Mold: Ignorance Is Not Bliss

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Whether you realize it or not, mold is part of everyday life. Fortunately, the levels of mold in ambient air have little to no negative impact on us. But under the right conditions, a few types of mold that are harmful to our health can grow in our homes. Mold basically requires the same things to survive as we do: oxygen; food; 60°F - 120°F temperatures; and water. Because of this, and because our homes and buildings are constructed with many materials that are suitable food for mold (wood, paper, and other cellulosic materials), the only way to prevent mold is to control moisture conditions.

If you spot a moisture leak in your home, you should take immediate action to fix the leak and dry the area, as mold can develop within a day or two. Also be aware that just because you can't see evidence of mold within your home, doesn't mean that you don't have it. "Mold thrives in environments where there is a lack of ventilation such as in wall cavities, sub-floors, beneath wall/floor coverings, behind vapor barriers, and behind ceiling tiles," so don't ignore your nose if you smell mold.[1] If you smell mold, first double check that it isn't coming from any food products in the kitchen. You should bring in a certified professional as soon as possible to investigate the potential problem and remediate as necessary. People can react differently health-wise to the presence of mold, so it is best to be cautious.

Here is one homeowners experience with mold (see images to left). This townhome owner first observed a mold smell in one of their upstairs bedrooms. They then noticed a little bit of mold forming around a concealed sprinkler head in the ceiling. Upon further investigation by a mold remediation professional, mold growth was evident on the fire blocking in the vented attic (flat roof). Upon removal of the party wall fire blocking, more mold was visible on the wood trusses. So what appeared to be just a little bit of mold to the homeowner led to the discovery of a major mold issue within this home's attic.

1 http://www.rci-online.org/interface/2002-02-taylor.pdf

FUNGI

- **Molds are surface fungi** that do not penetrate deeply into wood and are not directly responsible for wood rot.
- **Decay or wood-rot fungi**, which develop specialized structures (mushrooms), or thick, fan-shaped sheets of mycelium, dig deep into the wood.
- The most destructive type of wood-rot fungus, **brown rot,** grows "rhizomorphs" that transports water across dry materials to support its growth in otherwise dry wood (hence the "18 inches to untreated wood" requirement in building codes).
- **Most decay fungi need more water** than molds.
- An over-simplification is that **molds are a problem for people, while decay fungi are a problem for structures**.

MOLD

- Mold spores germinate and produce active colonies on porous surfaces, in the presence of food (like wood and paper), oxygen, **moderate temperatures (typically over 65°F, but if enough water is present, down to 40°F)**, and sufficient water.
- Mold goes dormant in cold weather (not killed during winter freezing conditions), but it can be killed by desert heat.
- The optimum conditions for mold growth include **surface relative humidities (RH) of around 80%.**
- **Space RH is not necessarily correlated with material surface RH** (surface can get wet from a leak).
- There is no simple correlation between wood moisture content and surface RH. However, **20% or higher moisture content is a reasonable level for concern.**
- Of the catalysts required for mold growth, **water is the most practical to control in homes**.

Various Ways Water Enters Homes

Unfortunately, in the effort to build tighter, more efficient homes, CARB is finding that quality control oversights in air and vapor barriers can exacerbate interior moisture problems. There are numerous ways in which water can enter a building and cause high enough surface relative humidity (RH) to result in mold growth, but some culprits are:

Rainwater and Groundwater

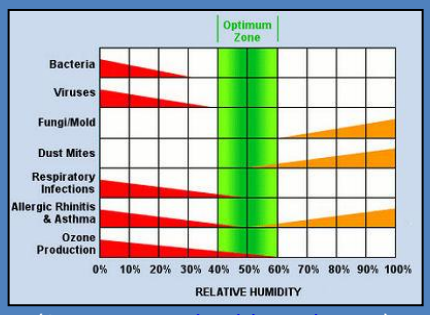
- Clogged, leaky or improperly sloped gutters, clogged downspouts, downspouts that do not sufficiently direct water away from the building foundation (causing rainwater to sit against the foundation).
- Poorly drained sites, where the water has no place to drain (or there is periodic flooding) and there is no reliable sump pump (with backup in case of a power failure).
- Underground water such as an aquifer in porous ground that rises to or above the level of the footings (high groundwater).
- Porches/terraces that settle and drain back toward the building. Note that even if the terrace surface slopes away from the building, the sub-grade under the terrace at the building wall may be lower than the surface grade.
- Dirt floor of a crawl space or basement without a vapor barrier (plastic membrane) or an improperly installed vapor barrier.

Envelope Water Leakage

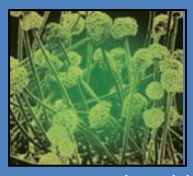
- Through deteriorated or improperly installed shingles and siding.
- Around improper or deteriorated roof flashings, especially at valleys, skylights, dormers and porch roofs.
- Through ridge vents during windy rain or snow storms.
- Around improperly flashed windows and doors.
- In older homes, from water dammed on the window sill.
- Through porous chimneys, cracks in the mortar, and down uncapped chimneys.
- Through imperfect joints in low-slope roofing.

HUMIDITY AND INDOOR ENVIRONMENT

- Research has shown that indoor relative humidity affects thermal and respiratory comfort. It impacts perception of indoor air quality (IAQ) and the energy consumed for conditioning. High relative humidity also favors growth of dust mites, molds and bugs. In the presence of moisture accumulation in the home, moisture induced damage may occur. According to EPA, indoor relative humidity levels less than 50% prevents growth of dust mites, mold, mildew and any bacterial growth while maintaining thermal comfort.



(Source: www.healthgoods.com)



Magnified images of dust mites and mold spores (Source: www.thermastor.com)

- Very low humidity levels can be unhealthy. Dry air causes dry, rough and flaky skin. Respiratory passages such as the nose and throat lose moisture from their membranes causing dryness and irritation. Low levels of humidity can also contribute to respiratory infections, allergic and asthmatic symptoms and an increase in airborne dust and allergens. According to the ASHRAE's website, a good range for relative humidity in homes is 30 to 60%.

Piping, Plumbing Fixture and Appliance Leaks

- Leakage at showers and tubs: The most typical leaks occur at the top of a tub or around faucets. The joint at the bottom of the tile is often too thin or grout is used instead of caulk, so it cracks and lets water in.
- Unconnected or poorly connected waste or water lines.
- Pipes in unconditioned space freezing during the winter and bursting.
- Leaking valves.
- Exhaust fans or dryer vents that discharge into cool spaces (attic, crawl space, etc.).

Cold Weather Effects

- Wind blowing away insulation at eaves, allowing cold air to continually wash against back of ceiling gyp board, causing condensation.
- Very common case: air gets into the floor or ceiling system through the eaves or alongside beams and runs the length of a joist cavity, creating a continuing flow of cold air that cools inside surface, causing condensation.
- Slab-edge condensation: cold slab edges very commonly cause condensation in carpets at the edge of the building.
- Ice dams (typically caused by interior heat leakage to the attic) causing water leakage into wall cavities
- Attic condensation/ice caused by air leakage from the interior. For minor amounts of leakage, attic ventilation can carry away the water vapor. For major air leakage, ventilation can make things worse by inducing air flow out of conditioned space, and cannot carry away much water. Careful sealing of the ceiling plane is the best solution.
- In SIP or cathedral ceilings, poorly air sealed construction details can induce (stack effect) a continuous flow of warm inside air to cold surfaces (roof deck) and potentially creating large amounts of condensation. The indoor air does not have to be particularly humid to create damage.

Humid Weather Effects

- Improperly placed vapor retarder behind the gypsum board can cause condensation in the wall cavity if there is outside air infiltration.
- When air conditioning, leaky or poorly insulated ductwork in attics can lead to condensation forming.

VAPOR DRIVE - CLIMATIC FACTORS

In **Cold climates,** the common practice of installing vapor retarders on the room side of wall insulation reflects the reality that indoor air humidity is higher than outdoor air humidity for much of the year. In this case, **kraft-paper or polyethylene vapor retarders** resist the diffusion of water vapor from household moisture sources into wall cavities. However, even if cold-climate building assemblies tend to dry to the outside, there are times when there is the potential for moisture diffusion in the opposite direction. In summer, **air conditioning can force vapor flow in the opposite direction**, with cold, dry air on the inside, and hot, moist air from the outside being forced in. This doesn't mean that there is a mold epidemic behind polyethylene vapor retarders in cold climate homes. It is likely that the brief instances of high afternoon humidity behind the vapor retarder are too short to trigger mold growth, but using a **smart vapor retarder** that changes permeance based upon the relative humidity, such as CertainTeed's MemBrain, is one option to alleviate this potential for moisture build-up.

Intense solar radiation and moisture are two significant problems in **Hot and Humid climates**. High humidity conditions and high rainfall cause an increase in moisture in the outdoor air. Since air conditioners are installed in most homes, there is the risk of condensation occurring on these interior cooled surfaces. **Controlling the infiltration** of ambient moisture-laden air into the building envelope and keeping moisture away from cold surfaces are major goals of high performance design and construction in this climate zone. The use of a **whole-house dehumidifier** or **keeping the home positively pressurized** can reduce the potential for moisture within the building envelope.

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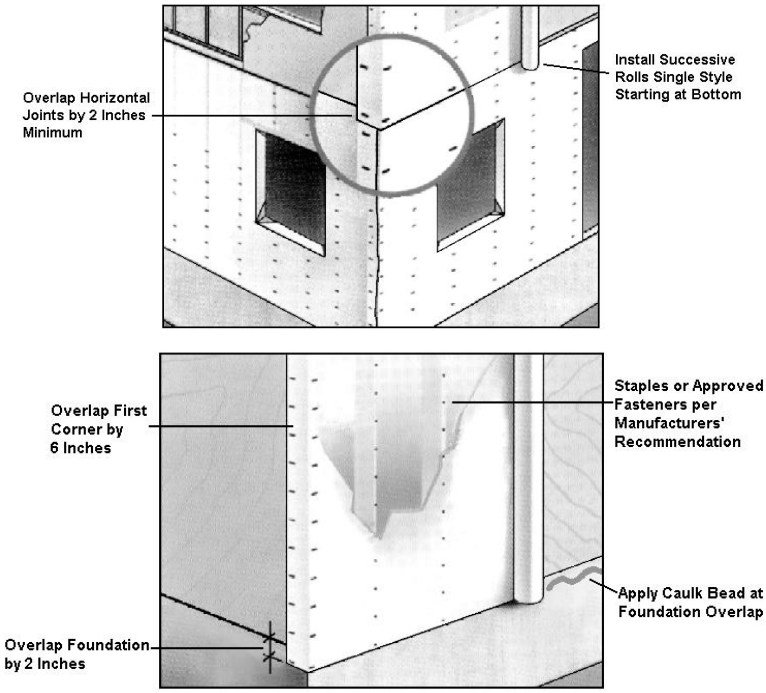
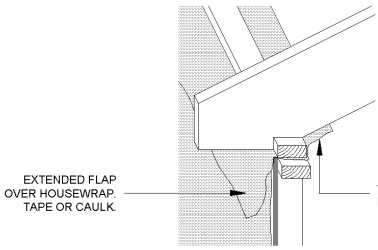
How to Prevent Mold/Moisture Problems

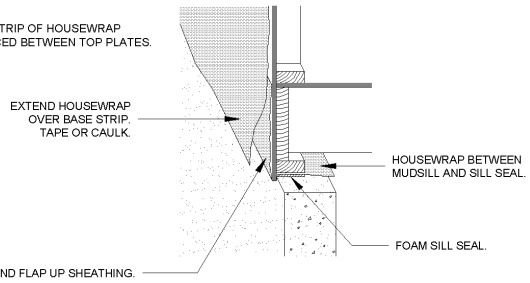
The key to preventing moisture problems is to have a well implemented durability plan during construction/renovation and to maintain those elements of the home over time. The durability plan should focus on methods to provide proper drainage and moisture control throughout the home. A best practices guide is provided by the Environmental Protection Agency (EPA) and is referred to as the Indoor airPLUS Construction Specifications (click here). Some common features that need to be addressed in a durability plan are presented below.

House wrap should be properly shingled with a 6" overlap horizontally, taped at the seams, and secured to the foundation. House wrap should be installed with a head and sill lap.





Head Lap



Sill Lap

ADDITIONAL MEASURES TO MAINTAIN A BUILDING'S DRAINAGE PLANE

- Make sure that all fenestrations (openings for windows, doors, and skylights) are properly flashed to maintain a continuous drainage plane on the exterior of the building assembly. For details showing the proper sequencing for moisture control around fenestrations, a good resource is EPA's Technical Guidance to the Indoor airPLUS Construction Specifications, located here.

- Several items to address at the roof line are (1) proper flashing at the chimney to roof edge, (2) proper gutters to collect rain and divert it away from the homes foundation, (3) proper installation of shingles to shed water, and (4) brick and mortar maintained in good condition. Kickout flashing can also be used to divert water from the side wall of a building where a roof abuts a wall.

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Just because it is out of sight, don't forget about the foundation. A waterproof barrier should be applied to the exterior of the foundation surface. In addition, foundation drainage (French drain, sump pump, etc.) should be provided to divert water away from the home. See the side bar for additional considerations.

Controlling Foundation Moisture:

- 2" exterior insulation provides a continuous R-10 thermal break along the entire perimeter of the foundation, which results in the concrete foundation wall being warmer, thereby reducing the condensation potential on the interior wall surface.
- Insulation and water-proofing membrane blocks water vapor transmission / diffusion from the exterior to the interior.
- Moisture laden air leakage into the basement can result in condensation issues, so it is recommended that the rim/band joist and sill plate are air sealed with a spray foam application of at least 2".
- No sealer should be placed on the interior wall surface. This allows the wall assembly to dry to the interior, rather than being trapped in the wall assembly.
- Regardless of how well a basement is constructed, a dehumidifier may be needed to maintain a dry basement (especially in the first two years after construction).

Maintaining Your Foundation:

- Regularly check foundation for dampness, leaks or cracks. The sooner foundation damage is identified and addressed; the less aggravation and cost will be associated with the repair.
- Make sure vents and ductwork are sealed to assure additional moisture is not introduced into this space.
- Regularly check water pipes for leaks or cracks.

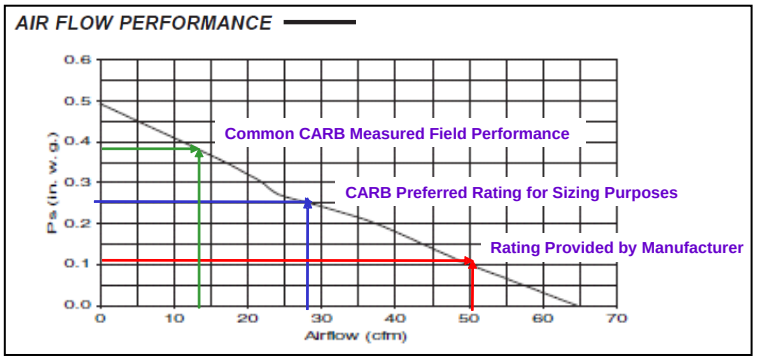
FOUNDATION DRAINAGE:

- Exterior surface should be water-proof (commonly urethanes, modified asphalts, clay based, or rubber based) and not simply damp-proof (generally asphalt or tar based compounds).
- Slope grade away from foundation a minimum of 6" in the first 10'.
- Rain gutters run at least 3' from house perimeter or refer to the International Residential Code 2006: Section R801.3.
- Around the foundation wall exterior, crushed stone and a 4" (or larger) perforated drainage pipe with a filter fabric should be installed next to the footer to divert water away from the foundation during rain events. In poorly draining soils, a sheet drainage material (e.g. black polyethylene) can be used over the exterior insulation to enhance the movement of water to the foundation drain and reduce hydrostatic pressure against the outside of the wall.
- 4" (or more) crushed stone and 6+ mil polyethylene vapor barrier below the slab will provide a capillary break to prevent moisture from wicking up through the slab.
- Depending on the local water table, a sump pump may need to be installed. This system should include back-up power and a solid sealed lid.
- Soils with significant clay or organic matter will retain water for extended periods. If these conditions are present, additional drainage measures may be necessary.

- Ground water has little or no long term affects on most water-proofing membranes. Usually these membranes retain their elasticity in case of small foundation cracks.
- Backfill may settle over the first year. Regrade exterior landscaping as required to maintain drainage away from foundation.
- Regularly clean gutters to allow roof run-off to be directed away from foundation.

Controlling Indoor Relative Humidity:

- Properly address indoor point source (i.e., showers and cooking range) moisture control. Common practice is to put a 50 cfm rated exhaust fan in most bathrooms (see side bar in reference to cooking range hoods). In some instances, an 80 cfm rated exhaust fan is installed in the master bath. Most bath fans deliver their rated flow at pressure drops of 0.1 inches of water gauge (wg). As a reference, this is roughly the pressure drop created by 50 CFM of flow through a grille, 5 ft of 3-inch flex duct, and a wall cap for the fan...that's it. It's best to use the rated flow at 0.25" wg to meet the recommended or required flow rate, since this is more likely to be the typical static pressure when fans are installed. A typical fan rated at 50 cfm @ 0.1" static pressure will operate closer to 23-31 cfm at 0.25" static pressure. An 80 cfm fan at 0.1" will operate at roughly 48-57 cfm at 0.25" static pressure.



- People generate moisture, so if you are having a large party, turn on the bathroom exhaust fan or open windows (as long as it is not too humid outside). Fish tanks can also increase indoor relative humidity. If you notice condensation on the interior of your windows, additional ventilation may be needed.

HOMEOWNER MAINTENANCE:

- Run bathroom exhaust fans for an additional 15 minutes after taking a shower. A delay-off timer can be installed at your fan switch to automate this control.
- When cooking, make sure to use the kitchen hood to directly exhaust local moisture to outside. If the kitchen hood recirculates (typically through a charcoal filter) rather than exhausting to the outside, open a nearby window or turn on a nearby bathroom exhaust fan. A quick way to know which type of kitchen exhaust you have is to open the cabinet above the range and see if there is a duct running up.
- Use a dehumidifier in the basement. It is most convenient if the dehumidifier can be directly connected to a drain rather than having to empty the catch basin from time to time. It is especially, important to run a dehumidifier in basements for the first couple years after pouring of a concrete foundation, as the foundation will continue to release moisture as it cures.
- The exhaust of clothes washing machines should be ducted to the outside (the most direct path should be used to minimize duct run length). Annual cleaning of the exhaust ductwork to remove lint is recommended.
- Have your air conditioner serviced at least every other year (every year is preferable) to ensure it is operating correctly. The air conditioner is able to remove some moisture from the indoor air when operating. Depending on your air handler unit, it might be possible to lower the cooling flow rate to increase the capability of your air conditioner to remove moisture. Talk to your HVAC contractor about this.
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If Mold Is Present

If mold is found in the bathroom (tub, tiles, shower curtain), on a windowsill, or sink, this mold can be wiped off the surface with a damp cloth and cleaning agent (e.g. window/bathroom cleaner).

If a small amount of mold (less than one square foot) is found elsewhere in the home, identify the source of excess water or moisture, fix the leak, and then clean up the mold. Wash mold off tough surfaces with detergent (or chlorine bleach) and water, and dry totally. For porous materials, a more aggressive solution (e.g. hydrogen peroxide) should be used to kill the mold. If mold is found in absorbent materials (e.g. ceiling tiles & carpet), they may have to be replaced.

When cleaning moldy surfaces, wear gloves, goggles, and long sleeves to not expose your skin. To limit airborne exposure, wear a respirator (half-face breathers can be purchased at your local hardware shop). Make sure to adequately ventilate the space you are working in by opening windows and turning on exhaust fans to get some fresh air.

If the cause of the mold can not be identified and/or if the mold growth is greater than one square foot, it is recommended to hire a mold consultant specializing in building assessments to evaluate the entire home. See the side bar for additional considerations.

An excellent resource is the Canada Mortgage and Housing Corporation's (CMHC) "Clean-Up Procedures for Mold in House" document. In the end, if you are not sure what to do, it is best to seek the guidance of a certified mold specialist.

For more information or comments, contact Srikanth Puttagunta at sri@swinter.com

MOLD REMEDIATION:

- If there are **infants or occupants within the home who are immune compromised, elderly, asthmatic, had recent surgery, or have any other medical condition** that might be aggravated by construction dust or other debris, they should **evacuate the building** until the mold remediation has been completed..
- The Remediation Contractor should **properly seal off the work area**, including creating a negative pressure to insure dust and other potential allergens are not carried into the surrounding areas of the home. If fans are to be used to dry out the wet area, proper containment must be utilized to avoid spreading the mold. All items should remain in containment until the level of contamination is determined. Items should only be removed after proper cleaning and decontamination. **The Institute of Inspection, Cleaning and Restoration Certification (IICRC) S520 Mold Remediation Standard** provides guidance on mold remediation requirements.
- Seal off and **do not use the HVAC or home's exhaust systems**. Replace the home's HVAC filter following the remediation.
- During the mold remediation, make sure that the **cause of the moisture has been addressed**.
- **Document all remediation efforts**, including the location and approximate size of contamination. Pictures should be taken before, during and after the remediation process to act as additional documentation.