PDHonline Course C227 (2 PDH)

Indoor Mold and Moisture Basics

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Mold and Moisture

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Molds can be found almost anywhere; they can grow on virtually any substance, providing moisture is present. Molds can grow on and within wood, paper, carpet, and foods. When excessive moisture accumulates in buildings or on building materials, mold growth will often occur, particularly if the moisture problem remains undiscovered or unaddressed. There is no practical way to eliminate all mold and mold spores in the indoor environment; the key to control indoor mold growth is to control moisture. If mold is discovered, clean it up immediately and remove excess water or moisture. In addition, maintaining the relative humidity between 30 and 60 percent will help control mold.

Molds produce tiny spores to reproduce. Mold spores waft through indoor and outdoor air continually. When mold spores land on a damp spot indoors, they may begin growing and digesting whatever they are growing on to survive.

There are many different kinds of mold. Molds can produce allergens, toxins, and irritants. Molds can cause discoloration and odor problems, deteriorate building materials, and lead to health problems—such as asthma episodes and allergic reactions—in susceptible individuals.

CONDENSATION, RELATIVE HUMIDITY, AND VAPOR PRESSURE

Mold growth does not require the presence of standing water, leaks, or floods; mold can grow when the relative humidity of the air is high. Mold can also grow in damp areas such as unvented bathrooms and kitchens, crawl spaces, ducts, utility tunnels, gyms, locker rooms, wet foundations, leaky roof areas, and damp basements. Relative humidity and the factors that govern it are often misunderstood. This section discusses relative humidity and describes common moisture problems and their solutions.

Water enters buildings both as a liquid and as a gas (water vapor). Water is introduced intentionally in bathrooms, gym areas, kitchens, and art and utility areas, and accidentally by way of leaks and spills. Some of the water evaporates and joins the water vapor that is exhaled by building occupants. Water vapor also moves into the building through the ventilation system, through openings in the building shell, or directly through building materials.

The ability of air to hold water vapor decreases as the air temperature falls. If a unit of air contains half of the water vapor it can hold, it is said to be at 50 percent relative humidity (RH) or greater. The RH increases as the air cools and approaches saturation. When air contains all of the water vapor it can hold, it is at 100 percent RH or greater, and the water vapor condenses, changing from a gas to a liquid. The temperature at which condensation occurs is the "dew point."

Reaching 100 percent RH without changing the air temperature is possible by increasing the amount of water vapor in the air (the "absolute humidity" or "vapor pressure"). It is also possible to reach 100 percent RH without changing the amount of water vapor in the air, by lowering the air temperature to the "dew point."

The highest RH in a room is always next to the coldest surface. This is referred to as the "first condensing surface," as it will be the location where condensation happens first, if the relative humidity of the air next to the surface reaches 100 percent. Understanding this is important when trying to understand why mold is growing on one patch of wall or only along the wall-ceiling joint. The surface of the wall is likely to be cooler than the room air because of a gap in the insulation or because the wind is blowing through cracks in the exterior of the building.

TAKING STEPS TO REDUCE MOISTURE AND MOLD

Respond to water damage within 24–48 hours to prevent mold growth, which depends on moisture.

Mold growth can be reduced if relative humidities near surfaces can be maintained below the dew point. This can be done by: 1) reducing the moisture content (vapor pressure) of the air; 2) increasing air movement at the surface; or 3) increasing the air temperature (either the general space temperature or the temperature at building surfaces).

Either vapor pressure or surface temperature can be the dominant factor in a mold problem. A vapor pressure-dominated mold problem may not respond well to increasing temperatures, whereas a surface temperature-dominated mold problem may not respond very well to increasing ventilation. Understanding which factor dominates will help in selecting an effective control strategy.

If the relative humidity near the middle of a room is fairly high (e.g., 50 percent at 70º F), mold or mildew problems in the room are likely to be vapor pressure dominated. If the relative humidity near the middle of a room is fairly low (e.g., 30 percent at 70º F), mold or mildew problems in the room are likely to be surface temperature dominated.

VAPOR PRESSURE-DOMINATED MOLD GROWTH

Vapor pressure-dominated mold growth can be reduced by using one or more of the following strategies:

- Use source control (e.g., direct venting of moisture-generating activities such as showers to the exterior).
- Dilute moisture-laden indoor air with outdoor air at a lower absolute humidity.
- Dehumidify the indoor air.

Note that dilution is only useful as a control strategy during heating periods, when cold outdoor air contains little total moisture. During cooling periods, outdoor air often contains as much moisture as indoor air.

Consider a school locker room that has mold on the ceiling. The locker room exhaust fan is broken, and the relative humidity in the room is 60 percent at 70º F. This is an example of a vapor pressure-dominated mold problem. In this case, increasing the surface temperature is probably not an effective way to correct the mold problem. A better strategy is to repair or replace the exhaust fan.

SURFACE TEMPERATURE-DOMINATED MOLD GROWTH

Surface temperature-dominated mold growth can be reduced by increasing the surface temperature using one or more of the following approaches:

- Raise the temperature of the air near room surfaces.
- Raise the thermostat setting.
- Improve air circulation so that supply air is more effective at heating the room surfaces.
- Decrease the heat loss from room surfaces.
- Add insulation.
- Close cracks in the exterior wall to prevent "wind washing" (air that enters a wall at one exterior location and exits another exterior location without penetrating into the building).

Consider an old, leaky, poorly insulated school that has mold and mildew in the coldest corners of one classroom. The indoor relative humidity is low (30 percent). It is winter and cold air cannot hold much water vapor. Therefore, outdoor air entering through leaks in the building lowers the airborne moisture levels indoors. This is an example of a surface temperature-dominated mold problem. In this building, increasing the outdoor air ventilation rate is probably not an effective way to control interior mold and mildew. A better strategy would be to increase surface temperatures by insulating the exterior walls, thereby reducing relative humidity in the corners.

MOLD CLEAN UP

Because moisture is the key to mold control, it is essential to clean up the mold and get rid of excess water or moisture. If the excess water or moisture problem is not fixed, mold will most probably grow again, even if the area was completely cleaned. Clean hard surfaces with water and detergent and dry quickly and completely. Absorbent materials such as ceiling tiles may have to be discarded.

Note that mold can cause health effects such as allergic reactions; remediators should avoid exposing themselves and others to mold. Wear waterproof gloves during clean up; do not touch mold or moldy items with bare hands. Respiratory protection should be used in most remediation situations to prevent inhalation exposure to mold. Respiratory protection may not be necessary for small remediation jobs with little exposure potential. Refer to **Appendix L:** "Resources," for more information on mold remediation. When in doubt consult a professional, experienced remediator.

IDENTIFYING AND CORRECTING COMMON MOLD AND MOISTURE PROBLEMS

Exterior Corners and Walls

The interior surfaces of exterior corners and behind furnishings such as chalk boards, file cabinets, and desks next to outside walls are common locations for mold growth in heating climates. They tend to be closer to the outdoor temperature than other parts of the building surface for one or more of the following reasons:

- Poor indoor air circulation
- Wind washing
- Low insulation levels
- Greater surface area of heat loss

Sometimes mold growth can be reduced by removing obstructions to airflow (e.g., rearranging furniture). Buildings with forced air heating systems and/or room ceiling fans tend to have fewer mold problems than buildings with less air movement.

SET-BACK THERMOSTATS

Set-back thermostats (programmable thermostats) are commonly used to reduce energy consumption during the heating season. Mold growth can occur when temperatures are lowered in buildings with high relative humidity. (Maintaining a room at too low a temperature can have the same effect as a set-back thermostat.) Mold can often be controlled in colder climates by increasing interior temperatures during heating periods. Unfortunately, this also increases energy consumption and reduces relative humidity in the breathing zone, which can create discomfort.

AIR-CONDITIONED SPACES

Mold problems can be as extensive in cooling climates as they are in heating climates. The same principles apply: either surfaces are too cold, moisture levels are too high, or both.

One common example of mold growth in cooling climates can be found in rooms where conditioned "cold" air blows against the interior surface of an exterior wall. This condition, which may be due to poor duct design, diffuser location, or diffuser performance, creates a cold spot at the interior finish surfaces, possibly allowing moisture to condense.

Possible solutions for this problem include:

- Eliminate the cold spots (i.e., elevate the temperature of the surface) by adjusting the diffusers or deflecting the air away from the condensing surface.
- Increase the room temperature to avoid overcooling. NOTE: During the cooling season, increasing temperature decreases energy consumption, though it could cause comfort problems.

Mold problems can also occur within the wall cavity, when outdoor air comes in contact with the cavity side of the cooled interior surface. It is a particular problem in rooms decorated with low maintenance interior finishes (e.g., impermeable wall covering such as vinyl wallpaper), which can trap moisture between the finish and the gypsum board. Mold growth can be rampant when these interior finishes are coupled with cold spots and exterior moisture.

A possible solution for this problem is to ensure that vapor barriers, facing sealants, and insulation are properly specified, installed, and maintained.

THERMAL BRIDGES

Localized cooling of surfaces commonly occurs as a result of "thermal bridges," elements of the building structure that are highly conductive of heat (e.g., steel studs in exterior frame walls, uninsulated window lintels, and the edges of concrete floor slabs). Dust particles sometimes mark the locations of thermal bridges because dust tends to adhere to cold spots.

The use of insulating sheathings significantly reduces the impact of thermal bridges in building envelopes.

WINDOW

In winter, windows are typically the coldest surfaces in a room. The interior surface of a window is often the first condensing surface in a room.

Condensation on window surfaces has historically been controlled by using storm windows or "insulated glass" (e.g., double-glazed windows or selective surface gas-filled windows) to raise interior surface temperatures. In older building enclosures with less advanced glazing systems, visible condensation on the windows often alerted occupants to the need for ventilation to flush out interior moisture, so they knew to open the windows.

The advent of higher performance glazing systems has led to a greater number of moisture problems in heating climate building enclosures because the buildings can now be operated at higher interior vapor pressures (moisture levels) without visible surface condensation on windows.

CONCEALED CONDENSATION

The use of thermal insulation in wall cavities increases interior surface temperatures in heating climates, reducing the likelihood of interior surface mold and condensation. The use of thermal insulation without a properly installed vapor barrier, however, may increase moisture condensation within the wall cavity.

The first condensing surface in a wall cavity in a heating climate is typically the inner surface of the exterior sheathing.

Concealed condensation can be controlled by any or all of the following strategies:

- Reducing the entry of moisture into the wall cavities (e.g., by controlling entry and/or exit of moisture-laden air with a continuous vapor barrier).
- Raising the temperature of the first condensing surface.
- In heating-climate locations: Installing exterior insulation (assuming that no significant wind washing is occurring).
- In cooling-climate locations: Installing insulating sheathing to the interior of the wall framing and between the wall framing and the interior gypsum board.

Mold and Health Effects

Molds are a major source of indoor allergens. Molds can also trigger asthma. Even when dead or unable to grow, mold can cause health effects such as allergic reactions. The types and severity of health effects associated with exposure to mold depend, in part, on the type of mold present, and the extent of the occupants' exposure and existing sensitivities or allergies. Prompt and effective remediation of moisture problems is essential to minimize potential mold exposures and their potential health effects.