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Integrated water management - the future

Eliminating odour from wastewaters

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Exhaust dilution - practical, economical and effective, says Paul A. Tetley, Vice President of Strobic Air Corporation.

No one likes foul odors - especially people who are not responsible for them yet must live with them daily. Unfortunately, foul odours (in the form of odoriferous roof exhaust) are a fact of life and a necessary evil at many wastewater treatment facilities.

To complicate matters, different people perceive odors differently; many people who are most sensitive to an odor can be as much as 10,000 times more sensitive to that odor than those who are least sensitive to it, according to the American Industrial Hygiene Association (AIHA). Consequently, many communities which were once reasonably tolerant of odors caused by wastewater treatment facilities —both municipal and industrial—have become less tolerant. In fact, more US communities are either passing laws that restrict odoriferous exhaust, or at least calling authorities' attention to situations in which wastewater is being processed and a visible exhaust stream is apparent.

Mixed flow stacks are substantially shorter and have less visual impact.

Defining odours

While there are many methods to eliminate most (if not all) odours emanating from wastewater treatment facilities, one relatively new technology has begun to make inroads for these applications. This article discusses that technology - exhaust dilution - and explains how it is achieved through use of mixed flow impeller technology as applied to roof-mounted exhaust systems.

Exhaust emissions from waste water treatment facilities may either be toxic or nontoxic, with toxic odors regulated by the US Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and other government agencies. Nontoxic emissions generally are considered completely safe (or safe in the amounts that are likely to be generated); although even 'safe' materials may have limits beyond which their emissions would be regulated.

Treatment considerations

Among the many methods to manage wastewater treatment odours are those using chemical additives such as potassium permanganate, sodium hypochlorite, chlorine, or other aggressive chemicals, as well as those employing precipitators, scrubbers, thermal oxidizers, charcoal filters, or other expensive hardware to treat process exhaust prior to discharge.

Toxic odor generation may require more aggressive approaches in many cases. However, in applications where toxicity is not an issue, use of mixed flow impeller technology has been increasing in popularity.

Mixed flow impeller technology dilutes exhaust gas emissions simply by mixing them with outside, ambient air. Although this is an efficient method of odour control - particularly when compared against other methods such as wet scrubbing. charcoal filtration, and thermal oxidation, for example - its efficacy is much harder to measure quantitatively than these others with regard to the precise amount of chemical materials that will be removed from the exhaust stream.

There are cases when a combination of one or more methods of odour control is required depending upon the materials being treated; and sometimes atmospheric conditions may also determine which approach or approaches might be best suited as well. However, for most applications, mixed flow impeller technology prevents offensive odours from permeating neighboring buildings in particular and entire neighborhoods in general. It also prevents offensive odours from being re-entrained into the waste-

Mixed flow impeller fans draw in nearly twice the amount of fresh air as exhaust air into the fans' exhaust and send it in a 'jet plume' up to 120' high (in a 10 mph crosswind) at an exit velocity of 80,000 cfm. This extremely high velocity exceeds ANSI Z9.5 Standards by three times its minimum recommendation of 3,000 fpm.

Because they introduce up to 170% of free outside air into the exhaust stream, a substantially greater airflow is possible for a given amount of exhaust without additional horsepower, providing excellent dilution capabilities and greater effective stack heights over conventional centrifugal fans.

These systems also reduce noise, use less energy, and provide enhanced performance with faster payback over conventional centrifugal belt-driven exhaust systems, with typical energy reduction of $.44 per cfm at $.10/kilowatt-hour, thus providing an approximate two year R.O.I. Energy consumption is about 25% lower than with conventional centrifugal fans, with substantially reduced noise levels, particularly in the lower octave bands. They conform to all applicable laboratory ventilation standards of ANSI/AIHI Z9.5 as well as ASHRAE 110 and NFPA 45, and are listed with Underwriters Laboratory under UL 705. The systems are designed to operate continuously without maintenance for years under normal conditions; direct drive motors have lifetimes of L_{10} 100,000 hours. Because there are no belts, elbows, flex connectors, or spring vibration isolators to maintain mixed flow impeller systems offer virtually maintenance-free operation. Consequently, additional savings are achieved by eliminating many hours of routine maintenance.

Mixed flow impellers are useful at wastewater treatment facilities for managing odoriferous exhaust.

water treatment facility. In addition, mixed flow impeller fans are low profile, and eliminate the negative connotations from neighbors typically associated with tall exhaust stacks on the roof and their perception of pollution generation. This is especially important at wastewater treatment facilities where employees or neighbors have previously complained of foul odour - a tall stack can be a daily reminder of the presence of the odour.

The theory of mixed flow technology is simple: to eliminate odour by dilution, fresh air is mixed in with the wastewater process exhaust gases until a suitable concentration (ppm or mg/rn^3) is reached and the odour is no longer perceptible or objectionable. There are two ways to achieve dilution: directly, by diluting the exhaust stream (plume) before it leaves the exhaust fan; or, indirectly, where the exhaust stream from the fan is diluted by the atmosphere before it reaches the property line, nearby air intakes, or sidewalks.

Direct dilution is the most efficient and cost-effective method, accomplished by using a mixed flow impeller fan which draws odour-laden exhaust into a ductwork system and carries it to the highest point of the building's roof. At the roof, fresh air is drawn into the exhaust fan to mix with and dilute the odoriferous exhaust gases generated by the wastewater treatment process. This technique is most effective when the resulting mixture of process exhaust and outside air is ejected from the fan upwards at a very high velocity

Wind tunnel studies have proved that direct dilution is most effective when the diluted air stream is projected upward at velocities in excess of 3000 ft./min. For comparable efficiency (at substantially higher costs) another system would require a centrifugal-type, belt-driven exhaust fan ducted to a dedicated steel stack which might be as tall as 100 feet, in order to disperse the exhaust odor stream from the fan. Obviously the cost and complexity of such a structure (and its negative implications) work against it.

Dilution & perception

Mixed flow impeller fans draw in nearly twice the amount of fresh air as exhaust air into the fans' exhaust and send it in a 'jet plume' up to 120' high (in a ten mph crosswind) at an exit velocity of 80,000 cfm. This extremely high velocity exceeds ANSI Z9.5 Standards by three times its minimum recommendation of 3,000 cfm. The jet velocity induces large amounts of outside air (up to 170%) to be drawn into the plume. This injection of fresh air causes immediate relief of odour perception by odour dilution, and sends the odour laden gas/air mixture high into the atmosphere. In most cases this system eliminates odour problems in the neighborhood; however, when it does not combining dilution with one or more of the other available odour control methods should be considered.

Dilution levels will vary depending upon chemical content of wastewater being treated. For example, mercaptan and hydrogen sulfide odors (irritating even in very low concentrations) require substantially more dilution than typical municipal wastewater treatment.

Mixed flow technology

Another major consideration with regard to mixed flow impeller technology is the aesthetics associated with tall exhaust stacks on the roof. Mixed flow fans are substantially shorter than tall stacks typically used with conventional centrifugal fans. Elimination of tall, unsightly stacks which are either prohibited by code or undesirable is an added benefit. In addition, low profile mixed flow impeller fans don't require structural reinforcements on the roof or complex, expensive mounting/stabilizing hardware such as elbows, flex connectors, guy wires, or spring vibration isolators, substantially reducing time and costs for installation.

Mixed flow impeller fans also typically consume about 25% less energy than conventional centrifugal fans (a common but less efficient approach to wastewater treatment odor management), with resultant faster pay back periods as well (see sidebar). Lower noise levels may also be advantageous in some locations. When noise is an issue, however, there are accessories available to deal with it including acoustical fences and acoustical silencer nozzles.

Additional odour control considerations

When evaluating dilution, either alone or combined with other odour control technologies, consider these basic guidelines:

- Odour-laden air must be pointed upward with rain protection that prevents downward flow (no rain caps, goosenecks, or flapper dampers)
- Use as high a stack exit velocity as possible (at least 3,000 ft/min)
- Locate exhaust fans on the highest usable roof with regard to duct connections
- Use a combination of extra fresh air from the roof into the stack flow along with stack height to achieve desired odour detection levels at the property line or supply air intakes

Keep in mind that dilution applies to the control of odour problems that are not subject to further regulatory requirements, such as standards for volatile organic compounds (VOCs) or hazardous air pollutants (HAPs). The cost for some types of control equipment depend on airflow rates (cfm). Thus, if additional controls are required, dilution could result in higher costs unless the other system is placed upstream of the dilution fan.

Other methods of odour control include:

- Prevention – eliminating the source of the odour or substituting a non-odor-causing material
- Minimization – reducing the amount of odour-causing material or causing it to evaporate at a slower rate
- Masking – adding a pleasant odour to the air to hide or mask the objectionable odour

Conclusion

While much literature exists on handling odoriferous exhaust at wastewater treatment facilities, determining the best method for relief is generally based on the compounds causing the odour and their concentrations as well as factors such as exhaust flow rates, atmospheric conditions, building configurations, and even adjacent buildings. Based on the growth of mixed flow impeller technology for odor control over the past few decades, because of its performance, cost, and aesthetic advantages it should be considered as the first line of defence at many facilities.