

Humidity Control in the Humid South

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Abstract:

Humidity concerns in the southern humid climates are particularly difficult to resolve. This is because one of the most effective approaches to dealing with humidity in heating climates, ventilation, can cause major humidity problems in the humid south. The issue becomes even more complex when you realize that you can replace the word humidity in the previous sentences with the words "indoor air quality " and not change the meaning or impact. Dilution is often used as the solution to indoor pollution in heating climates. Unfortunately, in humid, air conditioning climates, the greater the rate of dilution, ventilation or air change, the greater the rate of moisture entry with the exterior air. Therefore, the greater the likelihood of mold and other biological growth problems, particularly if the moisture in this incoming air is not removed.

Humidity Control in the Humid South

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Air conditioning buildings (mechanical cooling) is the major source of both humidity and indoor air quality concerns in the humid south. When exterior hot, humid air is cooled its relative humidity is increased. If it is cooled sufficiently, condensation occurs. High relative humidities and condensation can lead to mold and other biological growth. Interior relative humidities at surfaces and within building cavities need to be controlled to prevent condensation and biological growth.

An ideal approach to control indoor humidity and indoor air quality in the hot, humid south is to minimize the need for outside air. The air should be obtained in a controlled manner (mechanically with a fan). The air should be conditioned where it comes into the building. It should be dehumidified by cooling it below its dew point, and used to maintain the enclosure at a slight positive air pressure relative to the exterior. By doing so, it can be used to control the infiltration of exterior hot, humid air. Furthermore, the building envelope should be built in a manner that aides in the pressurization of the building. Tight construction is recommended. The building envelope should also exclude rain, control rain water absorption and control vapor diffusion. Vapor diffusion retarders should be installed on the exterior of building envelopes in the humid south as compared to the practices in northern heating climates. Finally, the building envelope should be forgiving so that if it gets wet, it can dry to the interior. Interior vapor diffusion retarders such as impermeable wall covering should be avoided.

This approach has implications with respect to building envelope tightness and moisture permeability/resistance, air consuming devices, interior activities, interior pollutant source strengths, housekeeping practices, operating costs for air conditioning equipment, and air conditioning loads.

Not following this approach has even greater implications with respect to health, safety, comfort, durability, maintenance and affordability.

Mold and Biological Growth Problems

When problems from mold and biological growth do occur in the humid south, they can be divided into three distinct categories:

- problems on interior surfaces due to elevated levels of moisture in the interior conditioned air (high interior air relative humidity);
- problems on interior surfaces due to surfaces being too cold leading to high relative humidities at the cooled surfaces; and
- problems within building cavities due to high cavity moisture levels or moisture passing through building cavities causing high relative humidities on material surfaces as the moisture migrates into the conditioned space

Although these problems can occur independently of each other they often occur in combination. For example, elevated levels of interior moisture are usually due to moisture passing through building cavities from the exterior resulting in both cavity moisture problems as well as problems on interior surfaces once the moisture has gotten into the conditioned space. Overcooling of the space just magnifies both problems thereby creating a third.

Interior Surface Related Problems Due to Elevated Levels of Moisture When interior moisture levels are high, relative humidities at surfaces also are high. Where relative humidities at surfaces are greater than 70 percent mold and other biological growth can occur. In the humid south, the moisture source for these problems is almost always the exterior air. Moisture must be removed from the air within conditioned spaces such that relative humidities at surfaces remain below 70 percent. Where conditioned spaces are cooled to 75 degrees Fahrenheit, relative humidities in the air within the space should not exceed 60 percent.

Air which is brought in from the exterior to supply ventilation needs and make-up air needs should be conditioned to "dew point 55". In other words, this air should be cooled to at least 55 degrees Fahrenheit in order to dehumidify it. At dew point 55, the temperature of the air is 55 degrees Fahrenheit and its relative humidity is 100 percent. Once this air is warmed up to 75 degrees Fahrenheit, the temperature of typical air conditioned spaces, its relative humidity will be approximately 50 percent. This air now mixes with the air in the space diluting/reducing the conditioned space moisture levels/relative humidity. The rate of dilution or mixing is determined by meeting the 60 percent relative humidity limit within the conditioned space.

The dehumidification capabilities of air conditioning systems are typically used to remove moisture from the air within the conditioned space. Unfortunately, the latent cooling loads (the energy required to cool/remove the moisture in the air) are usually higher than sensible cooling loads in the humid south. This means that air conditioning systems should be sized for their latent loads, rather than their sensible loads. Sizing of equipment becomes critical. Undersizing of air conditioning equipment can lead to obvious comfort and humidity problems. However, oversizing of air conditioning equipment can also lead to high interior humidity problems since oversized equipment will not operate as often, and therefore will dehumidify less than properly sized equipment.

Concerns about energy conservation has lead to the development of energy efficient mechanical cooling systems. Unfortunately, this has also reduced the ability of many of these systems to dehumidify air. In many cases, the exterior air is not cooled sufficiently to remove sufficient quantities of moisture.

Air cooled to 55 degrees Fahrenheit is usually too cold to introduce into a space. In the past this cooled air was heated after it was cooled ("reheat") prior to use. Reheat results in a significant energy penalty, and is not allowed in many jurisdictions for this reason. To avoid reheat requirements, some systems do not cool air down to "dew point 55". Unfortunately, this can result in insufficient moisture removal and subsequent high interior moisture levels.

Two approaches have been successfully used to address the issue of reheat. One is a new technology: heat pipe heat recovery. The other dates back to the 1930's and has been recently "rediscovered": run-around coils. Both of these approaches use heat removed during the mechanical cooling process to "reheat" the cooled air once it has shed its moisture thereby reducing the energy penalty of standard reheat.

Interior Surface Related Problems Due to Overcooling of Surfaces

When surfaces become too cold, surface relative humidities rise above 70 percent. When they rise to 100 percent, condensation occurs. If air conditioned air is supplied at too low a temperature, the diffusers can be extremely cold leading to condensation ("sweating"). Where diffusers are located poorly or adjusted incorrectly, cold air may be "blown" against surfaces creating cold spots and localized areas of high relative humidity and mold growth.

Supply ducts enclosed in interior walls and dropped ceilings often are not sealed and leak supply air. This supply air is typically under substantial positive air pressure and the resulting "jet" of air can "blow" against a surface leading to localized cooling. The cooling happens from the building cavity side, whereas the mold growth usually appears on the room side.

In cooling climates, condensing surfaces of exterior walls are typically the interior gypsum board. If interior spaces are "overcooled", the interior surfaces fall below the dew point temperature of the exterior air and condensation occurs. Figure 1 illustrates the case of a wall experiencing condensation as a result of overcooling. By raising the interior conditioned space temperature, the temperature of the first condensing surface is raised. Consequently, as the graph in Figure 1 shows, the potential for condensation is eliminated in this climate.

system. Stale air is removed through a central exhaust system. Exhaust vents are located in the kitchen and bathrooms.

The central exhaust system operates intermittently under a "summer/cooling" setting, being activated by timed switches in the bathrooms. Under a "winter/heating" setting the central exhaust system operates either continuously (at a low speed setting) or some fraction of time (intermittent operation ventilation approach during heating) every hour whenever occupants are present. During heating periods it may be desirable to control the central exhaust fan high speed setting by a humidity sensor.

The forced air system provides effective distribution of fresh air throughout the house. The overall system should be designed, balanced and commissioned so that positive air pressure relationships are maintained during cooling periods.

Ventilation Requirements

Enclosures should be ventilated in a controlled manner. During cooling periods controlled ventilation should be limited to minimum levels (unless the exterior ventilation air is preconditioned) to reduce latent cooling loads (exterior humidity brought in with the ventilation air) without compromising indoor air quality. ASHRAE 62-89 recommends - 15 cfm per person. When applying this rate to a residence, the design occupancy can be based on the number of bedrooms. This determines the minimum standard for continuous base rate ventilation for the house. It can be assumed that two people sleep in the master bedroom, and one other person sleeps in each additional bedroom. The following ventilation requirements result:

- one bedroom house 30 cfm
- two bedroom house 45 cfm
- three bedroom house 60 cfm
- four bedroom house 75 cfm

This minimum base rate ventilation should be continuously distributed throughout the house when the building is occupied.

Forced Air Ducted Systems

A forced air ducted system, including all duct work, the air handling unit, supply plenum and return plenum should be considered a closed system. In other words, when all registers and grills are taped shut, no air leakage occurs. The only place for air to leave the supply duct system and the air handling unit is at the supply registers. The only place for air to enter the return duct system is at the return grills.

The air handling system requires an air barrier/air retarder system similar to that required by the building envelope. The materials used to create or seal an air handling system air barrier/air retarder system should have the following characteristics:

- The materials should be healthy and safe with respect to the occupants (flame spread, smoke development, toxicity, off-gasing, aerosolization)
- The materials must be impermeable to the passage of air.
- The material or system of materials used must be continuous.
- The materials must be sufficiently rigid to resist the air pressures and gravity forces which act on them.
- The materials should be durable, maintainable, cleanable and able to last the life of the system.

Duct work can take numerous forms:

- ^a sheet metal
- fiberglass duct board covered on one side with foil

In some slab homes, a 4 inch diameter chase pipe enters the plenum. The chase pipe carries the refrigerant lines, condensate piping, and control wiring which connect the indoor and outdoor units. This chase pipe is frequently unsealed, allowing unconditioned air or soil gases (radon, pesticides, herbicides, moisture) to be drawn into the return. Chases should never terminate inside the return air stream.

Return plenums are sometimes formed by the enclosed space below the air handler support platform. This plenum may leak to adjacent walls and directly to the space in which it is located. A return plenum in an air handler closet may have no gypsum board separating it from an adjacent tub enclosure. As a result air may be drawn from the attic (Figure 16). The adjacent walls often have plumbing and wiring in them that either comes from the attic, crawlspace, garage, basement, outside, or some other interior space. Many of these platforms are lined with insulation or fibrous ductboard because of fire codes and soundproofing. This lining is not an air barrier and leakage will occur if the joints and penetrations are not sealed.

Leakage can also occur at the connection between the air handler and the support platform. All sides of the air handler must be sealed to the support platform. Supply plenums also leak at seams, particularly sleeved plenums.

The air handler housings also have supply and return leaks which need to be sealed. Air handlers have removable panels to permit access to internal components. Gaps exist between panels and these leak sites may be enlarged when the panels are bent. The filter access panel is often a leak problem because it does not fit tightly on the cabinet. Mastic and fabric provides a permanent seal for many of the knockouts and panel joints. Access panels can be sealed with high quality tape to permit future access. A roll of this tape should be left with the unit so that owners can retape access panels after filter replacement or other servicing.

The Following Comments Are From The Overheads Presented During The Presentation

Mold, mildew, bioaerosols, dust mites, etc. are a moisture control problem.

Control moisture at surfaces and you control the problem.

How much moisture should be allowed at a surface?

air change during heating periods

dehumidification through mechanical cooling (air conditioning) during cooling periods

control vapor diffusion by using vapor diffusion retarders

on the inside in heating climates

on the outside in cooling climates

in the middle (thermally) in mixed climates

How to keep rain out of building assemblies? Easy - rain screen and/or drain screen.

How to keep ground water out of building assemblies? Easy - drain screen.

How tight should building envelopes be in order to facilitate air pressure control?

ASHRAE 62-1989 requires a minimum air change based on occupancy to provide acceptable indoor air quality (15 to 20 cfm per person).

An ideal approach would allow ASHRAE 62-1989 flows to control air pressure differentials across building envelopes.

Field experience has shown that leakage ratios of 1 to 1.5 square inches of leakage per 100 square feet of building envelope area allow ASHRAE 62-1989 flows to control air pressure differentials.

About this Report

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