NEW LOGIC RESEARCH

Case Study

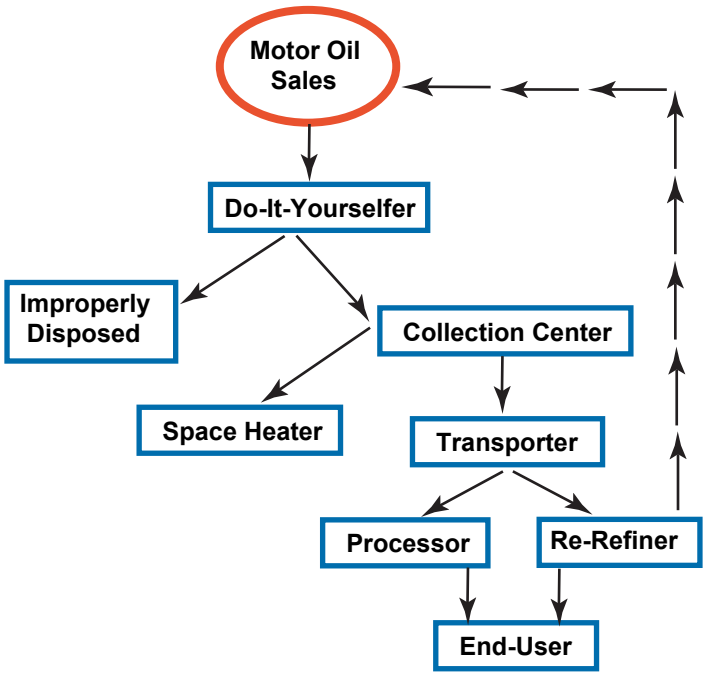
V✧SEP Membrane Filtration of Waste Oil

A cost-effective and environmentally sound processing solution

Overview

A unique membrane filtration system was installed in July 2001 at a major waste oil re-refining operation in Portland, Oregan. The system manufactured by New Logic Research, Inc. of Emeryville, California near San Francisco, is being used to process used crankcase waste oil and produce filtrate that can be sold as a higher value bunker oil. The V✧SEP, (Vibratory Shear Enhanced Process), system uses a Microfiltration membrane module with special construction for service with high temperature solvents and waste oils and is able to process up to 80% of the dewatered waste oil. The use of high temperature polymeric membranes has many significant advantages over the conventional methods of oil re-refing and also over expensive ceramic and inorganic filter media. New Logic's use of Polymeric membranes in it's V✧SEP Filter Pack is ground breaking and has stirred the interest of oil recycling companies around the world.

Used Oil Management System Site Map



Background

The waste oil re-refining operation in Portland services a large area in the Northwest and has several satellite transfer stations for pick up of used oil from many customers and other waste oil generators. Used oil is produced by many activities including auto repair, metal working, machine lubrication, and hydraulic equipment repair. Oil can be recycled to make new lubricants or industrial fuels. When properly recycled, used oil is excluded from regulation as a hazardous waste.

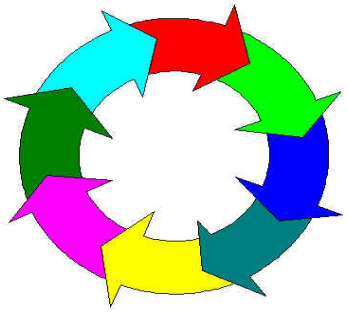
Used oil does not wear out, it just gets dirty. It can be used over and over again. 14% of used oil that is reclaimed is re-refined to its original virgin state. Re-refining base oil is the end product of a long process. The oil is first cleaned of its contaminants, such as dirt, water, fuel, and additives.

This is done through a process of vacuum distillation. The re-refined oil is blended with a fresh additive package to make the finished lubricant. 75% of used oil which is reclaimed is reconditioned and marketed to:

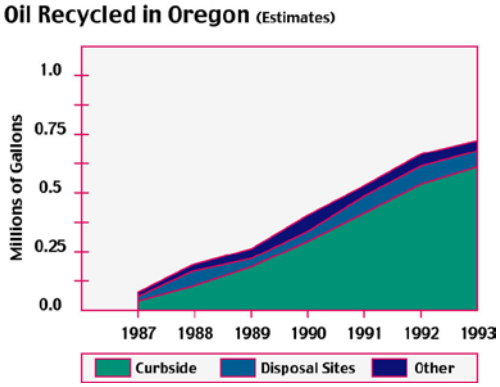
43% Asphalt Plants
14% Industrial Boilers
12% Power Plant Boilers
12% Steel Mills
5% Cement/Lime Kilns
5% Marine Boilers (Bunker Fuel)
4% Pulp & Paper Mills
5% Other

Used oil that is actually reclaimed represents a small fraction of oil actually sold and the majority of this oil migrates its way into the air and water posing a threat to the environment.

Regulators have been improving incentives for recycling and have been addressing the roadblocks to recycling like providing more convenient ways to drop off oil, increasing the number of collection sites, providing suitable containers for drop off, and monetary rebates similar to deposits paid on glass bottles.



Recycling Programs



Since the amount of used oil, which is mysteriously lost would dwarf the Exxon Valdez spill and is a huge environmental problem, governments have been looking at many ways to improve levels of recycling. The EPA, (Environmental Protection Agency), estimated that 210,000,000 gallons of used oil was generated in 1991. Only about 40% of that is recovered, with the disposition of the remainder being unknown.

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 binding 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 waste oil, large storage tanks containing waste oil are "batch" concentrated and volume reduced by as much as 80% leaving a thick viscous reject as the remaining 20% which can also be burned as a fuel product.

Results using V✧SEP

V✧SEP's Microfiltration high temperature membrane module is capable of treating used crankcase oil and providing a filtrate, which is free from suspended solids and dirt. In addition, the filtration process is able to greatly reduce the levels of various metals in the oil. Sulfur and Ash contents are also significantly reduced. Further refining to reduce Sulfur and Ash would yield a Lube Oil quality product and methods for doing this following V✧SEP are currently being investigated.

The resulting filtrate has an ASTM color index of about 8. The quality is comparable with Marine Grade Diesel Fuel or Bunker Fuel. Being able to sell the oil as Marine Diesel represents a significant value added when compared to the boiler fuel quality prior to the V✧SEP filtration process. The V✧SEP process does not involve any chemical addition and meets the criteria of process engineers' needs for inline automated production. Both the Permeate and Concentrate can be sold as product.

V✧SEP Filtration Results

Contaminent	Feed	Permeate	Concentrate
Iron	123	15	163
Chromium	3	<1	4
Nickel	5	1	7
Aluminum	18	<1	28
Lead	33	2	52
Copper	30	<1	44
Tin	<1	<1	2
Silver	0.4	0.1	0.5
Titanium	1	<1	1
Silicon	86	21	134
Boron	30	7	35
Sodium	109	4	161
Potassium	75	<10	209
Molybdenum	13	<5	16
Phosphorus	610	125	845
Zinc	827	8	1365
Calcium	1179	23	1623
Barium	28	23	41
Magnesium	348	10	429
Antimony	<10	<10	<10
Vanadium	10	2	11
Viscosity 40ºC	41 cSt	21 cSt	69 cSt
Ash (wt. %)	0.70%	0.03%	1.36%
Sulfur (wt. %)	0.38%	0.25%	0.48%
Water (vol %)	1.0 %	0.5 %	1.5 %
Permeate's Heat of Combustion:			
Gross Heating Value	19,922 btu/lb		
Net Heating Value	8,654 btu/lb		

Quantities are ppm (mg/L) unless otherwise noted

Process Description

The used oil is collected and stored in heated 20,000 gallons holding tanks. The water is boiled off after several hours at high temperature and then the used oil is pumped into the V✧SEP system for filtration. The viscosity of the oil plays a big part in the rate of filtration. Heat will help to decrease the viscosity of the oil and therefore improves the throughput of the V✧SEP system. The Portland installation is currently running at about 90ºC. Some experimental runs have been accomplished at temperatures of up to 115ºC. The mechanical design of the V✧SEP filter modules is being redesigned to handle temperatures over 120ºC which would double the throughput currently provided at 90ºC.

Once the oil has been heated and the water is driven off to less than 1% by volume, the feed waste oil is pumped into the V✧SEP Filter Pack at about 60 psi. The contents of the 20,000 gallon feed tank are processed so that the filtrate is removed from the system and sent to a "Look See" holding tank and then a larger product storage tank. As filtrate is removed by filtration and the reject is sent back to the feed tank, the contents of the feed tank are then concentrated and volume reduced in a process known as “Batch Process”. Multiple tanks are used and this same process repeats for each tank in series. Each V✧SEP unit is can process one 20,000 gallon tank in just under 2 days One V✧SEP was installed in Portland in 2001 and a second V✧SEP is currently being brought online to double performance.

The Permeate flow rate will drop off, as the feed material in the heated storage tank becomes more concentrated and viscous. At the end of a batch process, the Filter Pack is cleaned using clean diesel Fuel out of a Clean in Place tank of about 350 gallons. This is done by recirculating the diesel fuel with pressure and vibration to dissolve foulants that have found their way to the membrane. Months of pilot testing and also actual site conditions have shown that the membrane is able to clean up very well and the results from batch to batch are predictable and stable.

System Components

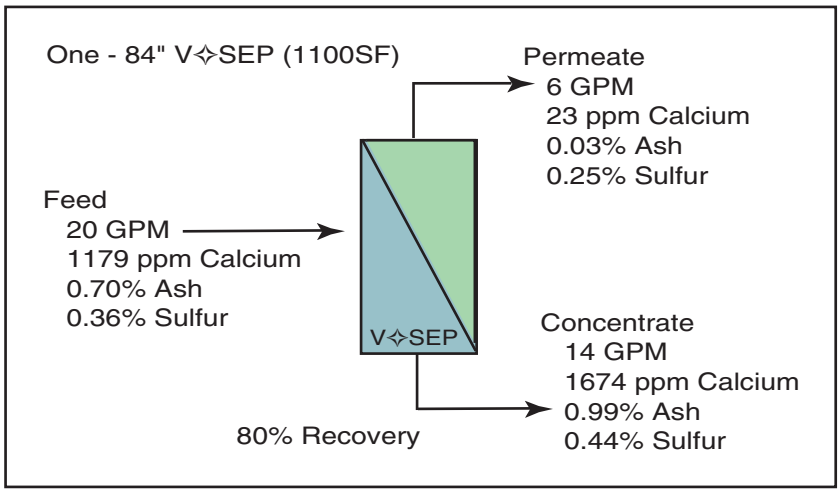
The V✧SEP system for this project was configured for manual mode where the operator would initiate all operating sequences. The unit has a PLC (Programmable Logic Controller) which monitors pressure, flow rate, and frequency. It also provides the safety in operation by monitoring conditions and initiating an alarm shut down should some configurable parameters be reached. The control stand contains the PLC, Operator display and terminal strips for wiring connections to instrumentation.

The Filter Pack is mounted on the V✧SEP base unit and contains about 1100 SF, (100m2), 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.

System Throughput

Each of the V✧SEP modular units for this project is capable of processing a 20,000 gallon, (76m3) tank of used oil in about 1.75 days. Since the units are modular and can be used in parallel or in series, the number of V✧SEP's needed can be calculated based on the amount of available used oil to be processed. At 90°C the membrane flux is about 8 GFD (Gallons per Square Foot per Day) or about 13 LMH. System throughput is also a function of the extent to which the feed tank is concentrated. At the beginning of a Batch run the flux is about 15 GFD and falls to about 4 GFD at the end of an 80% recovery of filtrate. The system throughput shown above is for one V✧SEP unit operating at about 90°C. A second unit is being installed in Portland which will double the throughput. In addition, the second module will be configured for operation at 120°C. The difference in performance between 90°C and 120°C is also doubled. So by running at higher temperature and by using 2 V✧SEP units, the system throughput would be four times as high as that shown.



Project Economics

Table 1 below shows the potential revenue from the installation of one V✧SEP module as currently configured in Portland. By adding the second machine and by operating at high temperature, the potential revenues would also be about four times as much as shown in the table below.

As you can see the economics are very compelling. The V✧SEP is uniquely energy efficient. It comes with a 20 HP dive motor and a 10 HP Pump Motor. Operators interface and maintenance a limited to starting and stopping the unit and a periodical cleaning of the membrane after a batch run. The diesel fuel cleaning solvent can be reused a few times further saving costs. Not only that the cleaning solution itself would have residual value which is not shown below. The membrane replacement is the largest operating cost and it is estimated that the life of each module is approximately 1-1.2 years. Operator care can improve the life and additional savings could be yielded by having the Filter Pack last 2 years or more.

Table 1:Waste Oil Economic Analysis

Description	Expenses	Value Added
V✧SEP System Power Consumption	$ 3,113	
System Maintenance & Cleaning	$ 15,095	
Added Revenue from Oil Spread*		
*2,956,500 gal/year x 0.30 $/gal		$ 886,950/year

The market for Oil and therefore recycled oil is subject to fluctuation based on supply and demand. The chief parameter for economics analysis of the V✧SEP process would be the spread in price between the boiler fuel grade oil which is the feed to the V✧SEP and the Marine Grade Diesel Fuel which is the by-product of the V✧SEP..The Table below uses a spread of $0.30 per gallon of filtrate produced. This spread will vary and can be as high at 0.50 $/gal and as low as 0.10 $/gal. No matter what the spread, the economics for V✧SEP filtration of used waste oil are very compelling and can lead to almost immediate realization of profits from the operations.

In addition to the value added form of Marine Grade Diesel Fuel which is currently under way, process development is now being done to find even higher value added products that can be produced from the V✧SEP including Lube Oil by reducing the Sulfur content and color index. The possible uses of the V✧SEP filtrate are wide ranging and another use includes dust control. Additional values and uses for the filtrate will be found in coming months.

Other V✧SEP Oil Applications

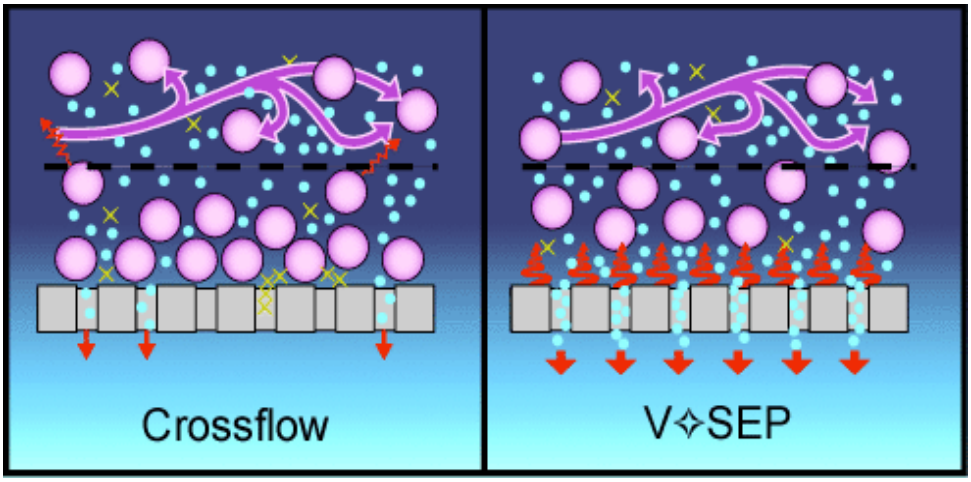
Oil/Water separation covers a broad spectrum of industrial process operations. There are many techniques employed depending on the situation. The oily wastewater application can be broken down into categories determined by the type of user of the V✧SEP and the oil/ water separation desired:

- Produce Water - Drilling Operations
- Bilge Water from Drilling Derricks
- Used Coolant from Manufacturing
- Drilling Mud
- Waste Oil Haulers

There is a saying: “Oil and Water don’t mix”. This is true, but, they can exist as an emulsion. Oil is not soluble in water but it can exist evenly dispersed as globules in water. The concentration of these globules is a function of mixing or stirring. If allowed to stand, the emulsion will separate because oil is lighter than water, although, some amount of oil globules will remain in the water. Another interesting fact is that this emulsion can exist two ways. If the concentration of Oil is less than 50%, the water will be the suspension fluid and the oil will be the globule. A phase transition occurs if the oil content is more than 50%. When this happens, the oil is the suspension fluid and the water forms globules. For this reason, hydrophilic membrane separations will be possible only when the oil content is less than 50%.

Company Profile

New Logic Research, Inc. is a privately held corporation located in Emeryville, CA approximately 10 miles from San Francisco. New Logic markets, engineers, and manufactures membrane dewatering and filtration systemsused for chemical processing, waste streams, pulp & paper processing, mining operations, and drinking waterapplications.



The V✧SEP technology was invented by Dr. Brad Culkin in 1985. Dr. Culkin holds a Ph.D. in Chemical Engineering and was formerly a senior scientist with Dorr-Oliver Corporation. V✧SEP was originally developed as an economic system that would efficiently separate plasma from whole blood. The company received a contract to produce a membrane filtration prototype, which later would be incorporated into a blood analyzer system. Today the company has adapted the technolgy to address the problems that face the old traditional membrane systems and offer companies an efficient and economical way to meet their process goals.

The Series i (Industrial) is a full scale model and comes in sizes ranging from 100 Square Feet to 2000Square Feet. These units are modular and can be used in parallel or in s eries. Successful VGSEP systems are in place now world wide including Europe, Central Asia, Southeast Asia, Australia, South America, Canada, Mexico, and of course here in the United States. New Logic offers a strong engineering staff to assist customers in the design, development, and testing of their filtration systems. After outgrowing two previous locations in the last ten years, New Logic is now located in a 40,000 square foot manufacturing building in Emeryville.

The plant has extensive equipment and machinery for manufacturing nearly all the V✧SEP parts. Manufacturing, assembly, and testing of all equipment takes place at this site. Systems and procedures are in place and geared towards high standards of quality control and have met the acceptance criteria of stringent applications such as nuclear waste processing.

For more information about the Portland Waste Oil Installation or on VSEP technology and its potential application to your process, please contact:

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