# Using Vibrating Membranes to Treat Coolant Wastewater from an Automotive Facility

## INTRODUCTION

The wastewater from the production of automotive parts can be difficult to treat due to its varied chemical composition. This type of wastewater contains high levels of COD that need to be reduced to meet local sewer specifications. The typical treatment scheme could consist of chemical treatment followed by a lot of pre-treatment steps and eventually a reverse osmosis membrane system. This type of treatment scheme can take up quite a bit of space in a facility and have high operating costs due to the chemical addition.

### New Membrane Technology

A new technology being used to treat coolant wastewater is known as VSEP™ (Vibratory Shear Enhanced Processing). Developed by New Logic International, Inc. of Emeryville, California, this revolutionary technology has made it possible to filter streams containing a variety of components without the fouling problems exhibited by conventional membrane systems. This advanced membrane system does not only remove the oil and grease but also significantly reduces the COD. The result is a crystal-clear water stream and a concentrated sludge.

The main difference between VSEP and traditional crossflow membrane filtration is the mechanism by which the foulants are prevented from accumulating on the membrane surface. A traditional crossflow system relies on the fluid velocity of the feed material alone to create shear forces needed to reduce fouling. This mechanism assists in slowing the fouling process but because a thin, stagnant boundary layer remains on the membrane surface, the foulants from the stream will accumulate over time and deteriorate the throughput rate. On the other hand, a VSEP system utilizes a patented vibratory drive mechanism that vibrates the membrane surface creating a shear force that disrupts the boundary layer. The resulting motion of the vibration drive is a _ inch peak to peak displacement, which constantly repels solids and other foulants away from the membrane surface. This mechanism enables the filter module to maintain higher, sustained throughput rates and process larger volumes of material economically.

*Figure 1:* An industrial VSEP machine. The vibration drive consists of a motor, seismic mass, and torsion bar assembly.

## CASE STUDY

### Industrial Installation in Shanghai

New Logic has recently installed an industrial VSEP system into an automotive engine manufacturing facility in Shanghai. This unit is used in conjunction with a nanofiltration tubular system to achieve an overall reduction in COD from 300,000 mg/L down to 3,000 mg/L.

The purpose of the installation is to volume reduce the wastewater prior to sending it to a centralized wastewater treatment plant. Due to more stringent environmental regulations, this facility was faced with paying excessive fines or finding a treatment method to meet the required discharge specifications. The VSEP was selected primarily due to its compact footprint, modular system design and effective filtration of a stream that fouled other membrane systems in minutes.

## Lab and Pilot Testing

The initial testing on the wastewater was used to identify a membrane that would not foul and yet still provide a significant reduction in COD. The membrane that was selected from the screening tests is a nanofiltration membrane with a 40-60% NaCl rejection. The membrane is known for its fouling resistance and can withstand cleaning routines involving both acidic and caustic cleaners. Although reverse osmosis membranes were able to provide a slightly better reduction in the COD they were limited in terms of recovery and produced much lower flow rates resulting in poor process economics. The nanofilter selected was able to provide a significant reduction in COD, economical throughput (flux rates) and a resistance to the foulants.

The first phase of testing was done in lab or L mode with a single sheet of membrane. The data collected gives an idea of the anticipated flux relative to the amount of permeate recovered. It was also determined that at a 75-80% permeate recovery the membrane was able to reduce 90% of the COD. The resulting effluent contained on average 30,000 mg/L from a starting feed of 300,000 mg/L.

Pilot scale testing or P mode at the customer's facility followed the first phase of testing. This testing involved using a small filter pack containing approximately 16.5 square feet. This system was used to collect data that simulates more of the type of performance of an industrial machine. Again the data that was most important in the initial P test was the flux versus the % recovery. The results of the two tests are shown in the following graph.

As you can see from the graph the lab mode results show a slightly higher flux rate than the P mode testing. This is primarily due to the manner in which each test was run. The lab scale test was completed with a small (15 gallon) sample while the pilot test was completed with more of a slip-stream of feed material. The smaller sample only has a finite amount of foulants and may not foul the membrane as rapidly as if the feed was constantly replenished with new foulants. The main purpose of the two tests is different with the pilot data weighted more heavily for an average flux determination.

The pilot test proceeded for approximately one month and showed that the flux was stable and the system could be flushed daily with warm water to maintain an economical average flow rate. The data from some of the pilot testing is shown in Figure 3. Over this pilot test period the machine was exposed to the variations that can occur with this type of a waste stream. The results not only confirmed the reliability of the membrane but also provided our engineering team with the information needed to design an industrial VSEP system.

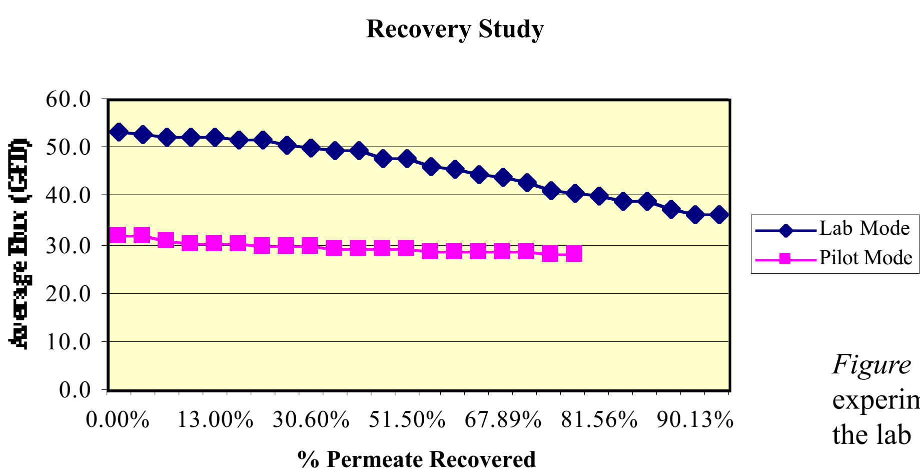


*Figure 2:* A comparison of the experimental data collected on the lab and pilot VSEP units.

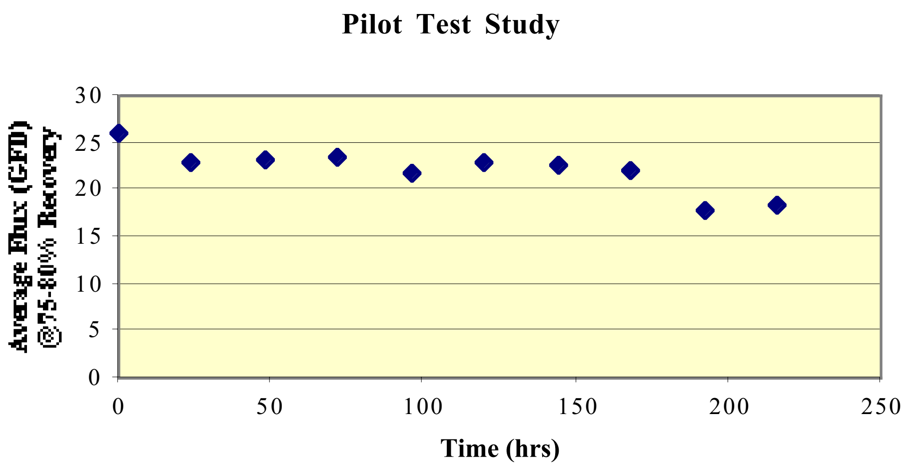


*Figure 3:* Pilot data for test at customer facility with a feed pressure of 350 psi.

### Industrial Installation

The industrial VSEP system was designed using 450 square feet of membrane area. The system included a feed pump, pre-filtration and CIP all contained on a single skid. The VSEP is fed using a vertical centrifugal pump with a feed pressure of 300-350 psi. The wastewater is collected in two separate 40 $m^3$ feed tanks and then pumped into a smaller tank that is approximately 10 $m^3$. This tank is operated in batch mode through the VSEP with the permeate going to the tubular membrane system for final COD reduction. The final permeate from the tubular system is sent to the sewer but the customer is investigating re-use. The concentrate is volume reduced to 20-25% of the original volume and is sent to the central wastewater treatment plant. Figure 4 shows a simplified flow diagram for the VSEP portion of the system.

The performance of the industrial unit corresponded well with the pilot test results. The system did achieve the desired 90% reduction of COD. The results of the first couple of hours of operation are shown in Figure 5. The preliminary start-up data shows that the flux is stable and slightly higher than the results of the P test but the membrane is still very new and so we would expect the flux to level off closer to 18-20 GFD.

The unit is only designed to operate for 16 hours per day with a warm water flush at the end of the day prior to shutdown. A chemical cleaning should only be needed once per week to reset the membrane and prevent accumulation of foulants present in low concentrations in the feed stream. The cleaning is completed with a small CIP tank and a low pressure feed pump. The cleaning solution is recirculated through the filter pack for anywhere from 20 to 30 minutes. This procedure followed by a flush is all that is needed for the system to be ready to run on the wastewater.

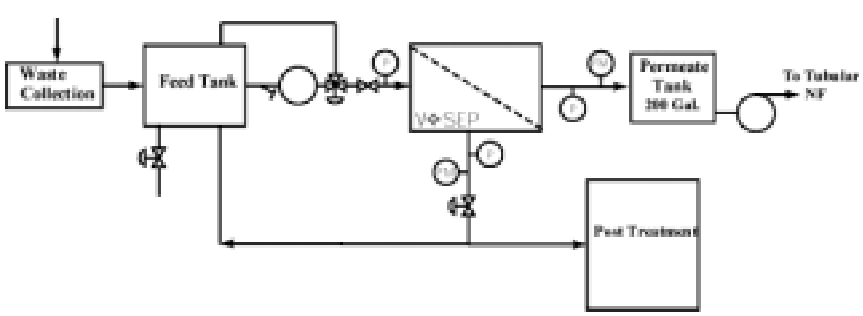


*Figure 4:* Simplified flow diagram of industrial unit. There is a peripheral CIP skid not shown in this diagram but was part of the purchased system.

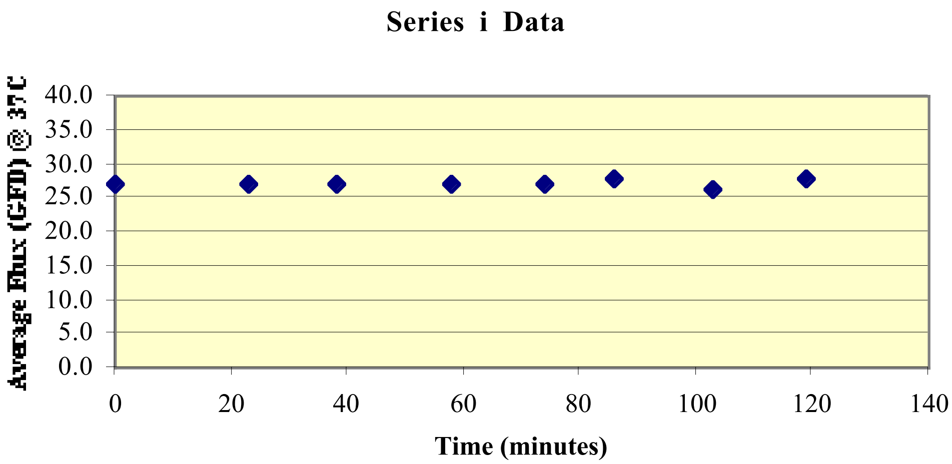


*Figure 5:* Industrial unit data for the final installation.

**CONCLUSIONS**

VSEP in conjunction with the appropriate nanofiltration membrane has been shown to be effective in the treatment of coolant wastewater. With a compact footprint, modular design and reliable operation the VSEP system was able to meet the stringent process objectives for a stream that would typically require a much more complicated treatment system.

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