Lift Stations
Hydrogen Sulfide
Corrosion

Oxidation of Hydrogen Sulfide in a Sewer Collection System

Situation:

A Tannery in southern Maine processes and "blues" animal hides (previously treated) which they manufacture into leather. Their product, treated leather, is then sent to other manufacturing facilities for conversion into finished goods leather products. This Tannery discharges ~500,000 gpd of process wastewater into the sewer collection system of their local town, but prior to entering the collection system the Tannery's wastewater enters a 150,000 gallon pretreatment and equalization (EQ) tank. In the EQ tank the wastewater is treated to adjust pH to 8.0 with the addition of hydrated lime. A small 20-hp blower was used for mixing and equalization and to introduce dissolved oxygen into the wastewater through diffusers to reduce BOD and control H_2S odors. The blower was ineffective in adding dissolved oxygen into the wastewater and also in controlling H_2S odors. The temperature of the discharged process wastewater varies from 106°--115° F (40°--46°C) upon entering the EQ tank depending on time of day and season of the year. Additionally, the Tannery added ferrous chloride ($FeCl_2$) to assist in controlling hydrogen sulfide (H_2S) odors.

The effluent of the EQ tank is pumped from the pretreatment tank into a lift station operated by the town but located on Tannery property immediately adjacent to the EQ tank. Then the wastewater entering the lift station is pumped up a hill to a drop manhole in the center of the street at the main intersection of Town. There it enters into a gravity flow line to the treatment plant 2 miles away. The principal problem occurs when the process wastewater enters the drop manhole. Because of the turbulence with the drop and splashing very large amounts of hydrogen sulfide (H_2S) gas are released in the manhole, which migrate into the surrounding residential area. Malodors linger for hours because the hydrogen sulfide concentrations are so high.

The local wastewater treatment plant personnel receive numerous complaints daily from residents about the odors at the intersection, and these odors are especially bad during warm summer days. The wastewater utility's consulting engineer contacted Venturi Aeration, Inc. directly trying to determine what treatment could be accomplished in the lift station to prevent the release of hydrogen sulfide in the drop manhole.

When treatment plant personnel investigated the odor complaints they discovered that H_2S levels were "off the scales" of their H_2S gas detection analyzer, which only had a range scale of 0.5 to 100 ppm, the device would immediately "peg out." Additionally, there were corrosion-related problems in that entire gravity flow collection line attributed to the release of the hydrogen sulfide gas in the drop manhole.

Sections of concrete would fall into the sewer line and the line was caked with lime that the tannery was using for pH adjustment. The Town had to jet clean this sewer line twice a year to remove the lime scale and they passed the cost for cleaning back to the Tannery in the form of a surcharge.

Solution:

Venturi aerators are frequently used in connection with lift stations to oxidize hydrogen sulfide odors into soluble SO_4. However, it became very apparent that the best location for a venturi aerator solution for odors was not in the Town's lift station but rather to treat the Tannery's process wastewater at the Tannery itself. The best location for treatment was in their pretreatment EQ tank prior to discharge to the lift station. Venturi Aeration, Inc. configured a system using a single venturi aerator that would:

1. Add sufficient dissolved oxygen (DO) to effectively oxidize hydrogen sulfide to eliminate odors at the drop manhole.
2. Reduce the temperature of the process wastewater (θ value) to allow for the solubility of dissolved oxygen to transfer into the wastewater.
3. Accomplish mixing and equalization for the alkalinity being added to the tank for pH control,
4. Strip carbon dioxide to non-chemically reduce the amount of alkalinity (hydrated lime) being added for pH adjustment, and to reduce lime sludge/ solids.
5. Eliminate the addition of the ferric chloride used for odor control.
6. Eliminate the blower, which exceeded the OSHA PEL for noise.

Venturi Aeration, Inc. installed a Gorman-Rupp T-6 series pump (with modification) with a 3-phase, 40-hp motor to provide the pumping capacity to develop the required head to operate a venturi aerator Model VA-1100 at 20 psi. The venturi aerator was installed on the top of the EQ tank. The kinetic energy of the discharge from the venturi aerator is also used for mixing and equalization.

The venturi aerator aspirates 2.0 volumes of ambient air into one (1) volume of process wastewater to provide for both cooling the process wastewater and inducing oxygen transfer. Even though the temperature of the influent process wastewater can be as high as 115°F (46°C), the venturi aerator aspirated air helps reduce the temperature to ~86°F (30°C). This is accomplished by the continuous recirculation of the contents of the equalization tank by aspirating ambient air into the wastewater. For every one volume of process wastewater 2.0 volumes of ambient air are mixed in the venturi aerator unit itself. There is a complete 100% turn of the contents every 2.3 hours. As the venturi aerator decreases the temperature of the process wastewater the solubility of dissolved oxygen increases achieving H_2S oxidation and allowing for sufficient residual DO to be present in the treated wastewater when it reaches the drop manhole. Having residual DO in the effluent prevents H_2S from reforming in the collection system as the oxygen is consumed in the sewer line enroute to the treatment plant..

There hasn't been sufficient time to evaluate the venturi aerator's impact on reducing lime scale in the gravity collection line due to the lower levels of lime addition for pH control. However, the basic fact that odor complaints from Town residents have stopped is testimony that the venturi aerator was the correct solution for the problem. Additionally, the Tannery has reduced both its chemical costs by reduced levels of hydrated lime and ferric chloride as well as labor costs.

Most importantly, Town residents now believe that the Tannery doesn't "stink" anymore and that the Tannery heeded their numerous complaints to solve the odor problem that had persisted for years. The community relations value of the venturi aeration project was as important to the Tannery as were the savings since many of the workers at the Tannery live in the local Town.