. These methods of transportation do not have the intermediate facilities, or terminals, but they do have tank storage at the beginning and end of the transportation. All of the transportation and storage methods involve holding the refined petroleum products in tanks for some period of time, and

so all transportation methods have to deal with FSTBW at some point.FSTBW has several characteristics that make it difficult to treat. Because of the biological growth that takes place in the water while it is at the bottom of the tank, a 'rag' layer tends to form between the water layer and the product layer above. This rag layer makes it difficult to clearly distinguish between the water and product layers. The result of this is that typically when the water is drained from the bottom of the tank, an excess of material must be removed in order to be sure that one has reached the end of the water layer and the beginning of the product layer. The material removed will then contain larger amounts of product and solids. The 'rag' layer also makes the FSTBW itself very difficult to treat. The first most obvious problem is that the solids can cause plugging or fouling of conventional oil/water separators typically used to remove the bulk of the product. A secondary problem is that the''rag' layer, and the solids it brings with it make the water layer too turbid to run through common air strippers that may be able to remove the smaller organics such as benzene and toluene. While the volumes of FSTBW in comparison to the amounts of refined petroleum product are not great, the cost of paying a second party to haul and treat the water can be quite dramatic due to the presence of benzene and other toxic hydrocarbons. Treating the FSTBW becomes a desirable option in order to avoid such costs. An added benefit to treating the material on site and recovering the product while generating a clean wastewater stream is often improving a company's local reputation with regard to environmental issues. The water recovered can be used as wash water at the facility, or in some cases can be directly discharged depending on local environmental constraints.

Filtration Type	Particle Size	Molecular Weight
Reverse Osmosis	A0.001 μm	A100 Dalton
Nanofiltration	0.001-0.01 μm	100 - 1000 Dalton
Ultrafiltration	0.01-0.1 μm	1000-500,000 Dalton
Microfiltration	B0.1 μm	B500,000 Dalton

Categories of Membranes used with VSEP

VSEP FSTBW Treatment

There are three options when using a V✧SEP to treat FSTBW. The three options exist due to the versatility of V✧SEP in it's ability to use membranes ranging in pore size from UF to RO, and also because different process objectives may be desired depending on a companies current situation before installing V✧SEP.

Ultrafiltration:
In cases where the process objective is to remove all the suspended solids in order to increase the efficiency of a current separation process, V✧SEP equipped with a UF membrane would be the best option. The UF membrane can be selected with the proper molecular weight cutoff range to allow the product and water through the membrane, while holding back the bacteria and other suspended solids. Held back with the solids would be the larger 'heavy' organics. This concentrated solids stream would then be sent back to the refinery if it proves to have any significant concentration of high weight petroleum products, or it can be disposed of by conventional means.

Nanofiltration:
In cases where the process objective is to separate the majority of the refined petroleum products from the water, V✧SEP quipped with a NF membrane would be the best option. When using NF filtration for this

application, the solids will be concentrated with the petroleum product. This typically does not interfere with reuse of the product in the refinery. The water stream generated in this process will be solids free, and greatly reduced in TOC. The smallest fuel components such as Benzene will have a removal rate on the order of 50-60%. This indicates that further treatment of the water stream would be needed before discharge of the water would be possible. This polishing of the water stream becomes much easier once the V✧SEP has removed the major solids and petroleum product.

Reverse Osmosis:

In cases where the process objective is to remove all of the refined petroleum products and all of the suspend solids, V✧SEP equipped with an RO membrane would be the best option. The RO membrane will allow for almost 100% removal of even the smallest refined petroleum product such as benzene. Unlike most RO systems, V✧SEP equipped with an RO membrane can handle large amounts of suspended solids. The product stream when using this process will contain all of the suspended solids, 99% of the dissolved solids and almost 100% of the petroleum product. The water stream in most cases is suitable for direct discharge or reuse depending on local regulations.

One V✧SEP Unit installed, Footprint is about 16SF

Process Description

Regardless of the process used, UF, NF or RO, the V✧SEP system is simple and easy to fit into an existing process. The V✧SEP system simply requires a feed source, typically a collection tank that all ready exists for FSTBW, and a destination for the two streams generated (Product and Water). The recovery as a percentage depends on the original product percentage of the feed material.

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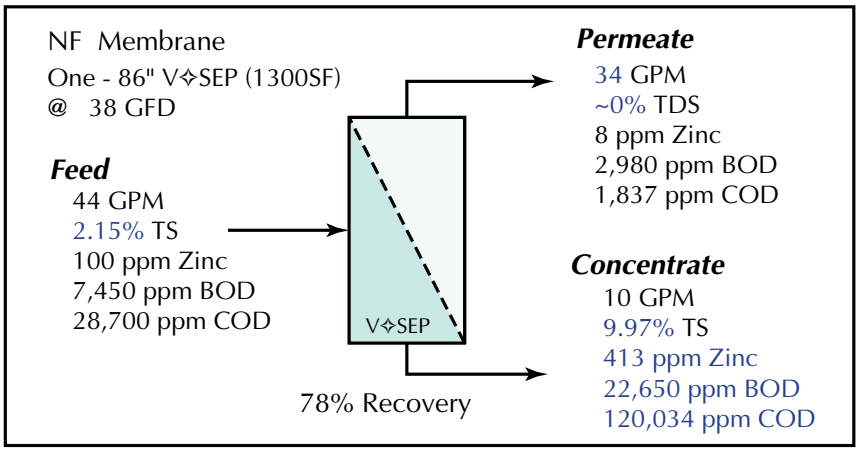
Application Note

Grab Samples from V✧SEP filtration of Tank Wash Water. The center two pictures show the difference between Ultrafiltration Permeate and Nanofiltration Permeate

The oily wastewater is fed to the V✧SEP treatment system at a rate of 44 gpm and a pressure of 250 psig. One industrial scale V✧SEP unit, using nanofiltration membrane is used to treat the process effluent. The produced concentrated stream at a flow rate of 10 gpm and a solids concentration of 10% TS is sent to a coalescer and stored for hauling.

V✧SEP generates a permeate stream of about 34 gpm which is recycled to the process or discharged to the sewer. 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 residue is concentrated from 1.5-2% to a final concentrate of 10%. The permeate quality from the V✧SEP can be controlled though laboratory selection of membrane materials available to fit the application parameters. The picture above show the difference between UF and NF membranes.

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).



Important Note: The Feed material is always different. The illustration above shows typical performance

Results showing BOD and COD reductions possible with V✧SEP

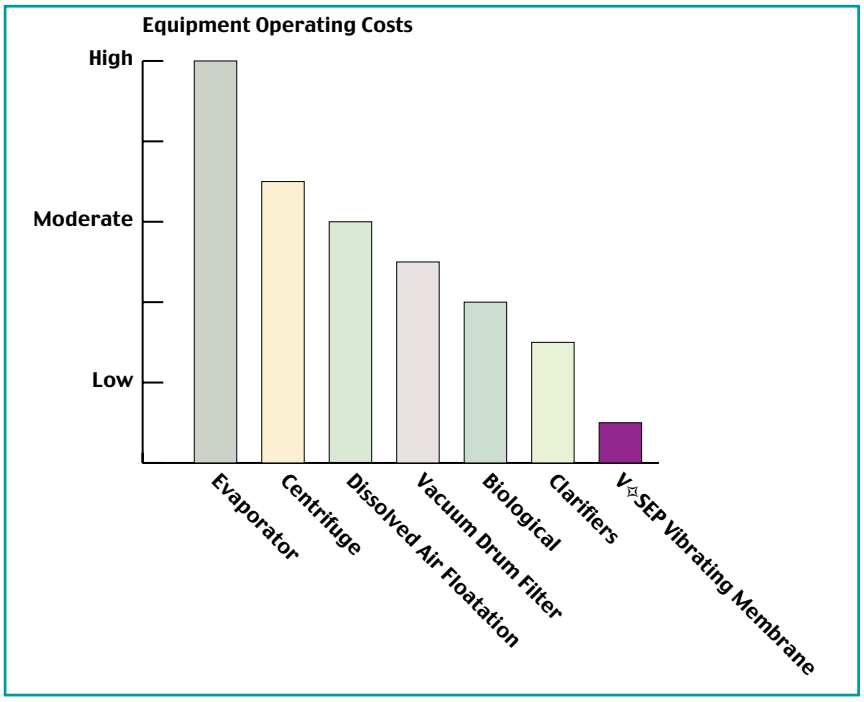
Comparisons of Oil Water Separation Technologies

Centrifuge:
Uses large horsepower motors and because of the number of moving parts is subject to high maintenance. While centrifuges are effective at removing suspended solids, they do not account for dissolved solids and heavy metal species in solution. The effluent from a centrifuge would need further treatment prior to disposal.

Rotary Drum Vacuum Filter:
Quite effective at rejecting large solids. sometimes filtrate must be sent back around to get all of the smaller particles. Usually employs coarse filtration. Vacuum filters require large floor areas and have high capital costs

Dissolved Air Flotation (DAF):
Large tanks where air is bubbled into the bottom and with the use of flocculants, solids are floated to the top and skimmed off. A very large tank is required due to the residence time required. Also chemical addition is a daily if not hourly process and is a significant operating cost.

Slope Plate Clarifiers:
Cheap and easy to use. The process relies on gravity to drop out heavy solids. Here again colloidal materials with small mass and dissolved constituents



Relative Operating Cost comparisons of various technologies for treating oily wastewater

Sedimentation Rate as a Function of Particle Diameter

Spherical Radius	Particle	Sedimentation Rate
10 mm	Gravel	0.3 seconds
1 mm	Coarse Sand	3 seconds
100 μm	Fine Sand	38 seconds
10 μm	Silt	33 minutes
1 μm	Bacteria	55 hours
100 nm	Colloid	230 hours
10 nm	Colloid	6.3 years
1 nm	Colloid	63 years

do not settle. Sometimes it is used in conjunction with flocculation chemicals. These chemicals have limited effect in dropping out heavy metals, BOD, and COD.

Biological Treatment:
This process relies on biological activity to digest the solids in the wastewater. The problem is that the system is extremely temperature and pH sensitive. Also loading must be done at a set rate. The operation of this kind of system usually requires a very skilled operator. It also can take up a lot of floor space due to the amount of residence time required for the bugs to digest the materials.

Evaporators:
Can reduce wastewater to dry solids that can be landfilled. Of course water re-use is not possible. Evaporators have very high capital costs and consume huge amounts of energy even for the most efficient models.

V✧SEP
Able to produce drinking water quality filtrate from any wastewater. Extremely energy efficient and vertical design allows for small footprint. Does not require pre-treatment or post-treatment. Wide range of membranes available allow for precise separations based on the process objectives. No chemical addition required.

Vibratory Shear Process

V✧SEP's unique separation technology is based upon an oscillating movement of the membrane surface with respect to the liquid to be filtered. The result is that blinding of the membrane surface due to the build up of solids is eliminated and free access to the membrane pores is provided to the liquid fraction to be filtered. The shear created from the lateral displacement caused suspended solids and colloidal materials to be repelled and held in suspension above the membrane surface. This combined with laminar flow of the fluid across the membrane surface keeps the filtered liquid homogeneous and allows very high levels of recovery of filtrate from the feed material. In the case of Tank Wash, up to 97% of the water can be filtered in a single pass filtration using V✧SEP. Flux is inversely related to % recovery, so the optimum % recovery may vary for each application. Other methods like filter presses are done in batch mode with operators opening and cleaning the filter cake on a regular basis. V✧SEP is a continuous automated process requiring very little operator attendance.

The industrial V✧SEP machines contain many sheets of membrane, which are arrayed as parallel disks separated by gaskets. The disk stack is contained within a Fiberglass Reinforced Plastic (FRP) cylinder. This entire assembly is vibrated in torsional oscillation similar to the agitation of a washing machine. The resulting

shear is 150,000 inverse seconds, which is ten times greater than the shear in crossflow systems. High shear has been shown to significantly reduce the fouling of many materials. The resistance to fouling can be enhanced with membrane selection where virtually any commercially available membrane materials such as polypropylene, Teflon, polyester, and polysulfone can be used. Each Series i system contains up to 2000 square feet of membrane filtration area. A single V✧SEP unit is capable of processing from 5 to 200 U.S. gallons per minute while producing crystal clear filtrate and a concentrated sludge in a single pass. This large throughput capability can be accomplished with a system, which occupies only 20 square feet of floor space and consumes 15 hp.

System Components

The V✧SEP system is configurable for manual mode where the operator would initiate operating sequences, or for full automation including seamless cleaning operations with round robin cleaning or multiple units. The V✧SEP has a PLC (Programmable Logic Controller) which monitors pressure, flow rate, and frequency. It also provides the safety in operation by monitoring conditions and initiating an alarm shut down should some configurable parameters be reached. The controls include the PLC, Operator display, and process instrumentation. The Filter Pack is mounted on the V✧SEP base unit and contains about 1300 SF, (120m2), of membrane area and is constructed out of high temperature materials. The V✧SEP drive system, which supports and vibrates the Filter Pack is engineered using space age alloys and materials to withstand the applied stress from a resonating frequency of about 50 hz. Each base unit is fully stress tested and the factory prior to shipment. The V✧SEP drive system is made up of the Seismic Mass, Torsion Spring, Eccentric Bearing, and Lower Pressure Plate.

Company

New Logic is a privately held company located in Emeryville, California. Incorporated in 1986, New Logic manufactures a proprietary membrane filtration system called V✧SEP ® (for Vibratory Shear Enhanced Processing). Originally developed for blood plasma separation, the technology has been scaled up to meet the growing separation needs for many industries. V✧SEP can be employed in water treatment, product separation, solids dewatering or wastewater treatment. The industries and applications for V✧SEP are quite diversified and include: **Pulp & Paper** (black liquor, whitewater,box plant effluent, end of pipe), **Industrial Water Pretreatment** (ultrapure, boiler feed, surface

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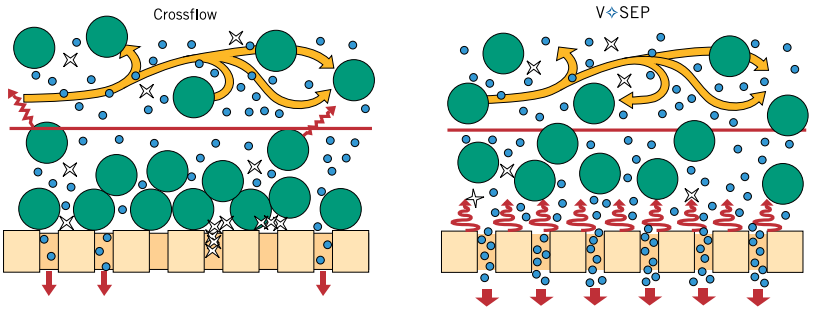
water), **Pigments & Paint** (latex emulsions, product recovery), **Mining** (mine tailings), **Solids Dewatering** (calcium carbonate, kaolin clay, TiO_2), and **Metal Working** (oily wastewater, metal hydroxides).

Technical Services

New Logic has years of experience and expertise in membrane filtration. Their 40,000 sq. ft. facility provides comprehensive manufacturing and facilities. Highly trained engineers and technical staff are available to support your application questions. Feasibility testing can be accomplished in-house, or a fleet of pilot units are available to support on-site testing. Operational surveys are available to help assess your needs and the potential cost savings. An experienced team of technicians are available to support both on-site pilot work and V✧SEP system installations.



Conventional membrane systems rely on laminar crossflow of the feed slurry across the membrane surface to keep the surface clear for filtration. V✧SEP's patented technology vibrates the membrane surface and can produce 15 times the permeation performance when compared to conventional membrane systems. With V✧SEP, the membrane surface is moving at a rate of 3/4″ displacement 50 times per second.

People

From scientists to customer service associates, New Logic recruits some of the best people available. Academic credentials include doctorates and advanced degrees from such notable universities as Northwestern, Cal Berkeley, UC Davis, UCLA, North Carolina State, Johns Hopkins and others.

For more infomration, contact:

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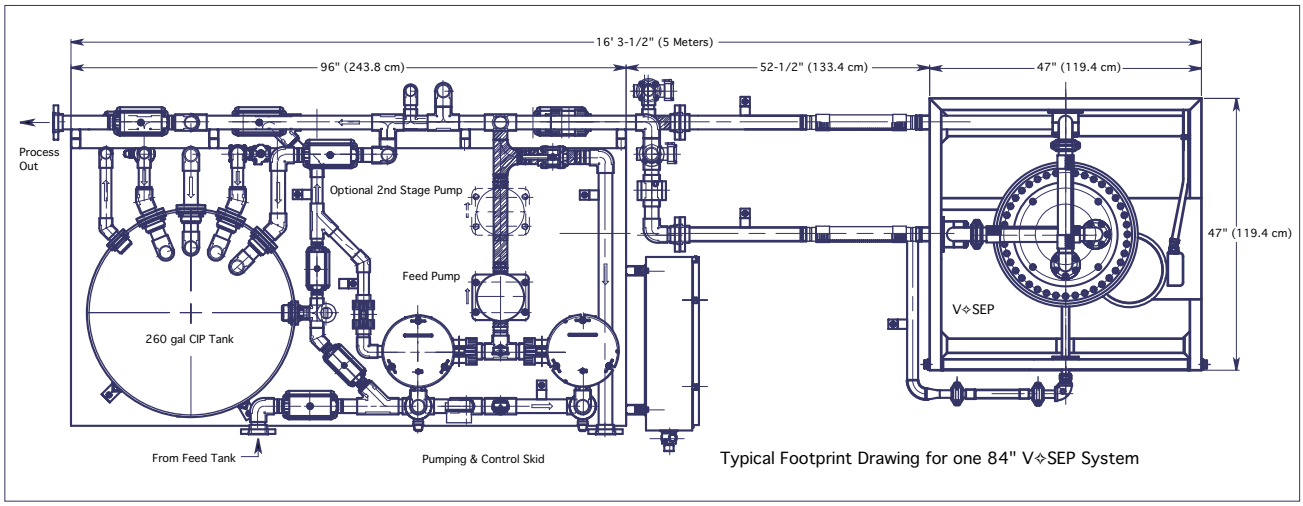

Typical Footprint Drawing for one 84" V✧SEP System