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Solving  
Community  
Odor  
Problems  
using the  
Science of  
Odors



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**S**ummary: Using odor science to identify odor source and measure their impact are the first steps to a long-term solution to community odor complaints. Unlike other air emissions, odors are best measured using simple tools and human noses – both low tech and cost effective. The solutions to odor problems sometimes require money for equipment, or they may just involve changing the way things are done. In either case, measurements provide the direction for cost effective solutions and the means to show improvements

## Solving Community Odor Problems Using the Science of Odor

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Odors are everywhere; they bombard us every waking moment of the day. Odors can be pleasant, such as baking bread, or unpleasant – like a barnyard. Odors such as the smell of smoke can be a signal or warning. Odors can trigger memories from years or even decades in the past.

But what happens when odors become a nuisance? Is it possible to put your arms around the problem or to put a number on it? How much of a nuisance odor could you reasonably be asked to ignore?

Biologists today are discovering how odors are perceived at the molecular level, but odors have been studied and measured for over a century. Understanding the science of odors is one key to reducing community odor complaints. Even though we do not yet understand exactly how we smell odors, there is a lot we do know.

Odors are considered to have four dimensions. They are “Character”, “Hedonic Tone”, “Intensity”, and “Concentration”. Character is the dimension most people are familiar with. Odor Character is measured with common, descriptive words. Fruity, floral, musty, foul, skunk-like, or burnt are just a few of the terms used to describe the Character of an odor. Characteristic terms are key to tracing odors back to their source, since similar activities tend to produce similar odors. Also, most people can recognize and agree on basic odor Characteristics and descriptions- it’s a human survival skill.

The observation by Bay City and township residents of multiple Characteristic odors simply means that there are multiple activities producing odors in this area.

The way odors are perceived can change as you move away from the source. The best practical example of this is a farmyard manure pile. Close to the pile, the Characteristic odor is often described to be “ammonia, sharp, pungent”, but further away from the pile, the Characteristic is “foul, manure-like.” The foul odor can be detected thousands of feet away from the source. So, the pile smells different to you, depending on how close you are.

The next dimension of odor is Hedonic Tone. If you recall that the word “hedonism” refers to seeking pleasure, then it becomes clear that Hedonic Tone is a measurement of how pleasant (or not) the odor smells to you. It is interesting to point out that even an odor considered to have a pleasant Hedonic Tone, such as the smell of baking bread, can become a nuisance when the odor is strong and persistent. Most would agree that manure-like or rotten-egg odors are very unpleasant. Both Character and Hedonic Tone are measured with descriptive words.

Intensity is an odor dimension that can be measured with numbers and/or words such as “strong” or “weak.” With some training, the words can be replaced with a number. Trained odor observers smell odors in air directly from the atmosphere, or through a filter and then assign a number to the perceived Intensity.

Back at the manure pile, ammonia is a chemical with an odor that has a high Intensity when you smell it standing relatively close to the source. Sulfur compounds have a high Intensity even when you are far away from the source. Foul, nauseating odors from manure or other rotting materials get their smell partly from sulfur containing compounds. Natural gas and propane suppliers (and skunks!) take advantage of this property of sulfur compounds by adding them to their gas products. The noxious odor alerts consumers to leaks. This

protects humans because nearly everyone can smell and recognize the characteristic odor of sulfur compounds at extremely low concentrations. But this property of sulfur also makes it a potent source of unacceptable odors.

Understanding how odor Intensity, Character and Concentration are linked is key to finding the source of unpleasant odors.

Which brings us to Concentration, probably the most interesting and misunderstood characteristic of odors. Concentrations are routinely measured for community odor reduction projects. The equipment to accurately and consistently measure odor concentrations can be surprisingly low-tech. With the right equipment and training, concentration can be measured as the “Dilution to Threshold” of an odor.

Abbreviated as “D/T”, Dilution to Threshold is just that – how much clean air is required to dilute an odor to the point where we cannot smell or identify it. D/T can be measured for different sources of odors. The source might be a point source, like a vent pipe, or a more diffuse source like the surface of a liquid or a pile of solids. The D/T is analogous to a concentration.

The D/T is measured by presenting highly diluted samples to odor “panelists,” who have been brought together to help make these measurements. The panelists compare the diluted samples to two other blank samples in a blind test. The panelists do not know which of the three samples is the diluted one. Initially it is not possible to distinguish between the three samples. The concentration is gradually increased just until the odor panelist correctly identifies the mixed sample. The concentration where this occurs is the D/T concentration. By approaching the D/T in this way, odor panelists never have to smell anything other than a highly diluted sample.

Samples that may contain harmful chemicals cannot be tested in this way, but most odor measurement projects are done on odors already in the air and already being smelled by hundreds or thousands of people. Odor panelists are people who have an average sense of smell and no complicating factors (like cigarette smoking) that could decrease their ability to smell. Special training is not required, odor panelists are usually people selected from the community.

Putting it all together, observations in the community about odor Characteristic, Hedonic Tone and Intensity are used to identify potential odor sources. Then, samples are taken and the D/T is measured to get a number for the concentration. For example, if odor panelists can just detect an odor in the sample when it has been diluted at 1000:1, the D/T or concentration would be 1000. Samples are usually taken over a period of days to weeks, to get an accurate picture of the typical odor concentration at the source.

Just because a source has a high odor concentration, it does not necessarily mean that it is the source of community odors. The potential for an odor source to impact the surrounding community is determined by combining the odor Concentration with the vent rate, to determine an “Odor Emission Rate.” The vent rate is how fast the odorous gas is being emitted from the source. For point sources, like a vent pipe, the vent rate is just the flow rate of air or gas coming out the vent. For liquids surfaces, like ponds, or piles of solids, or landfills, the vent rate can be estimated from average temperatures and wind speeds.

Sources are ranked by their Odor Emission Rate for their potential to create odor problems in the community. Sources with a high Concentration and a high vent rate have the biggest potential for creating odor problems. These are the sources that should be considered first. Conversely, a source that has a very high concentration but a low vent rate has a lower probability of producing enough odors to be a real source of odors in the community at large.

Knowing the most likely sources of odors allows the people working on odor reduction projects to focus on the solutions that will deliver the most value. Community odor assessments pinpoint the sources of the problems. Measurements at the source allow us to monitor and show improvement and they allows us to compare high odor emissions to conditions at the source, weather conditions, wind speeds, and other factors.

Using odor science to identify odor source and measure their impact are the first steps to a long-term solution to community odor complaints. Unlike other air emissions, odors are best measured using simple tools and human noses – both low tech and cost effective. The solutions to odor problems sometimes require money for equipment, or they may just involve changing the way things are done. In either case, measurements provide the direction for cost effective solutions and the means to show improvements.