WWi
WATER & WASTEWATER INTERNATIONAL
Industrial Treatment & Recycling
Jack Shih and Orest Zacerkowny

Zero liquid discharge system maximises recycling success

The USFilter zero liquid discharge system continues to produce more than 119,000 gallons per day for water reuse at a truck manufacturing facility in Escobedo, Mexico.

Declining water reserves and high costs make water a valuable resource in Mexico where it is considered a key manufacturing resource.

International Truck and Engine's truck manufacturing facility in Escobedo, Nuevo Leon, Mexico, reduced its fresh water demands and eliminated wastewater discharges into local waterways by installing USFilter's zero liquid discharge (ZLD) system, which produces more than 119,000 gallons per day (gpd) for water reuse.

The ZLD system provides an economical solution for International, which must contend with local water availability, water costs and wastewater discharge criteria. Since installing the system in 1997, International has treated 5,000 gpd of gray water; 31,500 gpd of sanitary water; and 35,900 gpd of pre-treated water. Drinking water is trucked in directly and separately. Of the treated water, 68,000 gpd are sent back into plant processes and 9,000 are used to irrigate the grounds. Approximately 20 per cent of the RO input is discharged into the evaporation ponds.

International Truck and Engine Corporation's 1,080,000-ft^2-assembly plant, located in the middle of Mexico's northern desert, requires several thousands of gpd of water to produce more than 100 medium and heavy trucks daily. The facility has operated Monday through Friday, from 7:00am to 5:00pm since 1997.

To meet its water needs, the Escobedo facility would have had to consume a large amount of expensive fresh water, thus placing an inefficient cost burden on the plant. International also did not wish to further strain the rapidly dwindling local drinking water supply. Moreover, to meet the stringent local water discharge limits, International would have to provide extensive treatment of sanitary and industrial waste streams, such as reverse-osmosis (RO) rejects and acid and caustic streams from the painting process before discharging them into local waterways.

International contacted USFilter for a solution, which in turn, proposed installing a ZLD system that would maximise water recycle. Installed in 1997, the ZLD system combines a number of wastewater treatment technologies, including sanitary collection, biological water treatment, microfiltration membrane softening, RO water recycling and evaporation ponds. Proper technology integration has been key to the overall system's success, as each individual system along the process train relies on the other in order to perform continuously within its set design parameters.

An Integrated Approach

USFilter's design team found the plant's water supply to be inconsistently high in hardness and silica, which presented additional challenges. Water entering and exiting the plant needed softening and total dissolved solids (TDS) reduction. It would be difficult to accurately size the pretreatment and wastewater treatment systems to provide the necessary capacity to process all of the required feeds. Each system would need to process 100% of the flow, but this would be uneconomical and costly.

The wastewater reuse system provider recommended using microfiltration membrane softening for pretreatment and wastewater treatment. For a water source, International would use a blend of high-quality treated wastewater. The facility would only use fresh water on an extreme-needs basis.

USFilter used its piloting and system installation experience at another automotive manufacturing plant in nearby Saltillo to design the Escobedo plant's ZLD system. The majority of chemicals, paints and solvents were similar enough to assume the biodegradability of the wastewater.

The ZLD system also incorporates the Escobedo plant's original wastewater treatment system, provided by the paint line supplier to remove metals and paint solids.

...the ZLD system combines a number of wastewater treatment technologies, including sanitary collection, biological water treatment, microfiltration membrane softening, RO water recycling and evaporation ponds.

Jack Shih, International Truck and Engine

Sanitary wastewater is collected in a sump and then pumped into an equalisation (EQ) tank before it passes through a strainer basket. From here, it is pumped into a biological treatment EQ tank that also receives the following streams:

- Paint line wastewater treatment system (29,900 gpd);
- Wastewater from biological transfer sump (109,500 gpd);

Duplex reverse osmosis

The plant uses several thousands of gallons per day of water to produce more than 100 medium and heavy trucks daily. International 9000i Series heavy trucks can be customised at Escobedo's Truck Specialty Centre.

- Biological filter press filtrate (744 gpd); and
- Biological digester decant (396 gpd).

The feed is then sent into duplex sequencing batch reactor (SBR) systems, which operate in a batch mode and can easily be adjusted to meet the variations in feed water quality and volume. Each reactor is equipped with air distribution systems and a decanting mechanism. Sludge from the SBRs is fed into two digester tanks.

Effluent from the SBRs is then sent to a raw water treatment system and mixed with the paint line RO reject. The raw water treatment system consists of triplexed microfiltration systems, each capable of handling 150 gallons per minute (gpm) of feed. One-inch diameter polyvinylidene fluoride tubular membranes are used in the microfiltration system.

The dual-train reaction system softens the influent water prior to the microfiltration treatment. In the first reaction tank, caustic soda is added to increase the pH and precipitate calcium carbonate. Sodium hypochlorite is also added as disinfectant. The first reaction tank gravity feeds to the second reaction tank, where polymer, a more viable substance than the formerly used ferric chloride, is added to coagulate the suspended material. Effluent from the second reaction tank gravity feeds to the microfiltration skids.

Each of the three microfiltration skids is equipped with a concentration/feed tank that serves to collect the influent and the concentrate stream for the microfilter. The microfilter is operated to maintain two percent solids in the concentration tank.

USFilter recommended microfiltration as pretreatment to the RO systems because it provides a physical barrier for solids separation and removal. This barrier is more reliable than a traditional clarifier/filter mechanism, as it more easily tolerates operator error and will not foul a RO with solids carryover. A silt density index (SDI) of < 1 is continuously achieved. On average, the RO membranes only require cleaning once every two months.

Microfiltration sludge is drawn from the concentrate and sent to a filter press. Filtrate from the microfilter is sent to two reactors for pH adjustment, where dilute sulphuric acid and sodium bisulphite are added. The pH is lowered to optimise the RO units' performance.

Sodium bisulphite acts as a reducing agent to destroy any residual oxidising materials that may damage the RO membranes. Thin film composite (TFC) membranes were selected for this application because of their higher reject and flux characteristics. Using TFC membranes without microfiltration pretreatment would not have been prudent. Had cellulose acetate membranes been used instead, larger RO systems operating at higher pressures would have been required. This, in turn, would have significantly increased the plant's capital and operating costs.

The RO units are currently operating at 90% recovery due to the high quality of feed water produced by the microfiltration system. Permeate is chlorinated and directed to a 100,000 gallon plant water storage tank. The RO reject flow is split between the evaporation ponds and the raw water storage tank, where it can be fed again to the raw water recovery system.

This system demonstrates that environmental protection is a good business practice and reaffirms that a majority of US-based international companies work efficiently to comply with national environmental regulations. Notably, the ZLD reduces water supply costs given that International no longer must purchase as much fresh water for manufacturing.

USFilter used its piloting and system installation experience at another automotive manufacturing plant in nearby Saltillo to design the Escobedo plant's ZLD system. The majority of chemicals, paints and solvents were similar enough to assume the biodegradability of the wastewater.

Orest Zacerkowny, USFilter

Authors' Note

Jack Shih, the environmental affairs manager for International Truck and Engine, is based in Warrenville, Illinois, USA. Orest Zacerkowny is USFilter's vice president of sales and marketing for the metals and manufacturing industries as well as for industrial membrane technologies. He is based in Lasalle, Ontario, Canada. This article is based on the paper "Zero Liquid Discharge in the Automotive Industry: A Review of Three Facilities in Mexico," presented by Orest Zacerkowny at the 2002 Water Reuse Federation Conference in San Antonio, Texas.

Microfiltration softening