# Containment Methods for Odor Control Systems in Wastewater Plants

**By Arie Kepets**

Containment and processing of odors, as well as emissions of VOCs (volatile organic compounds) and HAPs (hazardous air pollutants), whether regulatory-driven or good neighbor-/community-driven, are forcing municipal and industrial wastewater facilities to evaluate and re-formulate their processes so they can achieve the mandated or desired atmospheric emission levels. Obviously the choice of any specific method of containment will have a significant effect on the cost, performance and success of the odor control system installed.

The 1990 Clean Air Act specifies and lists the HAPs and VOCs and requires the USEPA to set maximum allowable emission standards for all major sources of emissions. To date, the most prominent regulations have been CFR 40 part 61 NESHAP (National Emission Standards for Hazardous Air Pollutants), with standards for specific industries and applications being continually issued and modified.

Compliance with the new regulations will affect the economics of wastewater treatment facilities in a substantial way. The impact will be in the form of

- Costly upgrades and installation of major equipment.
- Training, monitoring and compliance with new regulations.
- Process changes to achieve reduction, containment and processing of the offending components.
- Significant increases in operational costs.

It is expected that the higher operational and regulatory costs will overshadow the initial capital costs rapidly. Operational costs will, to a large extent, be accounted for by chemicals, filtering and scrubbing media, training activities, record keeping, testing and monitoring. But by far the biggest portion will be in the form of electrical and other utility outlays that will be needed to operate this extensive transformation. Fans, blowers and scrubbers will have to handle and process huge volumes of air if the facility is to meet its regulatory compliance goals.

The types of covers over process units and the method of containment selected can have the most significant impact on these costs and will affect

- Air volumes, which will in turn influence process equipment capacity, type of media, and electric power consumption.
- Whether spaces and areas will be subject to safety-related regulations, such as confined space rules and their effect on costs and operations.
- Process access and equipment maintenance, which will further influence operational costs.

Emission reduction can be achieved in part through process changes, for example, by adding chemicals upstream, reducing turbulence, or slowing down the entire treatment process. Factors such as combined sewer overflow (CSO) regulations, growth in population, Clean Water Act requirements for secondary and tertiary process levels, real-estate restrictions, and the ever-present N.I.M.B.Y. syndrome, all put additional constraints on existing plants.

Containment and downstream processing of the offending elements would appear to be the corrective path of choice. Not only is the technology to accomplish this available, in many cases it would allow for capacity increases in existing plants. Facilities that have been forced to lower throughputs and slow down aeration and other process rates to avoid or reduce undesirable emissions, potentially can reverse these actions through appropriate containment and process technology.

Various regulations affect the need, method and other aspects of containment of hazardous emissions from wastewater facilities. The Clean Air Act defines areas and processes that require containment measures; OSHA deals with safety-related issues of contained and covered areas. NFPA 820 deals with fire protection, explosion potential, and ventilation of covered and non-covered areas. These regulations must be incorporated into projects that consider containment alternatives.

Setting the goals for a wastewater emissions containment project must take into account the myriad of regulations that exist. They must be evaluated and balanced in a total sense, so that compliance with all, and not just some, is achieved. The relationships among economics, efficiency and successful plant operation also have to be weighed into the final solution.

While the containment system chosen may represent only a fraction of total project cost, the method of containment and the covers specified will significantly influence other components or factors. A successful design project will attain the following goals:

*Flat covers on wastewater plant process tanks contain the odors and gases generated in them but are an unobtrusive addition to the facility.*

1. *Containment:* Offending areas must be totally contained efficiently.

2. *Air Handling*: Maximize the efficiency of the air handling systems through the reduction of the total volume to be handled.

- Contain air as close as possible to the water level.
- Reduce ventilation rate by eliminating requirements associated with routine entry into process spaces.
- Install a system free of cracks, gaps, and other unnecessary openings that will limit its ability to maintain a slightly negative internal pressure.

3. *Worker Safety:* Eliminate dangerous working conditions such as unsafe platforms and confined spaces.

4. *Accessibility:* Ensure that covered areas are easily accessible for monitoring the treatment process. Provide easy access to equipment for preventive maintenance and repair tasks.

5. *Plant Operations*: Make provision for minimum interruption of plant operations by any cover-related activity. Eliminate permitting and training needs, access restrictions, unsafe platforms, or special equipment/personnel requirements to facilitate cover removal.

## Factors Affecting the Selection of a Containment System

### Air Handling

Controlled ventilation and air flow rates are absolutely essential in a properly functioning emission and odor control system.

Large volumes of low pressure, constantly flowing air are required in wastewater treatment plants. Once volume and pressure requirements have been determined, the handling equipment can be selected after the air volumes, leakage rates and air exchange rates are established. Most emission sources in wastewater systems are treated by means of an actively ventilated system using a fan or blower to induce air movement over the process area, conveying the air either to other parts of the plant or through a process unit. This requires a constant low negative pressure. Typically, air is replaced so that flow rates and pressure can be regulated.

The source and method of air replacement is extremely important. Ideally, air is to be replaced through controlled ventilation points and vacuum relief openings. An effective active ventilation system must take into account the negative air pressure requirements of the emission source as well as the desired maximum VOC concentration within the system. Insufficient negative pressure may allow fugitive emissions to escape to atmosphere, as well as improper air exchanges that could lead to fire or explosion hazards. Improper air exchanges and dead air pockets will cause severe corrosion problems, particularly in the case of concrete. Dead air spaces cannot be allowed to occur or large chunks of concrete will be eroded away by high concentrations of sulfuric acid formed by hydrogen sulfide gas. Too high a negative pressure will cause excessive air flow and increases the cost of treating the emissions. Proper control of the air flow's volume and velocity are imperatives if the system is to run successfully.

Ideally, airflow should be maintained at the point where the maximum safe concentration of VOCs is delivered to a control device, and at the minimum negative pressure to produce an in-draft condition at all wastewater flow rates. Normally, either VOC concentration or the negative pressure requirements will dictate the design flow. If the air flow rate is set by the negative pressure, then sealing gaps and cracks is essential. If VOCs determine the air flow rate, then the system must be regulated to ensure that adequate air is drawn into the contained space to dilute the VOC concentrations. In any event, it is imperative that the system's air flow and tightness be regulated and controlled.

The size of the air handling equipment in wastewater applications can be reduced in the following ways:

- Reduce the leakage rate of the system.
- Reduce the air volume by designing a system that requires the least volume of air and area to be treated.
- Change the system configuration to reduce the number of air exchanges mandated by regulation.

Leakage due to poor fit and deficient design will affect both the size of the equipment and the operational costs. The geometric configuration of the containment components is a major factor in the design of the entire air handling system. Low profile structures are more efficient than full height structures. Flat covers placed as low as possible and as close as possible to the emission source have been shown to be extremely effective, and possibly the most efficient method of containment.

NFPA 820 and OSHA 1910.146 concern themselves with the rate of air exchanges within these contained and covered areas, for the sake of air quality and breathing and asphyxiation considerations, as well

| Component | Item | Non-rigid systems | Semi-rigid systems | Raised systems | Flat non-tight systems | Flat tight systems |
| --- | --- | --- | --- | --- | --- | --- |
| Air Handling | Volume of air to be exchanged | Average | Above average | Very high | Above average | Lowest |
| | Attainable degree of tightness | Difficult | Not possible | Average | Not possible | Best |
| | Equipment costs | Minimal | High | Very high | High | Low |
| | Operational costs | Minimal | High | Very high | High | Low |
| Safety | Capital equipment costs | Not applicable | Not applicable | Applicable | Not applicable | Not applicable |
| | Operational Equipment costs | Not applicable | Not applicable | Applicable | Not applicable | Not applicable |
| | Operational costs | Not applicable | Not applicable | Very high | Not applicable | Not applicable |
| | Operator safety | Unsafe | Unsafe | Unsafe | Not applicable | Not applicable |
| Plant Operation & Maintenance | Access monitoring and inspection | Difficult | Average | Mixed/potentially limited | Easy | Easy |
| | Major repair | Difficult | Difficult | Very difficult | Easy | Easy |
| | Corrosion | Above average | Above average | Above average | Above average | Below average |

as concentrations of explosive gases. Areas that require entry for routine equipment and process monitoring not only, by design, have a larger volumetric space, but require air to be exchanged a minimum of 12 to 16 times per hour. At the same time, areas not requiring entry will need four to six air exchanges per hour. As a rule, covered areas where entry is neither allowed nor needed will require air to be exchanged at a rate that is 50 to 75 percent lower than areas that must be entered for process control and maintenance activities.

Large volumes of air will result in additional one-time costs for larger air handling equipment (fans, blowers, scrubbers, ducts, etc.) along with heavier in-plant power transmission and switchgear requirements. Operational costs will be the greatest cost factor. The larger volumes of air will affect maintenance costs, as well as disposable air filtration products such as carbon and scrubber media. Since wastewater treatment facilities typically operate continuously around the clock and on a year-round basis, even the most modest gains in air moving efficiency can have significant financial benefits. A design combining lower volumes, a minimum number of air exchanges, a high degree of containment, and minimal air leakage clearly approaches the conditions required for the ideal cover and containment system.

### Safety

Safety concerns should be carefully addressed. Covers, particularly flat covers, should be sturdy and not require railings or other accessories which might restrict access. Designers should provide access in the form of hatches, vents and ports. Flat covers should be lightweight and not exceed 150 lb per unit, within the 75 lb maximum lift for a single person as allowable under OSHA regulations, while not requiring special lifting equipment. Forward looking designers should limit cover weight to 100 lb per unit in anticipation of newly-contemplated OSHA workplace regulations limiting maximum allowable lifting weight to be 50 lb per worker. These requirements for strong lightweight clear-span covers should favor marine grade corrosion resistant aluminum as the material of construction.

Containment systems incorporating raised structures should be evaluated to determine if they might be defined as confined spaces. Once a space has been designated as confined, considerations other than air handling must be taken into account. One-time equipment costs in the form of, for instance, safety suits, portable air breathing apparatus, lights, alarms, gas and air quality monitoring equipment, and premiums paid for explosion-proof motors and junction boxes should be be factored into the initial purchase price. The added operational costs associated with confined spaces will far exceed any differential in initial equipment costs. Permitting and record keeping tasks, training and safety drills, and hole watch requirements are but three of the mandated


Close-up of flat covers shows the modular fabrication style of these systems, and the ports which allow operator access to selected equipment or process areas.

functions that are bound to influence costs significantly. The requirement that an attendant be present outside each time an entry is made into the confined space is the costliest requirement of all. The advantages of dealing with a covered area that is not designated a confined space can amount to substantial operational savings that may dwarf the initial equipment cost.

#### Operation & Maintenance

While raised spaces, particularly domes, offer convenient access to some equipment, particularly center drives on basins with rotating arms of some type, they do have drawbacks. Scum wells, collection boxes and weirs may not be easily accessible. Apparatus not close to the center of the tank (particularly in circular domed applications) may not be very accessible from the central interior area of the structure. Hatches and side openings may have to be be provided, so that inspection and access are possible. Flat covers can provide access in the form of swing hatches directly above pieces of equipment. They also can lower maintenance costs by isolating bridges and railings from the corrosive environments frequently found inside the contained areas in wastewater treatment plants. On the occasions that drives and other mechanisms need to be attended to or removed, the dismantling and access provisions of a raised structure can be considerably costlier than in the case of flat covers. The removal of a dome may involve the services of contracted, specially trained factory personnel for removal and for reinstallation. On the other hand flat covers usually can be removed and reinstalled by plant workers for a relatively low cost.

#### Methods of Containment

Typically the least costly method of containment is a *non-rigid system* using film, membrane, or fabric placed over the offending area. Operationally, it is difficult to maintain a negative air pressure without causing the system to collapse. While it may be possible to achieve a high degree of tightness, the attainment of the required air circulation, however, is very difficult to achieve. This type of system is restrictive as far as access is concerned, if not outright dangerous. Since it cannot support any weight, loads caused by snow or rain, and certainly by plant personnel, the system must be considered a non-accessible, operationally restricted area. Furthermore, the removal and installation procedures required, as well as possible frequent repair of tears in the material, make the choice of such a system impractical in many designs.

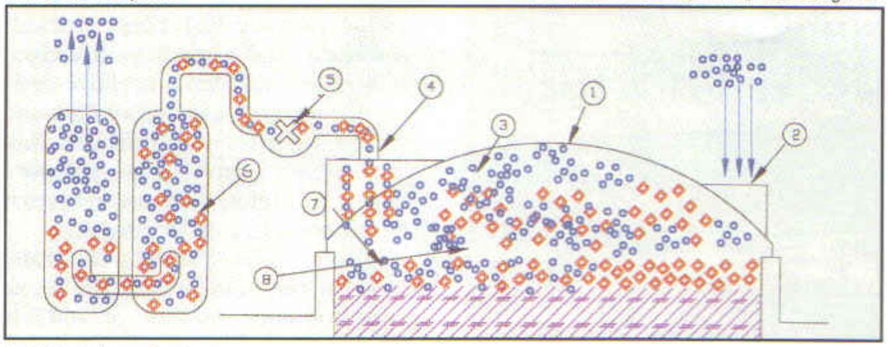
*Semi-rigid systems* have been used in designs for covering areas where instruments and other components have to be supported, but they offer neither rigidity nor containment capability. Any type of planking in the form of corrugated light weight steel, aluminum, fiberglass or wood should be discouraged. Their use can result in a a dangerous platform that lacks good containment properties. These features, along with the higher operational costs that tend to be associated with non-tight installations, should be factored into the design and selection equation.

*Raised rigid structures* are commonly used in odor control installations and do offer high containment efficiencies. But their operating costs tend to be on the high side. They require bigger air handling components such as larger fans, blowers, ducts, and scrubbers, and heavier-duty electrical accessories and wiring. Greater outlays for electricity, maintenance needs, chemicals and neutralizing media follow. Raised structures offer good access for O & M tasks required for equipment located at the center of the contained area, but poor access if major work is called for. As a result of the large volumetric space, they contain atmospheres that can be excessively corrosive to equipment above the water level in the process basins covered, for example bridges, railings, motor housings etc. Raised structures cover in most cases what are defined as permit requiring confined space areas, and as such will be subject to additional one time safety-related equipment costs. Structures designated as confined spaces also will incur costs caused by the obligatory permitting, training, and hole watch regulatory requirements.

*Flat covers* offer safety features, reduced air volumes, good access through hatches and openings directly over equipment. Relatively low equipment costs are due to the smaller air volumes that result from the geometric configuration and the smaller number of required air exchanges. Flat covers also can eliminate the need for compliance with confined space regulations. Furthermore, they offer good access for major equipment maintenance and removal. However, they may lack air tightness. The inherent design of a system constructed of modular covers, limited by weight, and mandated to be easily removable, creates a structure that contains many cracks and gaps between its components. Flat covers are meant to be modular and their segments relatively small to

Raised dome system

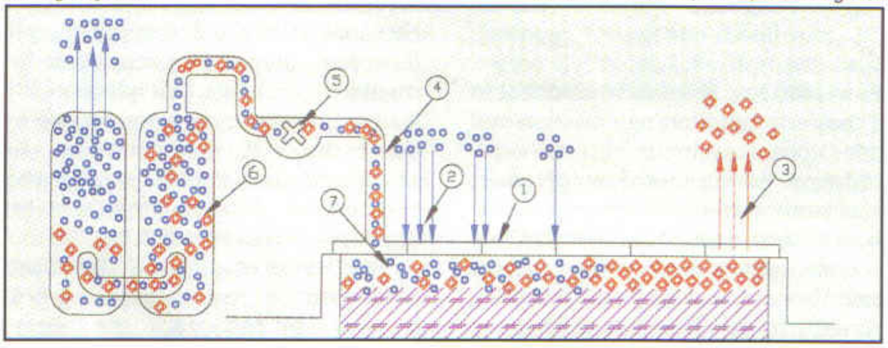
° Fresh Air ◊ VOCs, HAPs, odorous gases



1. Raised dome structure
2. Fresh air forced in by fans enters the system through enlarged intake points
3. Unsafe confined space with concentrations of VOCs and HAPs
4. Oversized ducts needed to handle larger volume of air
5. Oversized fans needed to handle larger volume of air
6. Oversized treatment units needed to handle larger volume
7. Uneven air exchange with large concentration of fresh air
8. Confined space permit entry area

Non-tight system

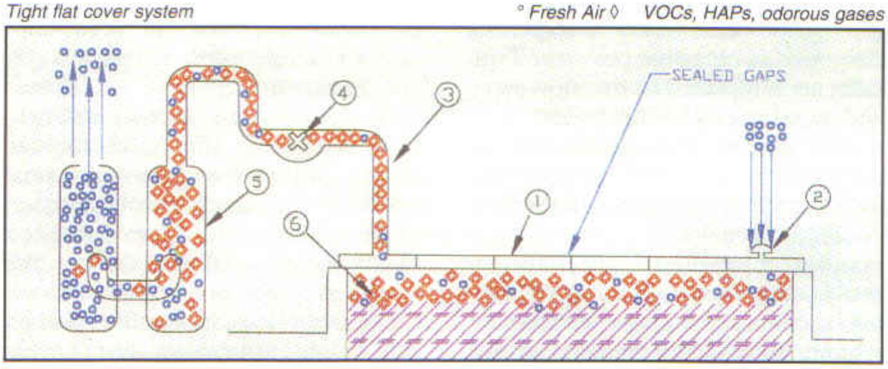
° Fresh Air ◊ VOCs, HAPs, odorous gases



1. Non-tight system with gaps and un-sealed joints
2. Fresh air forced in by fans enters the system through gaps between covers
3. Uneven air exchange may cause concentration of gases that can lead to emisions rather than containment
4. Oversized ducts needed to handle larger volume of air
5. Oversized fans needed to handle larger volume of air
6. Oversized treatment units needed to handle larger volume of air
7. Uneven air exchange with large concentration of fresh air

Tight flat cover system

° Fresh Air ◊ VOCs, HAPs, odorous gases




1. Tight flat cover
2. Intake vent—controlled ventilation
3. Smaller duct sized to match reduced air volume
4. Smaller fan sized to match reduced air volume
5. Smaller scrubbers sized to facilitate reduced air volume
6. Air exchange with minimal amount of fresh air

comply with weight restrictions. They are not to be bolted to each other to facilitate easy removal. At the same time they are to provide for thermal contraction and expansion. These features result in a system that is less efficient.

It is for this reason that flat covers can be designated as *typical flat covers* and *tight flat covers*. The latter type carries the process an extra step, adding to the features described above the most important characteristic of tightness. Even the slightest gaps (1/8 in.) between covers—what may be acceptable commercial tolerance—will have a major negative effect on operating costs.

The insistence on tightness should not be waived, and claims such as "air tight" or "substantially air tight" should be investigated thoroughly. A properly designed system will have no air gaps, whether by design (or design deficiencies) or otherwise, as gaps cause significant reductions in its odor control performance. A well designed system should seal off these gaps by means of gaskets or other filler material, although caulking is not considered as an acceptable method of achieving tightness.

Basic steps should be taken to confirm that the design intent is indeed maintained, when the actual system is finally delivered and installed.

- Prior to vendor approval the mechanical design of the covers should be investigated thoroughly to determine the best method for achieving tightness.
- Evidence in the form of certified tests and prior installations that used specifications calling for an acceptable degree of tightness.
- Before installation, performance tests should be conducted on site, on small sectors consisting of multiple panel configurations. Watertightness and smoke tests are easy to conduct and give an excellent indication of system air tightness.
- Performance tests carried out on the complete system will indicate if the field installation work was done correctly.

System tightness implies the ability to control air flow, process air exchange rates, and the mixture of air and contaminants for optimum processing. It is the only way to ensure that the system will operate to its intended design limits. ■

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