TECH TIP # 29

HARDI
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HOW HUMIDITY AFFECTS ODORS

Humidity -- or the lack of it -- is a very popular topic. Despite all the disclose, however, little has been said about the effect of humidity on odors.

The hunter knows that his dog tracks better on humid nights; strong odors often emit from a damp room; and yet cigarette odors are more irritating in dry atmospheres.

That humidity affects odors is a fact. How and why is the theme of this tech tip.

Of all the factors commonly considered part of the air conditioning process -- namely control of temperature, humidity, air motion and air cleanliness -- humidity is presently perhaps the most often discussed item.

Much emphasis is placed on the need for proper moisture levels to improve the comfort and health of occupants and also to protect furnishings the year 'round. Unfortunately, by now the constant reference to dried up nasal passages, fewer colds, warped pianos and static electricity have for many contractors become old and tired clichés -- however true the statements may be. Isn't there something new or different that can be said about humidity?

How About Odors?

One major phenomenon not widely discussed is the effect of indoor humifidy on odors. Now it's probably safe to say that hardly a contractor exists who hasn't been confronted with an odor problem. And in the future, chances are there will be more, not fewer, odor problems as buildings become tighter, more year round systems are installed (and operated as such), and air pollution becomes more widespread. While there isn't a great deal known about humidity and odors of a very precise and practical nature, there have been a few studies made that can be a source of useful information for the contractor. Before considering the humidity-odor relationships, let's first review what is known about odors themselves.

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Odors Involve Both the Physical and Psychological

The human machine signals the mind by means of the five senses -- sight, hearing, smell, taste and touch. The exact mechanism of the sense of smell is not fully understood, but it is believed that impulses are sent to the brain when certain (not all types of gases or vapors -- termed odorants -- are dissolved in fluids found high in the nasal cavity. Some odors are also conveyed on liquid and solid particles.

In many practical respects the senses of sound and smell are analogous.

For one thing, there is a *threshold* of smell just as there is of sound. Below a certain concentration of an odorant gas or vapor, no odor will be detected. Exact threshold values vary between people and the *type* of odor (much as the threshold of sound does between people and *frequency*). A "weak" odor to some may be concentrations of from 5 to 10 parts per million -- a strong odor to others, one part per billion. As a comparison, carbon monoxide gas is considered dangerous in concentrations of 50 parts per million. The nose is a very sensitive instrument.

As between decibels and sound power, there is a logarithmic relationship between the sense of smell and odorant concentration. Thus, detection of a small change in odor signifies a considerably larger change in actual odorant concentration. A practical result of this fact is that an odor "filter" must be a device of higher efficiency than a dust type filter to achieve any noticeable reductions.

Another analogy between sound and smell is the masking effect. Just as one sound can "drown out" another, one type of odor can cover up another.

Finally. The sense of smell, like hearing, involves both the physical and the psychological. One of the more important psychological aspects of the sense of smell, is the ability to become accustomed to a particular odor, while odor concentration remains unchanged. (we get used to background noise, too.) Another psychological element, perhaps the opposite of getting used to odors, ius lingering detection after a strong odorant has initially been sensed and later eliminated or removed.

People's reactions to both smells and sounds vary with mood as well. For example: food odors are usually pleasant to a hungry person -- after dinner is another matter. As a general rule, women, young people, non-drinkers and non-smokers have a more acute sense of smell.

Odors Behave Like Moisture in Air

Since odors are principally in the gaseous or vapor state their behavior is a lot like that of water vapor in air. Odors diffuse through space uniformly as if other gases (air) were not present, and they are not affected by gravity. In fact, odors can be absorbed by and released from fabrics and wood just as water vapor can. In the case of wall surfaces, odors can (in varying degrees) diffuse through pores and seams or be adsorbed,* all of which can be loosely likened to water vapor migration and condensation through building materials.

* Adsorption vs. Absorption: Adsorption is the accumulation of a gas on the surface of a solid. There is no change physically or chemically. Absorption is a soaking up of the entire mass of a substance.

Odors originate from many substances and processes. In comfort air conditioning, cooking, smoking, household furnishings -- rugs, drapes, etc. -- are important sources of odors. Outside, hydrogen sulfide (remember the rotten egg smell in your high school chemistry class?) is one of several growing pollutants that may be drawn into the “fresh” air intake.

Perhaps the classic example of an odor source in air conditioning work is the coil odor problem. Odors, some initially undetectable, from a conditioned space may be absorbed by the cooling coil. After sufficient build-up over a period of time these odors are gradually released, producing a very pleasant smell. The problem can usually be eliminated by regularly operating the fan long after the cooling unit is required. For instance: Restaurant, night club and conference room equipment should not be shut down after hours. The ventilating fan should be allowed to run through the night to purge the system and avoid odor build-up.

Control Techniques

As just indicated, the most common technique to control odors is by means of adequate ventilation. Other techniques include odor adsorption on activated charcoal, spray washers to dissolve water soluble odors, chemical reactions and neutralization by masking. In industrial work, odors are sometimes destroyed by combustion. Regular filters, even electronic air cleaners, are for all practical purposes ineffective against odors. Only those few odors that ride piggyback on particulate matter may be affected.

Humidity Helps and Hinders

How about the effect of humidity? Humidity apparently does have an effect on 1) the sensitivity of the nose to detect odors; 2) the rate of odor generation from certain materials; and 3) the escape of odors from a room.

In the first instance, an increase in humidity reduces the sensitivity of the nose. The suspicion is that the added moisture in the air dilutes the odor concentration as the vapors dissolve in the fluids of the nasal cavity.

Next, for some materials, such as linoleum, rubber and paint, odor production increases with higher humidity levels. Fabrics, such as cotton, wool, nylon, etc., can absorb and release odors. Both rates are affected by humidity. In the case of odors released from fabrics, increasing humidity accelerates the rate at which previously absorbed odors are released.

Higher Humidity Accelerates Purging

A number of years ago a study was made which indicated that the difference in water vapor pressure between indoors and outside affected the natural purging of odors from a room.* In other words, for the same outdoor humidity, a higher indoor humidity could somehow help purge a space of odors.

Tests were conducted by detecting the odor level of cigeratte smoke in a large (1700 square foot) room of standard construction, one wall of which was exposed to the out-of-doors. Odor measurements were made, using what is called the dilution-to-threshold method.

The dilution-to-threshold method is a practical measurement procedure suitable even for actual on-the-job analysis. The technique involves dilution odor laden air with "fresh" air until the odor is just discernible -- that is, at its odor threshold. The ratio of the mixture volume of air divided by the volume of odor laden air is termed the number of thresholds. The higher the number, the stronger the odor.

A small fan fitted with two inlet ducts, suitable dampers and some type of flow indicators is one form a field type test apparatus may take. In the laboratory, a smaller apparatus perhaps made of glass and employing compressed air might be used to sample and mix air streams. In any case the observer breathes the mixture at the point of discharge.

In the test room, it was initially observed that a smoking rate of two cigarettes an hour would produce an odor level of about seven thresholds after one hour, (six volumes of fresh air needed to dilute one volume of room air) rising to about 14 thresholds (stronger odor level) after seven hours. This was in the summertime, when the moisture level, hence, vapor pressure, was greater *outside* than in.

In the winter, for the same test, room air never exceeded one threshold even after seven hours of smoke production. This lower odor level for the same smoking rate was attributed to the winter's vapor pressure gradient which now was higher *inside* than out. Somehow, this helped odors to escape from the room more rapidly. In the summer, the reverse vapor pressure gradient helps to contain odors.

The mechanism of adsorption probably comes into play here as well. Odor adsorption is higher on cold surfaces than warm ones. In summer, then, the coldest surfaces in a wall are inside, in winter near the outside. Precise actions are yet to be verified.

Equipment installed in cocktail lounges, restaurants, conference rooms and other similar spaces where odor concentrations tend to be high, is frequently plagued with cooling coil odors. Room odors, some undetectable, accumulate and intensify on the coil surfaces. In time a very unpleasant smell is emitted. This odor build up can be avoided by operating the blower long after unit is no longer required, say through the night. And if high temperature and humid air is used for a time prior to venting a space, odors sorped on room surfaces and furnishings will be driven out into the air for easy purging.

Trends, But No Specifics

While the evidence is strong that humidity can affect odor in a room, there are no numerical relationships available to solve problems.

For example: We know that increasing the relative humidity decreases a person's sensitivity to detect an odor. Also, we know that increasing relative humidity causes paint or rubber products to emit more odors. The question is, if we lower room relative humidity, can we reduce odor output from surfaces faster that we increase the noses sensitivity to detect odor? To these facts we must consider indoor-outdoor humidity gradient. Right now no one can predict the answers. It must be a trial and error approach for the most part.

Why a Damp Room Smells

There is one thing most odor experts agree on, and that is a constant humidity level is preferable to one that fluctuates.

If moisture is constantly absorbed and released from furnishings and wall surfaces, it will drive out adsorbed odors. A natural example of this is the residential odors after a party. During the party, odors penetrate fabrics, say curtains or drapes. Later, the humidity inside rises as a consequence of night time weather conditions, and the fabrics exchange odors for moisture. When the host gets up in the morning, all the evening's odors have re-entered the air. Therefore, maintaining a steady indoor relative humidity should help to avoid some of these familiar odor problems.

Achieving a steady indoor relative humidity in summer can sometimes be a problem with oversized equipment and continuous blower operation. Here, then, is another reason for proper sizing of equipment; also, the need for more reheat options on unitary equipment.

Another point agreed upon by experts is that to correct some types of odor problems, such as smelly cooling coils or rooms with surface adsorbed odors, the space should be purged with high temperature and humid air. This will greatly reduce the time needed to "clean" the space.

Worth Mentioning?

To sum it up, humidity is important in the odor phenomenon -- raising relative humidity reduces perception and accelerates purging. Odor generation, however, may increase. Summertime poses more problems than winter, but in any case, indoor humidity levels should be held stable.

Interesting? Perhaps the next time you get involved in reviewing the benefits of controlled humidity you might want to add odors to that list of good and evil attributable to humidity -- or the lack of it.