Controlling Mold In Residential Construction

by

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A. MOLD

1. Member of a family of plants know as fungi
2. Are present everywhere including the air we breathe
3. Only need food and water to grow
4. Used extensively in food, beverage and pharmaceutical industries
5. Contain no chlorophyll, so don't photosynthesize like flowering plants or trees
6. Reproduce through spores, which germinate wherever they find food and water
7. Airborne spores coming from outside are only a problem when they start growing indoors and inside air becomes concentrated with allergenic spores and mycotoxins (the chemical toxins that some molds produce)
8. Mold growth generally really takes off when relative humidity exceeds 80% for extended time periods. It follows that mold is controlled by controlling moisture sources:
   a. Control interior moisture generation
   b. Eliminate surface condensation
   c. Do not allow water to penetrate exterior envelope

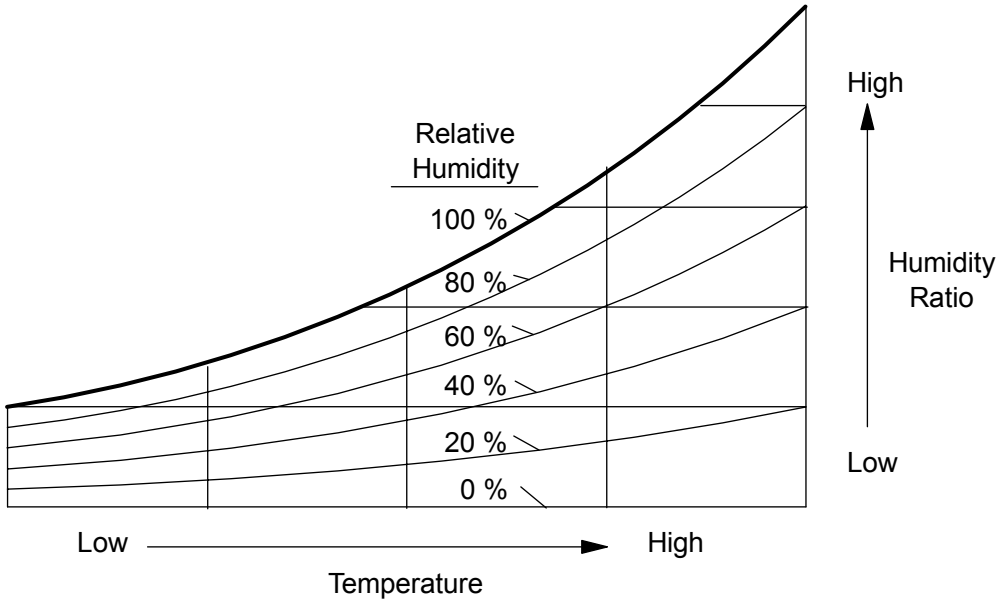
B. CONTROLLING MOISTURE GENERATION

1. If an existing house has a moisture problem, the first step is to evaluate living habits
2. Limit evaporation/production of moisture from sources within the house:
   a. Take colder, shorter, and/or fewer showers
   b. Cover open water (aquariums, hot tubs, wash machines, pools, toilets, toilet tanks)
   c. Immediately dispose of wastewater (i.e., empty dishpans, bathtubs when done)
   d. Vent dryers
   e. Keep wet cloths covered in washer until ready to dry
   f. Clean up water spills immediately
   g. Keep pots and pans covered when cooking
   h. Limit number/size of household plants
3. Moisture problems are more often found in buildings housing younger families with low incomes. Such families:
   a. Do more laundry
   b. Have more individuals taking baths and showers
   c. Cook at home more frequently
   d. Have more pets
   e. Have fish (i.e., aquariums can generate significant moisture)
   f. Live in smaller homes (less air infiltration per family member)

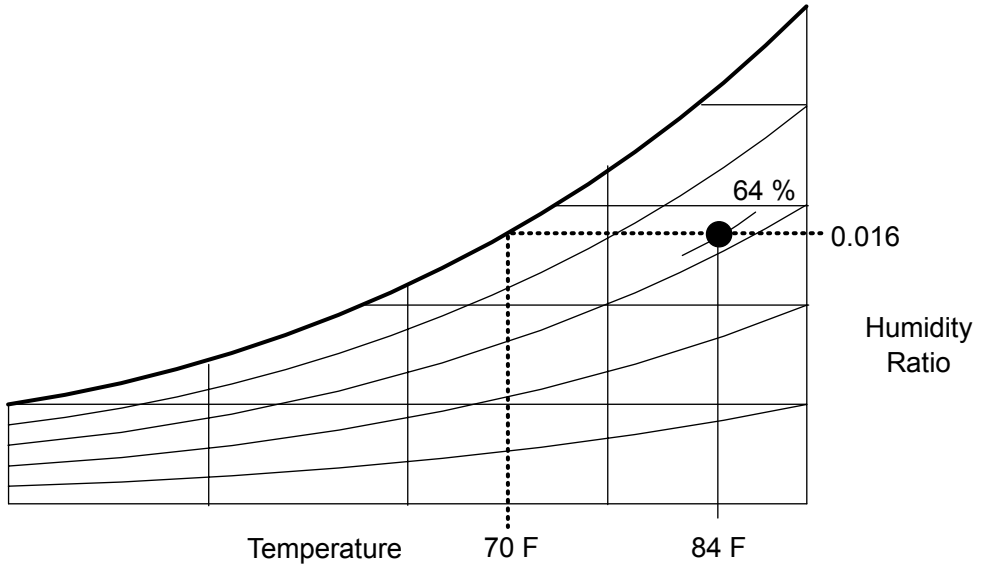
C. CONDENSATION

1. Air can only "hold" a given amount of water. The higher the temperature, the greater the amount of water that air can hold
2. The amount of water in the air divided by the amount of dry air (i.e., the ratio of water to dry air) is the humidity ratio of the air

3. The amount of water in the air divided by the maximum amount of water that air can hold at that temperature, expressed as a percent, is the relative humidity

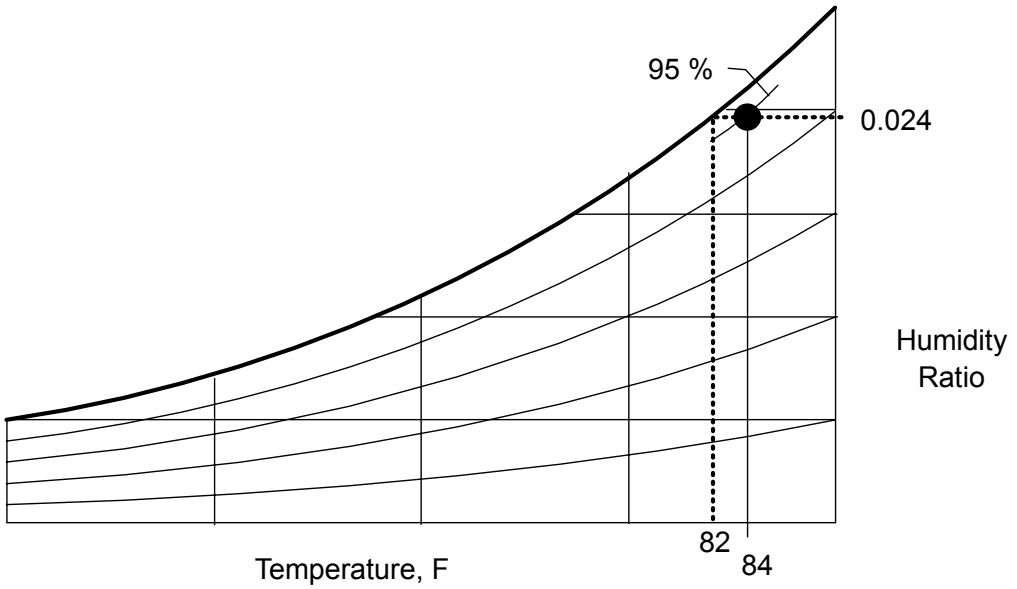


4. As air is cooled down at a constant humidity ratio, its relative humidity will continually increase until it reaches 100%. At that point, any further cooling will result in condensation
5. The temperature at which condensation occurs is called the dew-point temperature (note: there is a unique dew-point temperature for a given humidity ratio)
   a. The plot below shows that air with a temperature of 84 F and a relative humidity of 64% has a humidity ratio of 0.016 and a dew-point temperature of 70 F. In other words, if cooled without a change in humidity ratio, it will reach a relative humidity of 100% (and moisture will start condensing out of the air) at a temperature of 70F



D. CONTROLLING CONDENSATION

1. KEEP INDOOR HUMIDITY LEVELS LOW. As the following plot shows, when the relative humidity of the 84 F air is increased from 64% to 95%, the dew-point increases from 70 F to 82 F. Condensation is tough to avoid when there is only a 2 F difference between the air temperature and the dew-point temperature



2. Minimize shower temperature, duration, and/or frequency
   a. Showers are great humidifiers. They do an excellent job of rapidly dispersing moisture into air, they leave large moisture laden surfaces, and produce large wet towels
   b. Air in a shower facility (and surrounding rooms) can quickly become saturated with moisture. When air is foggy, it is saturated (i.e., at 100% relative humidity)
   c. When room air is saturated, water is generally dripping off every surface. Note that people only tend to notice water on mirrors and windows
   d. To keep moisture off a surface (e.g. mirror), you must heat it up above the dew-point temperature of the air (i.e., stick a hair dryer to it). Wiping it off is only a temporary solution in a saturated environment
3. DO NOT LET MOIST AIR COME IN CONTACT WITH A SURFACE COOLER THAN THE AIR'S DEW POINT TEMPERATURE. This is accomplished by:
   a. Placing water vapor retarders on the warm side of exterior wall insulation
   b. Wrapping cold water pipes and cold air intake ducts with (1) insulation surrounded with a water vapor retarder, or (2) insulation that is an effective water vapor retarder
   c. Not placing items against an outside wall (e.g. pictures, dressers, etc.). Items against an outside wall act as insulators and also prevent proper ventilation. As an insulator, the item will cause the wall temperature to drop resulting in a corresponding increase in relative humidity and possible surface condensation
4. DO NOT PLACE NON-HEATED, NON-VENTILATED SPACES ADJACENT TO AN EXTERIOR (COLD) WALL.
   a. If a closet or some other unheated space is against an outside wall, the temperature in the space will drop considerably during cold weather. This is because the doors on the closet, and the air in the closet, both resist heat transfer (i.e., act as thermal insulators). Moisture entering the closet space will more likely condense on the

exterior walls. This problem is worse behind a blanket (and any other moisture permeable material) that is pushed against the wall
   b. If mildew/mold is a problem in such a space, clean up the problem and remove the doors from the enclosed space.
5. Exterior corners are generally the coldest spots in a house. Corners contain more wood, less insulation, and more joints. They're subjected to higher exterior wind pressures and less interior ventilation than other exterior wall areas. Piling something against an exterior corner (blanket, pillow, etc.) will often result in mold growth behind that object
6. PROPERLY INSULATE AND SEAL THE EXTERIOR WALL SO THAT THERE ARE NO COLD SPOTS
   a. Do not run vent pipes or any other plumbing pipes in an exterior wall if it will affect the level of thermal insulation
   b. Properly install water vapor retarders (i.e., lap properly, seal all punctures)
   c. Minimize electrical wiring in exterior walls. Where a significant amount of wiring is required in an exterior wall (e.g. kitchen) consider building a wall inside of the exterior wall in which wiring can be ran without penetration of the vapor retarder
   d. Use proper techniques to insulate and seal openings in the exterior thermal envelope
7. DON'T LET AIR INFILTRATION "SHORT CIRCUIT" ATTIC INSULATION. This is a problem right above exterior walls. To reduce air movement through insulation, extend exterior sheathing above attic insulation. Without this air barrier, you are more likely to see mold growth in the upper corners of exterior walls
8. DO NOT ALLOW HIGHLY CONDUCTIVE MATERIALS TO "SHORT CIRCUIT" THE THERMAL ENVELOPE.
   a. Mold appears on window sashes in many homes, not because of condensation on the entire glazed area, but because of condensation around the perimeter of the glass unit where metal framing has increased thermal conductivity
   b. Color differences on only those exterior wall surface areas backed by steel studs are due to surface condensation brought about by greater heat loss (an thus lower surface temperatures) in those areas

E. PROPER VENTILATION

1. If you built tight, you must ventilate right. Air infiltration in today's structures is low, thus requiring mechanical air exchange
2. Good year-round air quality requires a system with an air-to-air exchanger (~250 cfm), dehumidifier and humidifier. The typical air-to-air exchanger will only recover heat from exhaust air and add it to the intake air; it will not affect moisture content of incoming air. During winter, incoming air is dry, and will require humidification. During summer, incoming air will be moist, requiring dehumidification
3. To minimize dust mites, mildew and mold, maintain an indoor relative humidity between 40 and 60% in all areas of the building. To adequately provide this in most buildings requires a system with dehumidification and humidification capabilities
4. Without an adequate dehumidification system, opening of windows during summer will generally result in a very high basement relative humidity and aggressive mold growth. This mold growth becomes a more serious health concern when the house is "closed-up" during the winter
5. Most homes rely solely on bathroom and kitchen exhaust fans for ventilation, and have no dedicated opening to bring in make-up air
   a. In such cases, make-up air must be drawn through wall openings by exhaust fans. This negative pressure system may also draw exterior water into wall cavities
   b. For a typical bathroom exhaust fan to run efficiently, make-up air should be allowed to flow freely into a house
6. Improve bathroom exhaust fan efficiently by using smooth ducts with short runs

a. Static pressure drops in most ducts are too high for the fan to move air efficiently
b. Be careful about long uninsulated exhaust ducting in cold attic areas. Air will continue to move through this duct whether or not the fan is turned on. Moisture in this air will condense and freeze. In extremely cold conditions, ice can build up and significantly reduce fan efficiency

7. Switching of bathroom exhaust fans should be humidity controlled

F. KEEPING COMPONENTS DRY DURING ORIGINAL CONSTRUCTION

1. Keep building materials covered until use
2. Avoid interruptions during framing (don't quit until roof is covered). If roofer will be delayed, cover roof with large tarps.
3. Install air retarder (a.k.a. house wrap), window and doors ASAP
4. Allow house to properly dry before finishing
5. Frame in winter
6. Speed framing by relying on more prefabricated components

G. DESIGN TO MINIMIZE MOISTURE PENETRATION

1. Keep water away from foundation walls
   a. Keep building elevation up. Few owners have complained about their own building being too high on a site. Many have complained about it being too low
   b. Properly grade away from the building
   c. Make sure downspouts discharge water away from the house (not into "flower garden" next to house).
   d. Adequately compact backfill so that it does not settle excessively and collect/trap water next to foundation wall
   e. When building in heavy clay, make sure to seal up around foundation wall with clay. Note that once you punch through a clay layer, all water above the clay layer will be directed to the hole in the clay layer
   f. In all soils, top the backfill off with clay and then add the finish surface. The clay layer will help move water out and away from the foundation wall
   g. Where subsurface water is moving toward a foundation wall, a drainage tile slightly below the surface may handle the problem (i.e., you may not have to dig all the way down to the footing)
   h. Use good construction techniques to move water down and away from foundation walls (i.e., use drainage mats, wall sealers, drainage tile, etc.)
2. Use large roof overhangs
   a. Protect siding, windows and doors from precipitation. Prolongs siding, window and door life and minimizes likelihood of moisture getting behind siding
   b. Rain water on "non-guttered" roofs is forced further from house sidewalls. In many cases, gutters can be eliminated when roof overhangs are increased
3. Resist complex roof designs
   a. Avoid valleys and roof-to-wall intersections that are known trouble areas
4. Properly lap exterior materials (flashing, siding, etc.) so that water is not trapped, but properly shed
5. Avoid "non-durable" architectural features