Processing Penetrant Rinsewater with Membrane Filtration

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Introduction -

Liquid penetrant inspection procedures often result in rinsewaters that are contaminated with dyes, oils and other materials that have been rinsed from the parts being inspected. Although most penetrants in use today are non-hazardous by design, the dye-contaminated rinsewater can cause problems when improperly disposed of.

Several technologies exist for disposing of penetrant rinsewaters. Each has its strong and weak points. Off-site disposal requires little labor, but is expensive and exposes the generator to residual liability if the waste is improperly handled. Evaporation is an easily understood technology, but is very expensive to operate due to the high energy consumption. The specter of air permits and air testing being required to verify that there are no air emissions is a second concern with evaporators. Activated carbon is very effective at removing dissolved contaminants such as dyes, but it is expensive when used with wastes such as penetrant rinsewaters because of the high level of contaminants that must be removed. Activated carbon is most economical when used to remove trace levels. A final argument against carbon is the high cost of disposing of the spent carbon which can be more than the cost to purchase the carbon.

The technology we're going to address here is membrane filtration, also called Nano-Filtration. Membrane filtration is cost effective, requires little labor, and will produce water clean enough to be discharged or re-used.

The Technology –

Many of you are familiar with conventional filtration where a liquid is passed through a filter that traps the contaminants, typically suspended solids. When the filter becomes fully loaded with the contaminants it is replaced. This type of filtration is often called pass-through filtration and is an "on-line" process. This means that we can filter out the contaminants while we continue to the use the liquid we are filtering. A common example is the oil filter on an automobile engine.

Membrane filters are very expensive compared to conventional filters. Consequently, the goal is to get the longest useful life out of the membrane. It is normal to use a membrane filter for 12 to 18 months before replacing it. With membrane filtration, the waste liquid is

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pumped from a process tank, under pressure, across the surface of the membrane. Because of the pressure, some of the water is forced through the membrane. The contaminants that remain are flushed away from the membrane surface by the high flow and returned to the process tank. This re-circulation of the waste continues until the majority of the water is extracted from the tank. The concentrated residue is then emptied from the tank and another batch is started.

Membrane Types –

There are several types of membranes available to system designers. The most common types for waste processing are spiral-wound, tubular and hollow fiber. Without getting into specific advantages and disadvantages of each type, spiral-wound membranes offer the widest range of pore sizes, are the most energy-efficient, and are the most temperature tolerant. The other two types have advantages for some types of waste processing, such as wastes with a high level of suspended solids. For penetrant rinses, however, spiral-wound elements are the best choice. The absence of suspended solids and the need to block the passage of dye molecules are the deciding factors.

For penetrant processing, a membrane with a small enough pore size needs to be used to allow water to pass through while blocking the dye molecules. For this we use a Nano-Filtration membrane. The pore size is considerably smaller than Ultra-Filtration while not quite as small as Reverse Osmosis membranes.

Operating Problems –

Membrane systems all have certain limitations in the types of wastes they can process. Strong solvents for example can damage membranes and any vulnerable system components. Luckily, the majority of penetrant applications involve chemistry that is compatible with membranes. The vast majority of problems caused by incompatible substances are weeded out during trial evaluations before a purchase order has been issued.

By far the most common source of problems is improper use of the system by the customer. This is usually the result of the person operating the system not reading the operating manual. The following problems are not uncommon. The good news is that they are easily corrected.

We have had customers successfully process with our systems for some period of time before calling to complain that they are no longer extracting water. One of the first questions we ask is “How often do you empty the concentrated residue from your tank?” Sometimes the answer explains the problem: “I didn’t know I had to.” Refilling the process tank with new waste without first emptying the residue results in a batch that is twice as concentrated as the first batch. This over-concentration continues with each successive batch until the system finally grinds to a halt.

Another favorite question is "How often do you clean the membrane?" Response: "What do you mean 'clean the membrane'?" The surface of the membrane becomes gradually blocked by contaminants that are not completely flushed away during processing. These are removed from the membrane by simply flushing the system with a membrane detergent cleaner. This rejuvenates the membrane and restores its full processing capacity. Membrane cleaning is a simple, automated task that keeps the system operating at peak efficiency and prolongs the life of the membrane. Cleaning after each day's batch is completed is the best regimen.

These few simple steps will usually ensure problem-free processing.

Summary –

Membrane filtration systems have established themselves as the preferred technology for processing a wide range of industrial wastewaters. Thousands of manufacturers are processing spent parts cleaners, machining fluids and other aqueous wastes with membrane systems. Penetrant rinsewaters are an easy waste to process with membranes because they are nothing more than a dilute dye solution. The key to a successful installation is choosing the right membrane and making sure that the operator is properly trained.

The nature of dye solutions requires a Nano-filtration membrane to ensure complete color removal without the need for activated carbon or some other post-treatment. The resulting processed water will be colorless and suitable for either discharge or re-use.

Care should be taken to make sure anyone operating the system understands the basic way in which the system functions. A regimen should be established to ensure that the residue is emptied after each batch and the membrane is cleaned on a regular basis.