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TECHNOTES

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ODOUR CONTROL BASICS

By John DeYoe, Project Manager, Senior Specialist

Odour is perhaps the most pressing of all air quality problems. The presence of odour in ambient air may or may not represent a health risk, but no other air pollution problem will provoke such an immediate response. People in the wake of an odorous source are quick to communicate with facility managers and regulatory agencies.

The key to controlling odour sources is to be able to quantify them. Often it is possible to control odour sources with simple and inexpensive methods, however, the level of control required cannot always be easily judged.

A response to odour is a subjective matter and varies from individual to individual. Odour strength can be measured in an objective manner based on the statistical analysis of a group response to a specific odour. The concentration of an odour is typically expressed in terms of odour units (OU) per cubic metre of air. An odour unit is the quantity of odorous substances that, when dispersed in one cubic metre of odour-free air, becomes just detectable by a 'normal' human observer whose sensitivity to the odorant represents the average of the population. The threshold of odour detection is thus defined as 1 OU/m^3.

Sampling diesel truck exhaust

Odour strength is determined by collecting samples of odorous emissions in sampling bags and submitting them to a test panel. These panels are typically made up of six to nine members, all of whom are screened through a standardized test for olfactory sensitivity. This ensures that the results are conservative since odour panels are made up of individuals with "better noses" than the general population. The panelists are given increasing concentrations of the odour sample through one randomly selected 'smelling' port in a two or three port system. The panelists are requested to choose the port from which they believe the sample is coming. The other port(s) contain pure odourless air. When all the panelists have detected the odour, the responses are plotted up and a curve is fitted through the points. Some typical odour response curves are depicted in Figures 1 and 2, on the following page. The figures demonstrate the typical scatter of results associated with odour panel testing.

It is possible to collect odour samples from nearly any source either by direct sampling from ducts and stacks or by using a flux chamber which can quantify the odorous off-gassing from any solid or liquid surface.

It is not always necessary to make measurements of specific odour sources since odour emissions can frequently be estimated using published data. This is possible if the chemical emission rates are known or can be easily estimated with standard methods. Odorous emissions which are a result of one particular compound are easily quantified in this manner.

Once an odour source has been effectively quantified, wind tunnel testing or numerical modelling may show that the off-site impact of the odour is not serious enough to require any controls at all. However, this will not likely be the case if a facility has an odour complaint history.

If an odour source is emanating from a building or enclosed structure via stacks, windows, vents or other apertures in the building, it is always possible to mitigate the problem. Outdoor or uncontained sources such as landfills, sewage treatment plants or composting facilities present a much greater problem.

Sources from buildings can typically be mitigated in one of three ways: operational changes; dilution; or installation of control devices.

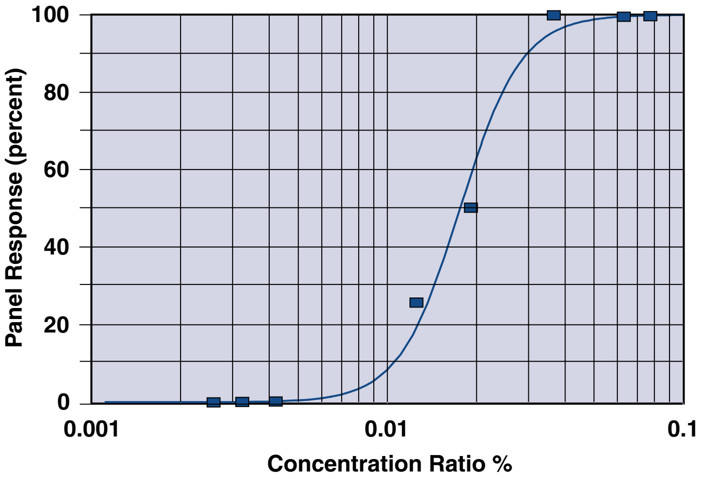
Operational changes are often overlooked since they tend to cause problems with production or personnel or they may simply not be possible. They include techniques such as replacing odorous solvents and chemicals with alternative compounds or rescheduling odorous processes so they do not coincide with one another. In some cases, simply adjusting exhaust flows from tanks and vats reduce odour emissions.

Dilution is usually the least expensive method of dealing with odorous sources from enclosed structures. If it is possible to collect all the odorous emissions from a facility via fumehoods or other ducted exhausts and dilute them with enough non-odorous air before they exit the building, the odour problem is solved. This can often be accomplished with a few simple changes to existing mechanical systems. Low flow odour sources, such as small paint booth exhausts, can be ducted into high flow air exhausts, such as waste heat vents. Redesign of the exhaust system to throw the exhaust plume higher into the air can also be effective in increasing dilution and reducing odour impact.

Regulatory agencies may have a problem with simply diluting an emission source if it represents a chemical hazard as well as an odour impact. In this case, control methods that reduce the emission rate are needed. The control technologies most often used to mitigate odour sources fall into three categories: adsorbent collectors; wet scrubbers; and thermal destruction.

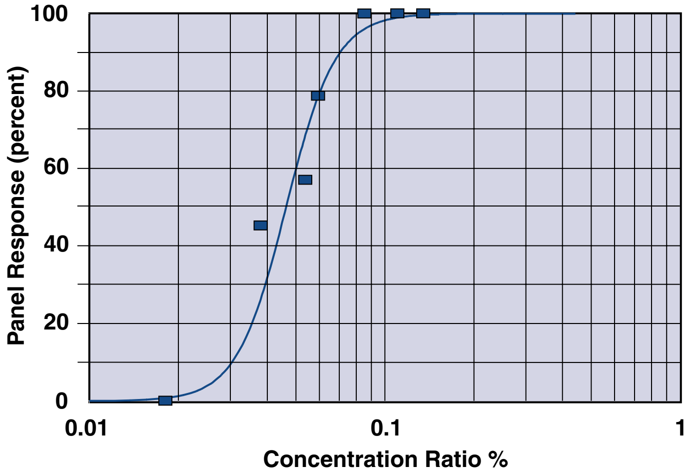
Adsorbent collectors are typically composed of activated charcoal (that traps odorous gas) placed inside a large canister. They generally have the cheapest initial cost of the three mentioned technologies. However, the charcoal must be regenerated or replaced based on the quantity of emissions that are collected in the charcoal. As well, the exhaust stream that passes through the charcoal must also be free of moisture and oil mists or the charcoal will lose its effectiveness very quickly.

Wet scrubbers come in a vast array of configurations and essentially bring the exhaust stream into contact with a huge surface area of water. The odorous compounds in the exhaust are dissolved in the water and the effluent can be expelled directly to the municipal sewer system or treated first if necessary. Wet scrubbers are extremely effective with amines and reduced sulphur compounds which are often the cause of odorous emissions. Wet scrubbers cannot deal nearly as effectively with odour problems caused by organic solvents, and depending on the composition of the exhaust, may simply change an air quality problem into a water quality problem.



*The concentration ratio % is the percentage of the original sample in the sample at the smelling port

Figure 1: Mushroom substrate compost - flux sample



*The concentration ratio % is the percentage of the original sample in the sample at the smelling port

Figure 2: Helicopter exhaust

Thermal destruction of odorous compounds in emissions is usually very thorough, but often is the costliest option of the outlined technologies. There are many different types of thermal destruction technologies available which either incinerate odorous compounds in a combustion chamber or oxidize them in a heated catalytic bed. Thermal destruction may cause additional air quality problems as a result of the combustion products that are formed.

Unenclosed odour sources such as landfills, sewage treatment plants and composting facilities are frequently more difficult to manage. Odour emissions from these types of sources generally have to be handled through modifying operational activities.

One method of dealing with these sources is to limit the off-gassing surface area to as small an area as possible. The surface odour flux should be determined to find the largest practical area which can be exposed without having an off-site odour impact. This method is particularly effective when dealing with the odour problems emanating from the working face of landfills.

Many unenclosed odour sources are caused by biological activity and covering the odorous surface may limit the oxygen available. The restriction of oxygen may trigger a change in biological activity from aerobic to anaerobic (without air) activity. This can have disastrous effects in terms of odour impact since the byproducts of anaerobic biological activity include reduced sulphur compounds which are extremely odorous. In composting operations, and other similar activities, odour can sometimes be controlled by increasing the materials exposure to the air which ensures that all of the biological activity is aerobic.

There are industrial “deodorants” which can be used as a spray treatment on odorous surfaces. However, these treatments are expensive and may or may not mask a particular odour. Also, regulatory agencies generally want to see a reduction of odorous emissions not simply a masking of them. They may also require confirmation that there are no adverse impacts as a result of emissions caused by the deodorant. Nevertheless, these deodorants may provide effective short-term solutions for specific cases.

In summary, the first step in odour control is proper characterization. Following the characterization, an appropriate control technique may be developed, based on the odour strength, chemical composition, and type of space.

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STACK EXIT VELOCITY - WHAT IT CAN AND CANNOT DO

by Glenn Schuyler, Principal

When designing exhaust stacks, it is important to ensure that the design provides adequate dilution for the particular effluent. There are several ways to achieve the design dilution chosen for a given stack and intake, but clients often wish to minimize the height of stacks to reduce their visual impact. For this reason, we are often asked how increased exit velocity can be used to reduce stack height.

High exit velocity can, in the correct situations, improve the dispersion of exhaust gases from laboratory or industrial stacks. To illustrate the effect of exhaust velocity, Figure 3 shows the results of varying exit velocity for a 6000 cfm, 20 foot high stack, based on the dilution calculations described in Chapter 15 of the 1997 ASHRAE Fundamentals Handbook. The dilutions shown in these figures represent a stack in the middle of a very large flat roof. They do not account for the effects of upwind buildings, multiple roof levels, or other commonly encountered situations and should not be used for design.

The first observation that can be made from this figure is that the minimum dilution is roughly proportional to exit velocity. The pressure losses in the system, however, are proportional to velocity squared. This means that there is a practical limit to exit velocity that is probably between 4000 and 6000 fpm.

Figure 4 demonstrates the effect of stack height for the same flow used in Figure 3 and a 2500 fpm exit velocity. It shows that a 25 foot stack provides the same dilution at 100 feet as the 20 foot stack with an exit velocity of 3500 fpm, shown in figure 3. This illustrates the advantage that can be gained through increased exit velocity.

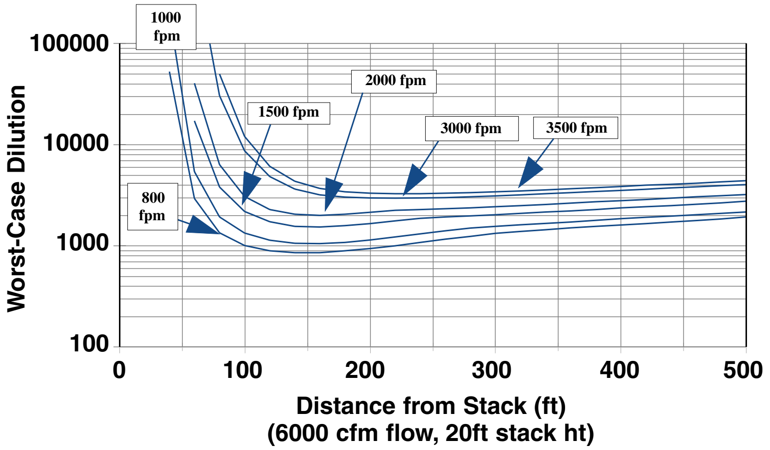

Figure 3: Effect of exit velocity on dilution

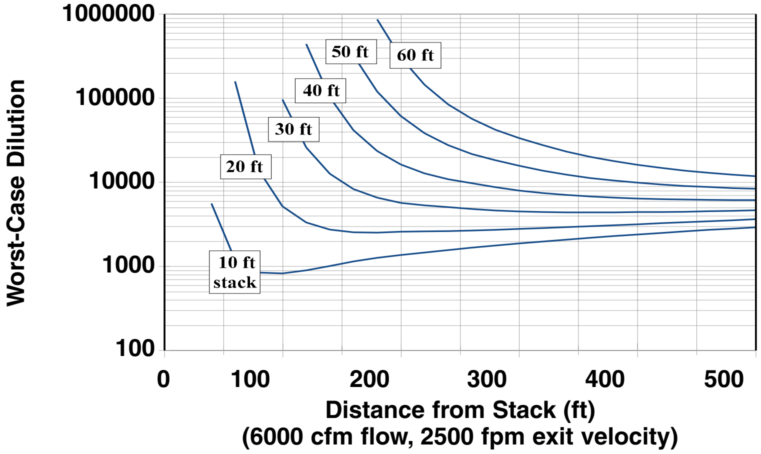

Figure 4: Effect of stack height on dilution

Secondly, the figure shows that within the first 100 feet, the effect of exit velocity is very significant. This tells us, that in cases where our intakes are within this region, (i.e., usually on the same building as the exhaust) stack height can be traded off with exit velocity quite effectively. However, at greater distances, exit velocity has much less effect. This indicates, that if there is concern with impact at a distant property line, stack exit velocity may not be depended on to solve the problem. Figure 4 shows that the effect of increasing stack height is also less at greater distances. If there is a situation at a property line where impact must be reduced, the only option available may be reduction at source (i.e. scrubbers, cyclones, filters etc.).

Fortunately, the large majority of the situations that must be considered are within the first 100 to 200 feet. This makes increased exit velocity a viable option for improving the performance of exhaust stacks.

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