NEW LOGIC RESEARCH, INC.

Case Study

Palm Oil Effluent Treatment with VSEP

Background

New Logic has installed a vibratory reverse osmosis system known as VSEP to treat the effluent generated during the production of palm oil. The company using the technology operates three palm oil mills in Guatemala. The VSEP system was installed at the company's new facility in Mexico near the border between Mexico and Guatemala. The three existing mills and the new mill can process sixty tons of oil per hour. The new mill will use fruit from existing trees in the surrounding area. The company will also plant its own trees and grow production as these mature.

Palm oil is harvested from local palm trees that produce the fruit which is the source of the oil. Palm oil production on a per hectare basis is much higher than other types of vegetable oil. For example, palm trees can produce about 4 tons of oil per hectare per year which is about ten times as much oil as soybeans. The oil harvesting happens all year long as the fruit ripens. The fruit must be processed within twenty-four hours of picking, so mills operate twenty-four hours a day.

The fruit is first cooked in a steam pressure cooker for about ninety minutes. The fruit is then separated from the "bunch" that holds all the fruit in a clump. The fruit is pressed and crushed, and oil and water are liberated. The hard core of the fruit is called the kernel, which is recovered and crushed in a separate process. This kernel contains another kind of oil that is almost the same as coconut oil, thus two kinds of oil are produced. The crude palm oil and kernel oil are then stored in tanks to be then sold and shipped to oil refining companies such as ADM.

The bunch (the part of the tree that holds the clump of fruit) is then shredded and pressed, as it also contains some oil. The oil is recovered from the pressing of the bunch and is blended with pressed oil of the fruit. After this, the shredded bunch is spread in rows to become the main ingredient in a composting operation. This company is unique in having its own composting step.

Effluent Waste : Product Oil Ratio

For every ton of oil that is produced, one ton of water or wastewater is generated. This water is very high in tannins, BOD, and COD. First the water is sent through settling tanks to recover small amounts of oil. Oil is skimmed from the top of the tanks and the water and solids settle

to the bottom. The water and solids are sent to centrifuges to separate the water and suspended solids. These solids are pressed and are combined with the kernel solids and other fibrous waste generated from the process and these materials are burned as boiler fuel to make the steam used to make electricity for the mill and to cook the fruit. The water left after solid separation has about 70,000 mg/L of COD and is sprayed on top of the shredded bunch in the composting operation. During this process, the nutrients from the water are transferred to the shredded bunch and the BOD/COD of the water is reduced. The finished compost is used in the planting of new palm trees which is done continually as these trees have a limited life.

Composting the Spent Fibers and Effluent

Some palm oil mills do not have a composting operation and so the water before composting which is called Palm Oil Mill Effluent (POME) is treated or discharged in a more concentrated form. Previously this very strong wastewater would be directly discharged to local rivers. Discharge rules have changed and at least some treatment prior to discharge is now used. The benefits of composting are that the strength of the wastewater can be reduced, and the compost material is beneficial when planting new trees which improves yield. Some water volume is also consumed from evaporation, as the composting is done in a greenhouse type building and the process of composting generates heat.

With both POME and compost leachate, the conventional method of treatment to-date has been the same as a conventional municipal wastewater treatment plant: multi-stage biological digester ponds. This includes aerated aerobic ponds as well as anaerobic (oxygen starved) ponds. This wastewater even after treatment cannot be used for irrigation because of the high level of tannins. These tannins are toxic to beneficial bacteria in the ground that enable the uptake of nutrients from the roots of the tree up into the tree.

Sustainability & Marketing Problems

The problem facing the industry is that the crude palm oil is being sold to large multi-national companies such as ADM that refine the oil and then sell it as a food product. These companies that buy the raw palm oil have very strict requirements for sustainability and environmental stewardship. The certification process for getting the certificates for sustainability is very difficult and is audited continually. Without these certificates, the palm oil mills cannot sell their product on the global market.

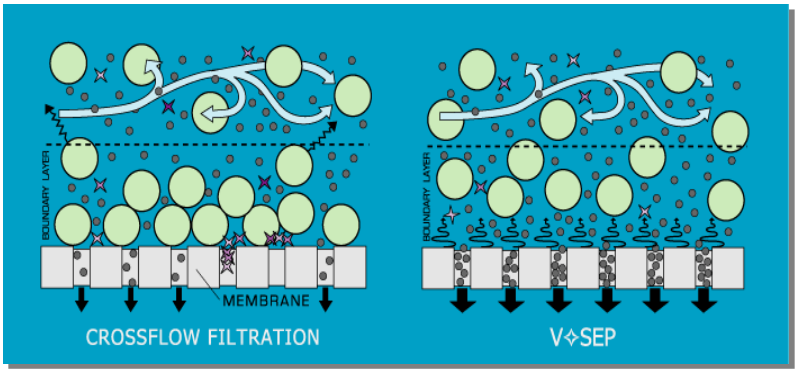
The sustainability rules cover all sorts of things that go beyond environmental stewardship and also include rules about labor, energy, use of the land, and many other things. Except for the wastewater, the industry has become very efficient and nothing is wasted in the production process. The fruit produces the oil, the spent fibers are burned as a fuel to make steam and electricity, and the shredded bunch is used to make compost where the nutrients are then put back into the soil. Nothing goes to waste except for the water which is treated and discharged.

However, the existing method of treatment with digesters is not able to treat this wastewater to meet the typical discharge requirements that meet most modern government regulations. The pond treatment process cannot remove all of the color that comes from the tannins and can only reduce the COD/BOD to about 400-500 mg/L. The oxygen demand from these two components will consume oxygen when the wastewater is discharged to surface waters and this can produce a dead zone in the water where no aquatic life can exist. This part of the sustainability puzzle has continued to be problematic for the palm oil industry.

By using VSEP to treat POME or the leachate from composting, the effluent is separated using an RO membrane and the water is recovered and recycled as feed to the steam boilers. The VSEP concentrate is sent back to the composting operation and is sprayed on the shredded bunch so that additional nutrients are recovered. Insodoing, the process becomes zero-liquid discharge; there are no surface water pollution issues, and the whole process becomes a closed loop. This is a big win for the industry so that complete sustainability can be achieved and all issues with surface water discharge and pollution are eliminated.

VSEP Process

VSEP uses polymeric membranes that employ a wide feed channel between membranes to allow passage of suspended solids. It also uses a resonant frequency to vibrate the membrane surface fifty times per second. The shear waves created from this vibration prevent fouling and scaling of the membrane surface and allow for efficient filtration rates and minimized cleaning frequencies compared to other membrane systems.



VSEP stands out with its simplicity, reliability, and economical benefits. Conventional membranes are limited in their abilities—particles can become lodged in spiral membrane modules and the pores can be blocked from fouling and scaling. These blockages cause reduced flow and permeate recovery, as well as more frequent cleanings. A laminar boundary layer will form at the surface of the membrane resulting in a formation of a barrier that restricts permeate flow. By applying a shear force to the surface of the membrane to disrupt the boundary, these problems can be decreased or even eliminated.

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VSEP is a cross flow membrane that is able to produce economical flow rates and reliability with fouling resistance due to the vibrations. The membrane vibrates at a 3/4" displacement at 50Hz. The vibration keeps the turbulent flow at the surface of the membrane allowing large molecules to continue movement away from the surface, avoiding fouling and allowing clean water to pass through the membrane.

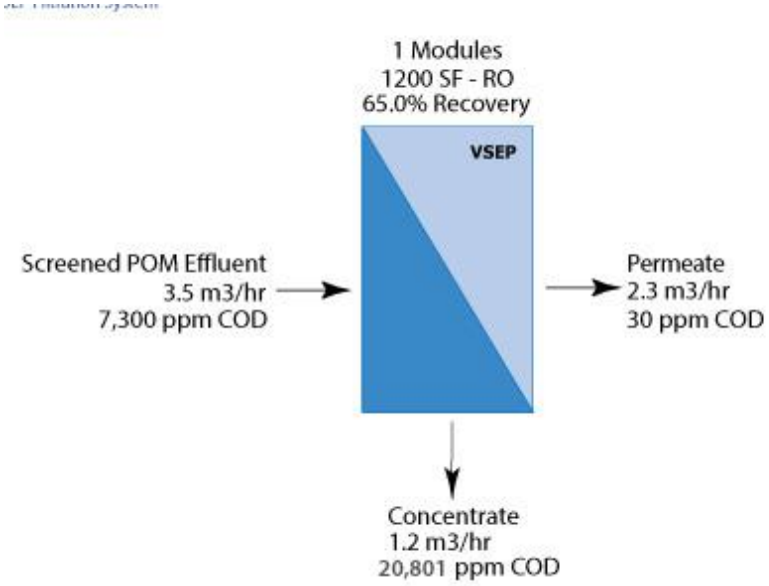
VSEP is modular and comes in a variety of sizes to accommodate different process flow rates. Systems are expandable and turn-down is dynamic based on production. Filter packs can be changed and different membranes can be used on the same machine for a variety of applications. This unique system has many advantages over conventional membranes and also other technologies for the same application. Additionally, VSEP can process much higher concentrations of feed. The feed can come from a variety sources and can vary in composition. The VSEP is designed to handle this variation in feed quality without sacrificing product quality.

For effluent with high levels of BOD and COD, New Logic often uses conventional spiral RO systems to polish the VSEP permeate. Each pass through an RO membrane reduces the BOD and COD greatly, but when the level starts very high and needs to be very low, then more than one membrane pass is often needed.

For palm oil, it appears that a VSEP RO system plus a single spiral RO system are enough to produce water with low enough levels of these contaminants. However, additional stages of RO spiral filtration can be added for any discharge level required.

This Project's VSEP Process

The production rate of this new mill is expected to grow over time. New Logic installed a two-module VSEP system to begin with, and the customer expects to be able to expand this system to up to 6 VSEP modules in the future. Each VSEP module will process about 3.5 m3/hr. The flow diagram below shows the mass balance performance of a single VSEP module. VSEP modules can be installed in parallel and therefore can accommodate any flow rate.



The reject from both stages of RO is sent back to compost piles where the concentrated nutrients are further absorbed into the fiber media. VSEP is producing approximately 75% of the volume as clean water and is leaving a reject volume of about 25%. The clean water is used as boiler feed water to make steam, or for irrigation.

Summary

New Logic Research has supplied VSEP membrane separation technology successfully into many industrial processes. The development of the palm oil industry, along with the availability of new membrane materials and VSEP technology make it possible to successfully deal with the very difficult effluent streams.

The commercial palm oil plant design has been constantly evolving. Improvements are being made to boost production and minimize waste. Many of these plants are being constructed using private financing that is based on the amount of product that can be produced. In addition, investors are conscious of the environmental impact and sustainability of the operations they fund.

Each application that comes to New Logic goes through rigorous tests and every system is custom-built to order. The process begins with an initial feasibility test using lab scale VSEP systems. An important characteristic of VSEP is that just about any membrane on the market can be cut and inserted into the VSEP to meet desired filtration needs. A variety of membranes are tested based on the application and the best membrane continues to test different variables including pressure, temperature, pH, filtrate recovery, and others. Further testing is completed onsite with pilot-scale VSEP systems. New Logic works with a wide range of applications from food products, landfill leachate, RO reject, all types of wastewater to even hog manure, and works to meet each individual application's objectives.

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

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