VSEP Vibes Newsletter

Welcome to the New Logic Research Newsletter.

Biogas Effluent with VSEP

Renewable energy is growing in its usage. Wind and solar are two popular ways of harvesting energy that can be unlimited. Each has advantages and disadvantages. Biogas, or methane production is another type of renewable energy that is very popular especially in Europe which does not have its own sources of petroleum. The problem with biogas digesters is what to do with the digested effluent or digestate. It cannot be discharge to surface waters and can only be land applied in limited amounts. New Logic has installed 30 projects to treat the effluent from anaerobic digester. The organic material used to feed the digesters has included pig manure, cow manure, and food waste.

Anaerobic digestion is one of the oldest processes used for stabilization of sludges. In an anaerobic digester, carbohydrates are converted to methane and carbon dioxide. Only the anaerobic process can be used for methane recovery. This process occurs in a closed system and requires 30-60 days of retention time. The residual sludge will contain many of the nutrients for fertilizer, but much of the nitrogen escapes as methane. One benefit is that the sludge is pathogen free and nonputrescible.

REFERENCE PROJECTS

As with the human stomach, digestion is very effective at consuming organic matter and converting it to carbon dioxide, water, and energy. Digesters can reduce some inorganic materials, but only those that can be settled. The problem is that manure and feedstock for biomethanization contains much more than organic material and solids that can settle. The remaining effluent is still potentially harmful if not treated in the proper manner. The digester will have little or no effect on things like chlorides, nitrates, phosphates, potassium, and sulfates. Digesters are also not capable of eliminating metals such as sodium, calcium, magnesium, iron, aluminum, copper, and zinc.

Digesters can produce methane, but are not a complete water treatment solution. The remaining digestate effluent water would need to be land applied or disposed of in some other way. Direct surface water discharge is not possible. VSEP RO filtration can be used effectively to treat the effluent from a biogas plant for surface water discharge or reuse. In addition, the VSEP system will concentrate many of the nutrients contained in the effluent and can yield a profitable value added stream of concentrated fertilizer that can be shipped as a slurry, or dried to make a dry fertilizer.

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Is Our Water Supply Safe?

We often take the safety of our town water for granted. In most developed countries clean water is always available. But the sad fact is that according to Swiss research, 4.4 billion people do not have access to clean water. It is not hard to treat water to make it safe, but unbelievably this is not a priority. There have been health campaigns to rid the world of HIV or Malaria, or Smallpox, but very little effort is given to making clean water available for everyone.

Additionally, even for those who have access to clean water, is it really safe? Researchers from Northwestern University and UNC found that in the United States, 40% of people worry about the health effects of drinking their tap water. This is despite the fact that over 97% have access to "clean" water. Another recent survey found that across 141 countries, 52% of those surveyed anticipate serious harm from drinking tap water. The biggest driver for this believe is corruption. In countries where corruption is widespread, there tends to be less clean water available and the water that is used is suspect as far as its treatment being safe.

Some of these fears can be for good reason. The episode in Flint Michigan where old pipes that

contained lead were found to have contaminated the town water supply is an example. Even though municipalities test their water and show that it meets EPA guidelines, what happens to the water after it leave the storage reservoir is not monitored. Also, the advent of the forever chemical known as PFAS is just now being identified as a carcinogen and is observed in many water supplies where it was not monitored previously. There is also a debate about Chlorination of tap water. When Chlorine is used to sanitize the water and prevent biological growth, the side effect is the creation of trihalomethanes (THMs)that derive from humic materials that can be found in surface waters. In some cases, Chloramine is used instead to avoid this problem, but there are questions about the health effects of Chloramines. There also can be risks associated with Chlorine resistant bacteria such as Giardia. Standards also change. The safe level for Arsenic used to be 50 parts per billion (ppb). But more recently, the EPA has decided there is no absolute safe level and moved the limit to 10 ppb

Existing method of water treatment are not very elaborate or expensive. Membranes are an option and have been used for desalinating seawater for a long time. But membrane systems can be expensive. Membranes are used to make "purified" bottle water and people accept that as safe. Membranes may play a bigger role in securing the safety of the water

supply. This could be especially true in the municipalities that have found elevated levels of PFAS materials. This could be done at the faucet with under-counter RO systems or at the municipality level with membrane water treatment systems. New Logic has installed VSEP systems for town water where the water source can be problematic such as surface water high in Nitrates or wells that have unacceptable levels of dissolved solids.

Tackling Refinery Effluent for Selenium

Hydrotreating of crude oil is a process that is used to remove contaminants like sulfur and nitrogen. Not only do these contaminants affect product quality and equipment operation, burning them is an environmental hazard and the removal from fuel is required by government regulations. Removing these contaminants will increase the product quality, reduce pollution, and some can be sold as a byproduct. Fractions from the distillation column can be finished products or can go through further processing.

Through many of these steps, wastewater streams are generated with contaminants that were removed. Wastewater that contains sulfide from the process is referred to as 'sour water.' This wastewater can contain other contaminants such as, phenols, ammonia, carbon dioxide, traces of metals and other compounds. There are a variety of sources of sour water that are involved in the refining process. Some by products are removed from the water through a process called stripping. The process begins with the sour water entering the top of a tower with steam entering the bottom. As the steam and water contact counter currently, dissolved compounds can be removed into the steam. Hydrogen Sulfide and ammonia are stripped by the steam and collected as a byproduct or for disposal. This may require a two-step stripping process due to the difference in solubility of ammonia and hydrogen sulfide. The residual water with the hydrogen sulfide and ammonia removed is referred to as stripped sour water and is sent for wastewater treatment for reuse in the process or sewer disposal.

VSEP Refinery System installed for Selenium removal

One of the problematic components in the stripped sour water is Selenium. This is especially true in heavy or "opportunity" crude. Recent government regulations are continually becoming stricter on selenium disposal due to the environmental impact. One particular concern is when Selenium accumulates in wetlands; birds will build up levels that are toxic causing egg shell deformation and birth defects. Selenium sources have been traced and stripped sour water has been identified as one source. Another source is the effluent from coal mining operations. The Clean Water Act has set limits on selenium discharge at a maximum of 0.005 ppm. One problem for refineries is finding a reliable treatment method to obtain consistent results to meet regulations. Selenium has also been found in some drainage areas from naturally occurring soil. The problem first was discovered at the Kesterson Reservoir in the California central valley where large concentrations of Se were found is migratory wetlands.

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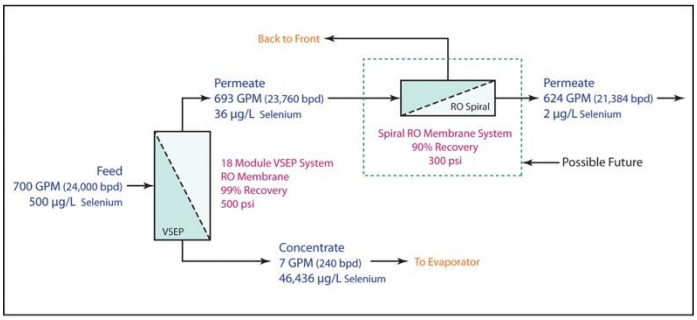
Kesterson Location where Selenium Problem Found

New Logic has installed its VSEP RO equipment to treat stripped sour water. Three stages of VSEP modules are used to achieve very high recovery rates. Spiral RO polishing can be used where the starting Selenium concentration is high. The VSEP is able to purify the effluent and achieve very low levels of Selenium. The water is so clean that it can either be discharged, or reused as process water for cooling towers or boilers. High Selenium levels are often found in heavy crude that is less expensive to purchase, but is more difficult to process. So, VSEP can be used to allow the purchase of less expensive crude without having the difficult issue of discharge compliance.

Refinery Stripped Sour Water

from Valero full-scale operation



Oil Spill Clean-up with VSEP

Written by Dr. Brad Culkin

Oil can reside with water in four basic ways:

1. Free oil mixtures exist as large globs of pure oil which quickly rise to the surface forming a pure oil slick or sheen. The free oil is readily removed by rope skimmers, cyclones, API separators and the like.

2. Oil dispersions are finely divided spheres of oil in water. Below 2000 micro siemens conductivity, naturally occurring charge at the oil/water interface prevents the oil spheres from touching and thus coalescing to form large globules of free oil. Breaking such dispersions is analogous to flocculation and sedimentation of fine aqueous dispersions of solids like clays or latex polymers. In both cases, chemical treatment with chemical flocculants induces agglomeration (in the case of solids) and coalescence (in the case of oil) by adjusting the mutually repellant surface charge toward zero. Absent these repellant forces, the dispersion forms larger particles which can be induced to sediment downward (solids) or upward (oil) under the action of "g" forces in sedimentation ponds, cyclones, centrifuges, and the like. In sea water, conductivity is more like 60,000 micro siemens. Dispersion cannot occur because the Debye length, i.e. the length scale

over which surface charge can be felt by another particle is less than the Vanderwaalds length scale and so particles can "touch" together and join by Vanderwaalds force. This is called flocculation (for solids) by "salting out" the dispersion.

3. Though limited, molecular oil can dissolve in water. The solubility of oil is strongly dependent on Ph. At high Ph, oil can be highly soluble in water.

4. Finally, oil can be emulsified with water. The simplest system is oil, water, and some emulsifying agent. Emulsion chemistry is more complex than dispersion chemistry because unlike solids, liquid oil can and often does respond to surfactant addition by spontaneously dividing and forming into small spheres called micelles. These micelles may be charged or uncharged, and charge may or may not matter to the stability of the emulsion for example depending on the conductivity. "Breaking" an emulsion, causing the oil to separate from the water and rise to the surface as free oil, may be chemically impossible, simply because unlike dispersions , which are charge stabilized, emulsions can be thermodynamically stable, i.e. even if one could separate the oil, upon water addition, the emulsion will spontaneously reform. Sometimes, emulsion can be "broken" by changing thermodynamic state variables. The most common are temperature (usually heating) and changing the chemical potential of the surface active emulsifying agent in the oil phase, the water phase, and at the interface of oil/water. Common examples include shifting Ph to change the partition of emulsifier into the oil or water phases, and solvent addition to partition the emulsifying species into the new oil/solvent or water/solvent mixture. If these methods fail, or become expensive, one must often abandon chemical and thermal breaking strategies. This is where membrane separations technology comes in.

As noted, if an emulsion is thermodynamically stable this means some free energy must be provided to separate the oil from the water. This free energy can

be supplied as work energy. For example a membrane can be introduced which passes water but not oil. If the emulsion contacting the membrane is pressurized, water but not oil will permeate through the membrane to the other side. The PV work done in forcing the water away from the oil and through the membrane is the thermodynamic motive force which "breaks" the emulsion. The process of water separation from the emulsion will continue until the oil concentration reaches 55% oil 45% water. At this point typically, the emulsion will "invert" from a water continuous emulsion with isolated spheres of oil, to an oil continuous emulsion with isolated spheres of water. This new system can often be broken easily by, for example, electrostatic precipitation, taking advantage of oil's low conductivity. Whatever method is used to recover the oil, the emulsion will invert back to water continuous at around 55%water and 45% oil. This emulsion can be sent back to the membrane separations process. Overall we see water leaving the membrane system as permeate and oil leaving a second stage separator which presumably takes advantage of the oil continuous nature of this stream. Can oil permeable membranes be used for this second step? Sure, but we find that with VSEP at least, much simpler and more cost effective methods also work.

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Best Practices

We often get in very lengthy engineering discussions where we provide our best advice to customers to insure a successful project. Sometimes our advice is not taken which can lead to lessons learned. We like to have the equipment indoors most of the time. If it is installed outdoors, we recommend a shed roof at a minimum to protect against the weather. We installed a large project in South Carolina where they decided to not put a roof over it. This project has been directly hit by three hurricanes including the latest Helene since it was installed only two years ago.

We also recommend a solids level smooth flat surface under the vibrating VSEP. We had a recent customer who provided this surface for us.

Our operator manuals are pretty detailed. There are some parts that need periodic maintenance like greasing a bearing. But just a little grease goes a long way and too much does not make it better.

We ship pilot equipment in wooden crates. When the equipment returns it is often not secured as well.

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Another Bottled Water VSEP Project

Bottled water companies face many image challenges. First, the single use plastic bottle is a problem. Even though it can be recycled, most are not and end up in landfills. California and other States have banned the use of single use plastic bags at grocery stores. But this is just the tip of the iceberg when it comes to plastic packaging. California charges 5¢ per bottle as an incentive to recycle, but, the State actually pockets a huge amount of that money collected because recycling is mostly not done. Estimates are only 30% of water bottles are recycled. Second, there is the water that is wasted during the bottling process. A typical water bottling facility will take in town water or well water and then filter it with a conventional spiral RO system. The yield or percentage of the water that is used and sold can be 65-85%of the total volume taken in. The fact that these companies might buy town water for $6 for 1000 gallons and then they sell the bottle water for $2 per gallon leads to a lot of resentment and even protesting at times.

So these companies respond to these image problems in a number of ways. They might advertise that the plastic they use is all recycled plastic or that the bottles are very thin. Some companies are also working hard to increase the yield of water from what they consume. This is where VSEP comes in. We have now installed 17 beverage projects and many of these are projects where VSEP RO is used to recover more water from the reject of the spiral system. By doing the water recovery yield of 98% can be achieved.

New Logic recently got an order for another large system for a major bottled water manufacturer. We are building the system now and it will deliver later next year. There will be two systems. One will process 75 gpm of reject from their spiral RO system. The filtered water from this will go back into the bottling process. The second system will filter 170 gpm of plant wastewater that is mostly flushing and cleaning water

for the equipment. A 15-module system will be provided for this and the filtrate will be recycled to be reused as flushing and cleaning water. The combined water reuse by adding the VSEP system will result in a 98% yield form the water taken in.

New Logic's largest bottle water installation consists of a VSEP system with 42 VSEP modules processing about 1 MGD (700 gpm) of spiral reject. The average US family household uses about 300 gallons per day. So, for this one VSEP installation, our system is recovering additional water that is equal to the amount consumed by about 3,300 households.

New Logic has delivered VSEP RO systems to bottling companies around the world and many in the United States. For some companies, VSEP has become part of the standard design when they build a new

bottling plant. The benefits of adding a VSEP system to reduce the brine volume include reduced water consumption and cost, reduced effluent costs, improved sustainability credits, better social acceptance, easier plant permitting process, and many other factors.

VSEP on Safari

We get to some pretty remote places and are often out in nature running a VSEP pilot test. On a pilot test in Appalachia at a remote coal mine, we were supplied with a container for shelter for the pilot unit. During the testing there were a lot of visitors including tree snakes, turtles, and plenty of bugs.

During a pilot testing India at a textile plant some curious monkeys attended making for an interesting audience

While running a VSEP system at a landfill in Panama, we had the attention of a resident crocodile who seemed to like the environment of the leachate pond.

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Then, of course, we do a lot of work at pig farms treating the manure. So we need to check the source of the effluent.

Recent Applications Tested with VSEP

New Logic performs bench tests on customer samples as an initial feasibility to determine the suitability of VSEP for their project. Here are some of the recent applications tested:

Urea purification
Manure digestate
Polymer dewatering
Acetic Acid purification
Bean soak water
Textile Dye effluent
Borax concentration
Flue Gas Scrubber water
Magnesium Hydroxide concentration
Evaporator concentrate with PFAS
Ion Exchange Regen water
Lithium Brine

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