Assessing Odor Control Options

Responding to public demand, wastewater treatment plants continue to improve efforts to control odors

Although controlling wastewater treatment plant (WWTP) odors has long been a priority for those who oversee and operate such facilities, the need to do so has intensified in recent years. As development encroaches on existing WWTPs, the desire for greater control of odors inevitably follows. Other times, utilities may need to construct new collection or treatment systems in established neighborhoods. In these cases, stringent control of odors is not only expected but demanded. Fortunately, the approaches available for treating odors continue to expand, enabling wastewater treatment professionals to choose from many workable solutions.

Public demand is the basic impetus for odor control. “As peoples’ incomes and living demands increase, they want an odor-free environment around their homes,” said Jay Witherspoon, vice president and wastewater services practice director for CH2M Hill (Englewood, Colo.). In such situations, context plays a critical role. For example, the public’s tolerance for odor tends to be “much higher” if a WWTP is located in an industrial neighborhood, he said. By contrast, if someone purchases an expensive home next to a WWTP in the winter, and odors occur the following summer, the owner’s tolerance for odor usually is “almost zero,” he said.

Different Locations, Different Odors

Different types of odors typically occur at various points in the process of collecting and treating wastewater. For example, anaerobic conditions in collection systems tend to foster the formation of hydrogen sulfide, as bacteria in the wastewater convert sulfate and other sulfur-based compounds to hydrogen sulfide in solution form. Turbulence within a collection system then causes hydrogen sulfide to enter the airstream, making the gas the primary odor of concern in sewers, pump stations, and headworks. “Hydrogen sulfide is predominant in the collection system and the front end of treatment plants,” Witherspoon said.

As wastewater proceeds through the various treatment processes, hydrogen sulfide becomes less of a concern, and reduced sulfur compounds typically become more prominent. Secondary treatment processes tend to generate “more organic, amine-based odors” that usually disperse more rapidly and are less offensive than hydrogen sulfide, said Bob Stallings, technology leader for the wastewater treatment group at Earth Tech (Long Beach, Calif.). Yet under certain conditions, offensive odors certainly can result from these processes, he noted.

Solids handling is another realm that tends to generate significant and more complex odors at WWTPs. Generally, solids-handling processes release dimethyl disulfide and other reduced sulfur compounds, as well as fatty acids and ammonia, Stallings said. In addition, “there is a good bit of hydrogen sulfide intermixed with all that,” he noted.

The various sources and types of odors demand creative approaches to address them. “You can see a whole suite of different compounds that all require different treatment technologies and approaches,” Witherspoon said.

Treating Collection System Odors

Because they often traverse...
residential areas, collection systems typically receive significant attention in terms of odor control. Such efforts confer multiple benefits, including better community relations, reduced odors at downstream treatment facilities, and improved infrastructure performance. If left untreated in a collection system, hydrogen sulfide can cause problems besides odor. The corrosive nature of the gas can severely damage critical underground infrastructure, necessitating costly — and sometimes urgent — repairs of pipelines and pump stations.

Odors in collection systems generally are addressed in one of two methods: liquid-phase or vapor-phase treatment. The predominant approach, liquid-phase treatment, involves adding some form of chemical to wastewater in a collection system to prevent or counteract the formation of hydrogen sulfide. Alternatively, vapor-phase treatment involves collecting and venting gases from the collection system to some form of odor-removal system.

Two common forms of liquid-phase treatment include nitrate salts to prevent the formation of hydrogen sulfide and iron salts to remove sulfides already present in the wastewater, said Dirk Apgar, program manager for hydrogen sulfide corrosion and odor control in the King County (Wash.) Wastewater Treatment Division. Other approaches include injecting oxidizers, such as hydrogen peroxide, sodium hypochlorite, or potassium permanganate.

Because they require more space than chemical-injection systems, vapor-phase treatment approaches used to address collection system odors typically are installed at pump stations, where more space is available, Stallings said. Such approaches can take many forms, including wet or dry scrubbers that employ chemicals to remove contaminants or filters that employ biological methods to dispense with odorous compounds.

Weighing the Options

Both liquid-phase and vapor-phase approaches have various advantages and disadvantages that must be weighed carefully. For example, using a liquid-phase approach to prevent the formation of hydrogen sulfide helps preclude corrosion within the collection system, said Vaughan Harshman, sales engineer for Siemens Water Technologies (Warrendale, Pa.). By contrast, vapor-phase methods prevent odors from exiting a collection system, he noted, but they do not address the formation of hydrogen sulfide. A provider of liquid-phase and vapor-phase approaches, Siemens offers such liquid-phase products as the nitrate-based solution Bioxide®, the ferrous iron solution Odophos®, and a solution known as Odofree® that blends ferric and ferrous iron.

Although using chemicals to eliminate collection system odors is relatively straightforward, the approach can prove costly. “It’s expensive,” Witherspoon said,
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“but it takes care of the problem.” Several factors can influence the cost of liquid treatment, including market prices for chemicals and the distance that they must travel before arriving at their destination, he said. Of course, the treatment cost also depends to a large extent on the amount of hydrogen sulfide to be addressed in a collection system, Apgar noted.

Depending on the chemicals used as part of a liquid-phase treatment, operators may be required to follow certain safety procedures. Special containment measures also may be necessary. Concerns also have been raised about transporting chemicals through residential areas and storing them at pump stations or other locations where they are injected into a collection system.

However, utilities increasingly are opting to use a combination of approaches to reduce odors in collection systems, particularly at pumping stations, Harshman said. At these locations, he said, the cost to use solely chemicals to reduce odors to nondetectable levels is prohibitive, whereas strictly using a vapor-phase approach would necessitate a large — and expensive — chemical scrubber. Alternatively, the combined approach involves feeding an amount of chemicals to the collection system sufficient to achieve a manageable odor level that then can be addressed by means of a biological scrubber. “Frequently, that’s the best overall choice,” Harshman said.

Another method for addressing odors and corrosion in collection systems involves the process known as superoxygenation. The technology uses an oxygen-transfer reactor and high-purity oxygen to effect high rates of oxygen transfer in wastewater. Known as a Speece cone, the reactor treats a wastewater sidestream before it enters a force main, elevating dissolved-oxygen levels in the wastewater to the point that hydrogen sulfide is oxidized. Superoxygenation can achieve basically nondetectable levels of hydrogen sulfide, said Lee Gardner, president and chief operating officer of Eco Oxygen Technologies LLC (Indianapolis), the manufacturer of the superoxygenation system.

The system’s operations and maintenance requirements are straightforward, Gardner noted, because the cone has no moving parts and the standard pump included as part of the system requires only normal upkeep. Oxygen can be supplied by a third-party vendor or generated onsite. The system “usually pays for itself in 3 to 5 years,” Gardner said. In addition, the system has been used to treat primary clarifier influent, as well as secondary effluent.

Treating Odors at a WWTP

When it comes to treating odors at a WWTP, the liquid-phase approach may be used at the headworks. Otherwise, one or more of three basic approaches typically are used to cleanse foul air at a treatment facility: wet scrubbing, involving chemical scrubbers; dry scrubbing, involving activated carbon or other media that adsorb odorous compounds; and biological treatment systems. Together, the three catego-
Odor control technologies

Adsorption technologies comprise approximately 90% of the odor-control market, said Martin Crawford, president of Bay Products Inc. (Stateline, Nev.), a manufacturer of adsorbers, chemical wet scrubbers, and biological systems.

Long a mainstay of odor-treatment regimes, chemical scrubbers typically include different stages that use such ingredients as caustic and sulfuric acid to absorb hydrogen sulfide, ammonia, and other odorous compounds into a liquid solution. Oxidants then are used to convert the compounds into nonodorous forms. Well understood and relatively simple to design, chemical scrubbers offer the “most foolproof method” for controlling odors, Harshman said.

As long as its mechanical components are in working order and it is supplied with the proper amount of chemicals, a chemical scrubber will work as desired, Harshman noted. Another advantage is that chemical scrubbers generally accommodate swings in loadings quite well, he said. This reliability, however, comes at a cost of significant maintenance and chemical requirements, factors that must be considered along with a chemical scrubber’s capital costs.

Typically used to treat smaller airflows, dry scrubbing systems, particularly carbon-based models, offer such advantages as relatively low capital costs and a small footprint, Stallings said. In fact, the capacity of carbon media to adsorb odorous compounds has doubled just in the past few years, said Gayle Van Durme, senior odor-control specialist at Black & Veatch (Kansas City, Mo.).

Another factor in favor of carbon systems is that they are generally “very low-maintenance” items, Apgar said. Van Durme agreed. “Carbon, by far, is the easiest, most operator-friendly technology,” he said. “It’s just dry media with a fan. It doesn’t get any easier than that.” However, Stallings noted that operators ultimately must replace spent carbon. Although infrequent, the task can be “unpleasant,” Stallings said, requiring the use of protective clothing.

As their name implies, biological systems remove contaminants from an airstream using microorganisms inhabiting the biofilm that forms on media included for this purpose. As foul air passes through the biological system, the biofilm absorbs pollutants, whereupon bacteria degrade the contaminants. Biological systems generally comprise biofilters, biotrickling filters, or bioscrubbers, said Bart Kraakman, manager of process technology for BioWay America Inc. (Marlton, N.J.), a provider of biological odor-control systems. Biofilters initially used mainly organic media, though inorganic media increasingly are used because they do not need to be replaced as frequently. Biotrickling filters and bioscrubbers typically use inert media and incorporate systems that continuously recirculate the liquid solution.

Because they require no chemicals and generate no waste, biological systems are an “environmentally friendly” approach to odor control, Kraakman said. In terms of operations and maintenance, biological systems are “by far the cheapest” approach to controlling odors, he said.

Depending on their size, bio-
ode control technologies

ological systems may have lower capital costs than chemical scrubbers. Up to ranges between 57 and 142 m³/min (2000 and 5000 scfm), biological systems tend to cost less than chemical scrubbers, Harshman said. However, even though larger biological systems may cost more to construct compared to chemical scrubbers, costs relating to operations and maintenance also must be considered.

New media and vessel designs are helping to promote greater use of biological systems in the United States, Crawford said. “It’s really good because you’re using nature basically to solve your problem,” he noted.

However, biological systems also have certain drawbacks. For example, they tend to have a larger footprint than chemical scrubbers, and they may not work as well in situations in which an odor-control system will be operated intermittently, such as in cold climates, Stallings noted. Whereas a bio-scrubber requires a “period of acclimation,” Stallings said, “a chemical scrubber starts working as soon as it’s turned on.”

Additional factors to be considered include the fact that bioscrubbers cannot handle spikes in loadings as well as chemical scrubbers, Harshman said. Furthermore, it can be harder to determine the source of problems within biological systems because of their complexity, he said.

Although biological systems have long been used in Europe, only recently have they begun to gain a firm foothold in the United States. Once considered something of a “black box” because of their complexity, biological treatment systems are increasing in popularity in this country as their operation becomes better understood and more easily controllable, Kraakman said. “The market is definitely swinging that way,” Harshman agreed.

However, much like the treatment of collection system odors, utilities frequently employ more than one method for treating complex odors at WWTPs. It is “very common” to have biological systems followed by carbon or a chemical scrubber, said Lanaya Voelz, project engineer for CDM (Cambridge, Mass.). “In some cases, you may see all three,” Voelz said.

Alternative Approaches

Black & Veatch also has used another form of biological odor control known as activated sludge diffusion. The process, which involves routing foul air through the aeration blowers and into aeration basins, has been conducted successfully at two WWTPs in Texas, Van Durme said. Because the process employs the existing aeration system, “there’s very little cost involved,” he said. However, special coatings were used to protect the blowers against corrosion.

“It’s not too difficult to design, and it works wonderfully,” Van Durme said. “We’re planning on using it quite a bit more in the future.” The main limitation of the process is that the volume of foul air to be handled by the system.

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treated is restricted to the lowest level of air to be fed to the aeration basin.

Air-ionization technology is another approach beginning to be used to control odors at U.S. WWTPs. An ionizer uses a polarized ion tube to produce a strong electromagnetic field and generate positively and negatively charged ions. Ionized air can oxidize chemical contaminants, including hydrogen sulfide, ammonia, and volatile organic compounds, said Dennis Tulenko, president of Trans-Tech Energy and Environmental Inc. (Pittsburgh).

Ionizers are installed upfront on a facility's ventilation system, rather than in an end-of-pipe configuration. "Any enclosure, from a small tank to a large building, can be treated," Tulenko said. "Air ionization works best," he said, "when there is room that can be used to provide the residence time for ionization" — that is, at least 10 seconds. The system uses no chemicals or water, and it generally requires approximately 10% of the energy needed by chemical scrubbers or biofilters, Tulenko said.

**Containment Is Key**

The increased focus on odor control means that containment methods must be analyzed carefully. Containing and ventilating odors well is the "most important thing you can do," Harshman said. "Any vapor-phase system can only treat the odors it receives," he noted.

As part of efforts to effect greater odor control at WWTPs, secondary treatment processes that once went uncovered are starting to be enclosed, at least in part if not in their entirety. For example, covers can be placed over the effluent troughs of final clarifiers, said Earle Schaller, president of NEFCO Inc. (Palm Beach Gardens, Fla.), a manufacturer of baffles and launder covers. Because "most of the odors" from final clarifiers occur at the point at which effluent passes over the weir, launder covers collect such odors and vent them to a treatment system, he said.

As demands for odor control increase, a growing number of treatment processes likely will be covered. For example, Black & Veatch is designing a new WWTP to be constructed in a residential area in Fort Myers, Fla., Van Durme said. "It's a given that we're going to cover everything," he noted.

To address odors better, WWTPs also are beginning to develop more sophisticated master plans for controlling odors, CH2M Hill's Witherspoon said. "We're seeing a lot of reliance on air-dispersion modeling" to estimate the potential for odors associated with various treatment processes and to determine what must be done to ensure that odors remain within the fence line, he said. This information then can be used to inform a utility's capital improvement program, enabling an agency to become "proactive instead of reactive," he said.

As improvements continue to occur in the odor-control field, the public can be expected to continue to demand ever greater efforts to alleviate WWTP odors. Assuming members of the public are willing to pay for necessary improvements, they can expect to be satisfied. "The technology is there" to eliminate odors, Van Durme said, "if you are willing to spend the money to do it."

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Monitoring Odor, the 'Other Effluent'

Real-time odor data help utilities track conditions, make adjustments

Just as wastewater treatment plant (WWTP) staff closely monitor effluent from the treatment process, odors increasingly are receiving a similar level of attention from wastewater agencies. Conducted as part of efforts to ensure adequate performance of odor-control technologies, reduce odor complaints, and comply with regulatory requirements, odor monitoring can be performed by means of a variety of approaches.

Because hydrogen sulfide is among the chief odors of concern at WWTPs, various analyzers have been developed for detecting the compound. Among them is the Jerome analyzer manufactured by Arizona Instrument LLC (Tempe, Ariz.). Ranging in price from $9450 to $13,000, the Jerome 631-X analyzer uses gold-film sensor technology to measure hydrogen sulfide concentrations down to 1 ppb. However, the analyzer is limited to detecting hydrogen sulfide.

To measure and quantify odors in the field, researchers decades ago developed the practice of field olfactometry, in which inspectors use a device — the olfactometer — to dilute odorous ambient air with air that has been filtered by carbon to remove odors. The number of dilutions needed to render odorous ambient air undetectable to an inspector is known as the dilution-to-threshold (D/T) ratio. Operating on these principles, the Nasal Ranger™ field olfactometer, marketed by St. Croix Sensory Inc. is looking for a few good treatment facilities. The Forum’s Profile section provides an up-close look at water and wastewater treatment plants, collection systems, and outstanding operations and maintenance personnel. The Forum currently is seeking new entries, so here’s your chance to brag about the technologies, processes, and people that make your facility exceptional.

For more information or to request a questionnaire, contact Steve Spicer, Operations Forum editor, at (703) 684-2463 or sspicer@wef.org.
For continuous monitoring, the OdoWatch system uses metal oxide sensors, known as “electronic noses,” to collect chemical data regarding ambient air at a facility. A central unit then combines this information with meteorological data collected from an onsite weather station to display odor intensity as a color-coded plume on a topographic map of the WWTP. By providing real-time measurements, OdoWatch™ can enable plant staff to determine precise site conditions at the time an odor complaint is received. Data are archived, so odor conditions can be assessed even when complaints are made after the fact. Because OdoWatch can be calibrated to recognize odors typically generated at a site, the system can determine if nuisance odors originate from offsite. Finally, the system can be used to analyze “before-and-after” conditions to assess the effects associated with changes to facility operations. Developed by Odotech Inc. (Montreal), OdoWatch is being distributed in the United States by N.A. Water Systems (Pittsburgh) and is priced at approximately $115,000.

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