ODOR CONTROL OPTIONS FOR CSO SYSTEMS

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Any wastewater process that includes storage, conveyance, collection, or treatment has the potential to create odors to some degree, including Combined Sewer Overflow (CSO) systems. Although there are many odor measuring parameters, by nature, odors and their nuisance are subjective to the individual. In offering a more simplistic perspective, I quote from one of my favorite Christmas movies. "One man's toxic sludge is another man's potpourri," Jim Carrey comically states as the Grinch to his blindly devoted dog, Max. If you are a Jim Carrey fan I urge you to see this movie. I watch it at least twice each holiday season with my 8-year old daughter.

Odors of Concern

Many of the wastewater process odor problems emanate from the collection system, plant headworks facility, and in the solids handling facilities. When sewage becomes stagnant, it can be depleted of oxygen and create anaerobic or "septic" conditions, resulting in odorous compounds. When the microbes present in the wastewater have deficient oxygen available for respiration, other undesirable microbes known as "sulfate-reducing bacteria" thrive by using the sulfate ion (SO^{4-}) that is inherent in most waters as an oxygen source, producing hydrogen sulfide gas (H_2S). H_2S has an offensive rotten egg odor and is often corrosive to most materials when it is oxidized into sulfuric acid. Other typical odorous compounds include mercaptans (skunk odor quality) and amines (fishy odor quality).

It could be anticipated that CSO flows would not have a high concentration of H_2S due to the dilution of the wastewater with rainwater and runoff, combined with the expected velocity in the conveyance line which causes turbulence and introduces oxygen. However, odors are most likely generated during the storage phase until the CSO volume can be transferred back into the collection system. When the CSO flow arrives at the storage tanks, the water is agitated, liberating the H_2S from the liquid phase to the vapor phase. Likewise, when the tank is drained back into the system, odors can be created from residuals left in the tank until the next filling phase. If the tanks are not flushed and/or cleaned after each draining event, the gases are trapped in the tank's void space during the next refilling phase unless exhausted and treated.

The longer the CSO is stored the more gases will be produced especially if some form of aeration is not provided. However, it is difficult to estimate the quantity and concentration of gases that need to be treated. To combat this issue, various technologies are available for controlling odors from wastewater facilities and collection systems.

Odor Control Options

Odor control technologies are characterized as either vapor-phase or liquid-phase treatment depending on whether the objective is to prevent future or treat existing odorous gases. Vapor-phase systems are typically employed at point-source applications such as wastewater treatment plants (WWTP) and pump stations where the gases are contained inside a building or enclosed structure and are used to treat the gases. Liquid-phase systems are generally employed in collection systems where control of both odors and corrosion are primary goals, preventing the formation of gases.

The driving force for design of vapor-phase systems is the ventilation rate for the headspace to be treated and the amount of the contaminants that may be volatized to the vapor phase. For liquid systems, the design shifts to the volume of flow to be treated coupled with the total mass loading of the contaminants in the liquid. With either technology, reducing the number of variables is a key component in designing a system. This often becomes more challenging in collection systems with CSO storage and treatment since it's difficult to predict flow events and gaseous concentrations. At WWTPs, enclosed processes provide a "controlled" environment with a known volume and better predicted pollutant concentration.

Vapor-Phase Technologies

Ventilation systems are utilized to maintain a negative pressure in the enclosed space and to collect and transport the gases for treatment. In occupied buildings, make-up air is supplied to ventilate the space. Ductwork is required to convey the gases to the treatment unit(s). Effective vapor-phase technologies include:

Wet Air Scrubbing

Because it can treat virtually any water-soluble contaminant, wet air scrubbing has been documented as being the most reliable and flexible vapor-phase technology. Chemical scrubbers utilize contact between an aqueous solution and the gas stream in a chamber filled with a packing material to transfer the odorous compound from vapor to liquid. In addition to the odorous compounds previously mentioned, wet scrubbing can be very effective for ammonia removal. Since this system is strictly a chemical interaction, it is not as subject to process upsets as are common with biological systems. In a basic sense, chemicals are used to "scrub" the odor producing constituents out of the gas and leaving an essentially odor free exhaust. The reliability and flexibility of the wet scrubbing system is provided by the use of chemicals and the chemical reactions, which is more of a controlled process than a biological system.

An example of a typical wet scrubber system, documented as the most reliable and flexible vapor-phase technology. (LOPRO® Odor Control System)

Biofiltration

Biofiltration uses an organic medium such as compost, mulch, or peat to solubilize odor contaminants from the vapor phase into an aqueous phase. A typical system is constructed in-ground in single layer units with an air distribution system, utilizing sprinkler-type irrigation for moisture control. A bacteriological population is established on the media surface to degrade odor causing compounds such as hydrogen sulfide, organic sulfides, and mercaptans. However, biofilters are not effective at removing nitrogen-based compounds such as ammonia and amines. Control of a biofiltration system can be challenging due to the potential changes of the natural bacterial environment and the media can become unstable if not properly maintained. The media can be prone to settling and compacting which increases the headloss through the filter, thus constricting the airflow causing fugitive odor emissions. Additionally, if the media is exposed to wide swings in environmental conditions, the bacteria population can become upset resulting in odor breakthrough.

Many of the challenges listed above can be addressed through the use of a manufactured biofilter design. With engineered biofilters, media instability is reduced and control issues are limited. In contrast with natural media beds using locally available materials, the media used for manufactured units are engineered for a specific application to meet a particular composition and performance specification. These systems provide consistent and repeatable performance through a specific combination of organic media materials. Many of the manufactured units are constructed in an enclosed, modular design that provides protection from temperature and humidity fluctuations, quick and easy construction, and straightforward media replacement.

Carbon Adsorption

Carbon adsorption is the most simple of the three vapor-phase systems since it does not require a chemical storage and feed system, and there is no biological process to maintain or concerns with upsets. Using a bed of carbon-based adsorbent, carbon adsorption systems attract and adhere the odor-causing compounds as the gas stream is passed through the vessel. The rough surfaces of carbon media provide a great surface area for the contaminants to attach to while being removed from the inlet gas stream. Various types of carbon are available offering higher H_2S capacities, which broadens the selection process depending on the H_2S level to be treated. This type of system is very effective at removing H_2S and related sulfur-based compounds, but has limited use in removing ammonia and other nitrogen-based compounds, however carbon type systems can be used independently or in combination to remove many different contaminants.

Liquid-Phase Technologies

The main driver in liquid-phase technologies is to control or prevent the formation of odorous and corrosion-causing compounds in the wastewater or react with those compounds should they be formed. Several effective liquid-phase technologies exist, all of which involve varying forms of chemical treatment. Control and monitoring of the chemical feed system is crucial in preserving an effective and efficient treatment system. These systems include:

BIOXIDE® Process

BIOXIDE® is a clear, odorless liquid that is not classified as a hazardous compound and is completely soluble in water. It is relatively easy and safe to store, handle, and apply and can be stored outdoors in ambient conditions.

The BIOXIDE® process is a proprietary product of Evoqua Water Technologies (formerly Siemens). According to Evoqua, the BIOXIDE® (a nitrate solution) biologically controls hydrogen sulfide odors and corrosion by creating an environment in which certain naturally-occurring bacteria can thrive. This bacteria can biochemically oxidize the dissolved sulfide in the presence of nitrate. For collection systems, treatment is typically applied upstream of the odorous control point with documented results of dissolved H_2S reductions from over 50 mg/L down to <0.1 mg/L in numerous force mains, wet wells, and gravity interceptors with similar results achieved in storage tanks. Because overdosing can cause sludge to float to the surface, the proper chemical dosage is crucial.

Oxidizing Agents

Through the injection of a strong chemical oxidizing agent to the wastewater, oxidizing agents chemically react with the dissolved sulfide, converting it to sulfate or sulfur. In addition to dissolved sulfide, other odorous compounds can be removed during the

With a manufactured biological odor control system, media instability is reduced and control issues are limited. (ZABOCS® Biological Odor Control System)

Carbon adsorption is the simplest of the vapor-phase technologies, with no required chemical storage and feed system, and no biological process to maintain. (RJMC Modular Carbon Adsorber)

BIOXIDE® Biochemical Solution is an odorless, non-hazardous, and water soluble liquid that is easy to store and safe to handle.

oxidation process. Unfortunately, some non-odorous compounds react with the oxidizer as well, requiring higher dosages than predicted. Commonly used oxidizing agents include chlorine compounds such as chlorine gas, sodium hypochlorite (bleach), and calcium hypochlorite (tablet form chlorine), as well as non-chlorine compounds such as hydrogen peroxide and ozone. The use of chemicals can pose safety issues and may have inherent confined space implications, which must be considered during planning and design. Chemical feed systems require proper control and monitoring in order to maintain a successful and efficient odor control system.

Supplemental Oxygen

Supplemental oxygen treatment promotes an aerobic environment to eliminate sulfide production, consequently making it difficult for the "sulfate-reducing bacteria" to thrive. By providing aeration or injecting oxygen into the flow stream, the biological community can remain in an aerobic state during storage periods. One system that accomplishes this is SDOX CS by BlueInGreen, which can be provided as a packaged, skid-mounted system that injects oxygen into the flow stream. They offer an on-site oxygen generation system that eliminates the need for oxygen deliveries with several options available for materials of construction and instrumentation and control.

View the Odor Control Process Comparison on page 75.

Several resources were utilized in reviewing the various odor treatment options for this article, including manufacturer representatives, equipment manufacturer engineers, and in-house staff. An evaluation of odor control provisions should be done on a case-by-case basis. Odor control may not be required for every situation due to the potential diluted nature of the CSO liquid expected during an overflow event. Although somewhat unknown, there may not be a large sewage component in the CSO, reducing the likelihood of odor associated with the process. However, if an odor control system is deemed necessary a simple, passive vapor-phase system may be the best alternative to treat the displaced air of the storage tank during filling. If odor control is assigned as a future expenditure, the tank will need passive venting above grade.

Suggested Treatment Option for CSO Tanks

Adsorbent Odor Control Systems are highly effective for removing H_2S and other compounds from intermediate municipal wastewater applications. With the use of adsorbent media, the systems do not require nutrient feed systems to maintain bacteria as required with Biofilters.

With adsorbent odor control systems, the process consists of moving foul air to a vessel and diffusing it through the adsorbent media bed. The H_2S (or other contaminants) are adsorbed and clean air is discharged to the atmosphere.

The design of an adsorbent odor control system would consist of sizing the media to treat the amount of air being displaced from the wet weather storage facility. The system would require an odor control supply fan to keep odorous air from leaking from the storage facility when it is filling. The influent fan would be designed to operate only when the storage facility is filling. Operation and maintenance would consist of replacing the media about every 10 years and maintaining the supply fan. For aesthetics, the system could be housed in a pre-fabricated structure next to the storage facility.

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Ohio Operators - Do You Know Your Core Person ID Number?

If you have a certificate, or if you have ever applied for an exam, certificate, or Operator in Training (OIT) status with Ohio EPA, you have a Core Person ID Number. If you are not sure of your Core Person ID Number, please contact the Ohio EPA Operator Certification unit at 1-866-411-OPCT (6728).

Your Core Person ID Number is the middle seven digits of your license number.

Example Core Person ID Number shown in **BOLD**: WW2-**1234567**-03.

You will need to record your Core ID Number on all OWEA Training Receipts.

The Ohio Water Environment Association has begun requesting your Core Person ID Number when you register for any OWEA event. OWEA needs your Core Person ID Number as we transition to using Ohio EPA's EBusiness site to report attendance at OWEA training events.

If you have any questions about using your Core Person ID Number at OWEA events, please contact Amy Davis, *amydavis@ohiowea.org*, or 614.488.5800.

Odor Control Process Comparison

Technology	Operational Complexity	Chemical Usage and Safety Concerns	Potential Advantages	Potential Disadvantages
Chemical Scrubbing*	• Sophisticated controls and instrumentation	• Requires chemical supply replenishment on regular basis • Requires safety protocol	• Highly effective at H_2S and ammonia odor removal • Proven historical performance track record • Available in a wide range of sizes	• May have significant footprint • High maintenance potential • Best suited for WWTP applications • High profile tower design
Biofiltration*	• Simple to operate • No sophisticated controls	• No chemicals required for daily operations	• Engineered units well suited for CSO storage applications • Proven historical performance track record • Low-profile design • Lower maintenance	• Not suited for higher H_2S concentrations • Could have significant footprint (engineered systems reduce footprint) • Lower removal efficiencies with natural systems vs. engineered • Required maintenance to sustain proper conditions during non-CSO events • Media replacement every 2-5 years
Carbon Adsorption*	• Very simple to operate • Very few moving parts • No sophisticated controls	• No chemicals required for daily operations	• Ideal for CSO storage applications • Can handle intermittent flow/ loading applications • Very high removal efficiency • Small footprint • Immediately effective upon startup • Lower maintenance	• Not suited for higher H_2S concentrations • Spent media must be regenerated or replaced
BIOXIDE® Treatment	• Requires controls and instrumentation	• Requires chemical supply replenishment on regular basis, but BIOXIDE® is a non-hazardous compound	• Well suited for CSO storage applications. • Provides corrosion control • High removal efficiency	• May require high chemical usage • Chemical dosage may be difficult to determine
Oxidizing Agents	• Requires controls and instrumentation	• Requires chemical supply replenishment on regular basis • Requires safety protocol, especially with chlorine gas	• Well suited for CSO storage applications • Provides corrosion control • High removal efficiency	• May require high chemical usage • Chemical dosage may be difficult to determine
Oxygen Injection Treatment	• Requires controls and instrumentation	• No chemicals required • On-site oxygen generation or storage tanks	• Well suited for CSO storage applications • Smaller footprint • Provides corrosion control • On-site oxygen generation eliminates deliveries • High removal efficiency	• May require high oxygen usage • Oxygen dosage may be difficult to determine.

**Requires some type of ventilation system and ductwork.*

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