New Logic Research Application Note

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 VSEP 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.

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. VSEP 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 to 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.

VSEP Use In FSTBW Treatment

There are three options when using a VSEP to treat FSTBW. The three options exist due to the versatility of VSEP 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 VSEP. In all cases prescreening with 120 mesh and air stripping to remove BTEX must be done to protect the membrane.

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, VSEP 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 achieve a cleaner filtrate to wens to a WWTP, VSEP quipped with a NF membrane would be the best option. When using NF filtration for this application, the solids will be concentrated with the rag layer emulsion. 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. 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 VSEP has removed the major solids and tramp materials.

Reverse Osmosis:
In cases where the process objective is to make water clean enough to discharge, VSEP equipped with an RO membrane would be the best option. The RO membrane will allow for almost 100% removal of even the smallest dissolved solids. Unlike most RO systems, VSEP 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 environmental regulations.

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

Process Description
Regardless of the type of process used, UF, NF or RO, the VSEP system is simple and easy to fit into an existing process. The VSEP 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 product recovery as a percentage will depend on the original product percentage of the feed material.

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 1400 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 1400 SF, (130m2), 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.