Case History: Optimization of a Wastewater Treatment Membrane System Designed for a Heat Treating & Metal Finishing Facility

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An integrated manufacturing facility involved in heat treating and metal finishing operations was experiencing poor waste treatment membrane filtration. By optimizing the chemical pretreatment of the wastewater, the following benefits were realized: improved flux rates, reduced regeneration cycles, decreased membrane operating pressures, and improved sludge dewatering of the reject water.

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Backround

An integrated manufacturing facility involved in heat-treating and metal finishing operations was experiencing wastewater treatment problems as a result of poor wastewater treatment membrane filtration. The 3-train membrane filtration system, (designed to process 100 gpm of wastewater per train), was now required to run 2-membrane trains to process an average of 25 gpm of wastewater. The pretreatment process for this wastewater treatment system was originally designed with large doses of calcium chloride and sodium sulfide. This coupled with the high pH required for the formation of insoluble zinc sulfide (pH 11-11.5), resulted in a highly alkaline water. Calcium carbonate and calcium sulfate was depositing on the filter membranes causing reduced filtration. The filter membranes required a higher than desired frequency of acid cleaning to remove the calcium deposits, and restore proper filtration rates. In addition, calcium deposits were plugging the filter press clothes resulting in unsatisfactory dewatering of solids.

A treatment program was required to replace the use of calcium chloride for coagulation, and thereby increase the filtration rates through the wastewater system membrane filters, and solids filter press.

Existing Technology
(S*ee Figure 1.)*

The existing wastewater treatment program consists of: chrome reduction via an automated ORP/pH controller, on-going flow through rinse waters and concentrates from Electroplating to a neutralization tank (pH 2.5-3), and bleed in of cleaners into a second neutralization tank (pH 11-11.5). Calcium chloride (500 ppm) was added to the first neutralization tank to condition solids. Sodium sulfide (500 ppm) was added in the second tank to form insoluble metal sulfides. The pretreated water then flowed to a concentrate tank, where solids were filtered out via a membrane filtration system. The filtered water was routed to a tank for final pH adjustment and discharged to the municipal sewer system. Solids filtered by the membrane system were routed back to the concentrate tank for continuing filtration or dewatering via a filter press.

Treatment action plan

The water treatment chemical supplier undertook a plant survey to assess the various electroplating and heat treating operations at the facility. Wastewater samples were collected and a treatability study was performed with various inorganic and inorganic/cationic polymer blends. These products were evaluated with the intent of replacing the calcium chloride coagulant currently used for solids conditioning.

- The treatability study data concluded that an all-inorganic aluminum/calcium/magnesium based coagulant worked very effectively to condition and neutralize ionic charges of solids.

- Though some inorganic/cationic polymer coagulants performed well in the study, an all inorganic coagulant product was selected due to the potential for membrane pore plugging by organic polymers.

The demand for the aluminum/calcium/magnesium coagulant was 200 ppm. Zinc and chrome concentrations were reduced to below 0.8 ppm and 0.2 ppm respectively *without the addition of sodium sulfide.* Filtration tests indicated good solids conditioning with no plugging of membrane pores.

The treatability study looked promising. A 60% reduction in the amount of coagulant required was observed using the aluminum/calcium/magnesium product versus calcium chloride. In addition, sodium sulfide was not required to reduce zinc, and chrome concentrations below the facility's effluent limitations.

Program evaluation

An on-line trial was initiated to evaluate the proposed treatment program. After a 2-month trial period it was evident that membrane filter operating run-times had increased dramatically.

Membrane filtrate flow (avg.)	
Calcium chloride program	25-30 gpm
Al/Ca/Mg coagulant program	55 gpm
Membrane run-time (avg.)	
Calcium chloride program	2-3 days
Al/Ca/Mg coagulant program	7 days
Membrane cleaning duration	
Calcium chloride program	8 hours
Al/Ca/Mg coagulant program	2 hours

- On the calcium chloride/sodium sulfide program, membrane run-times averaged two to three days before cleaning was required. With the Al/Ca/Mg coagulant program run-time between cleaning was seven days.

- Membrane filtrate flow increased from 25 gpm to an average of 55 gpm (one train operating) on the Al/Ca/Mg program. On the calcium chloride program, plant personnel had to place two membrane trains in service in order to achieve a filtration rate of 25-30 gpm.

- Cleaning duration decreased 75% using the Al/Ca/Mg coagulant.

In addition, a significant increase in solids dewatering was observed in the filter press operation.

Figure 1. Wastewater Treatment Process Flow Diagram