Mold: Causes, Health Effects and Clean-Up

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Mold

Mold requires water. No water, no mold. Mold is the result of a water problem. Fix the water problem. Clean up the mold. And you have fixed the mold problem.

To avoid mold problems, avoid water problems. Design and build in a manner that reduces water problems.

Mold also requires food. The food it likes best is cellulose – the more processed the better. Mold really likes wet paper. It kind of likes wet wood, but not as much as it likes wet paper. It likes processed wood better than it likes real wood. So mold likes oriented strand board (OSB) better than plywood and plywood better than a stud or a joist. Mold also likes the feces of cockroaches and dust mites, as well as some pastes, paints and adhesives.

Just because something gets wet, it doesn't mean it will get moldy. It needs to be wet for a while. Wet paper needs to be wet for a couple of days. Wet wood, for a couple of weeks. And it also needs to be warm. Warm, wet paper that is wet for a while is a problem. Because it usually takes time for mold to grow, promptly drying the building after a water event will prevent a mold problem from developing. Of course, make certain that the underlying problem that caused the water problem is also corrected.

There are always going to be water problems. But if you fix the water problems quickly enough you won't have mold problems. You want to be able to see a water problem right away if you have one so that you can fix it right away.

Water problems that you can't see for a long time are the type of problems that lead to bad mold problems. For example, wet paper faced gypsum board that you can't see is a problem. Like from a small plumbing leak. Especially in an exterior insulated wall. Why an insulated wall? The insulation reduces the ability of the water to drain and leak out so that you can see it. Also, the insulation reduces energy flow across the wall thereby reducing the rate at which the wall dries out. Also, a pipe in an exterior wall is more likely to have condensation on it especially in the south, and pipes in exterior walls freeze and break – even in the south.

One cavity insulation versus another doesn't matter much from a mold risk perspective. Cellulose insulation is paper based, but it is also treated with chemicals (borates) that suppress mold growth. Fiberglass does not support mold growth, but it gets dirty, and the dirt grows mold ,and it is often paper faced and this paper grows mold. In addition some fiberglass insulation contains urea based binders that do support mold growth. Fiberglass tends to concentrate the water locally whereas the cellulose insulation distributes it more. You need less water to cause a mold problem in a fiberglass insulated wall than you do in a cellulose insulated wall because of this concentration effect. However, the fact that cellulose distributes the water better also makes it harder to spot a leak. So which to use? From a mold risk perspective it doesn't matter one way or the other. The best thing to do is not put pipes in the exterior walls.

What about rainwater leaks and the type of insulation? With a little bit of rainwater leakage, cellulose works better than fiberglass because it absorbs the rainwater, redistributes it and then lets the wall dry in a controlled way (assuming you have designed the wall to dry). With a lot of rainwater leakage, fiberglass works better than cellulose because you see the water sooner and realize that you have to fix the leak. Rainwater leakage is different from pipe leakage because rainwater leakage is more intermittent – that makes it less of a problem than a constantly leaking pipe from a mold perspective. Cellulose is nice with a little bit of rainwater leakage if the wall is designed to dry. Fiberglass is nice with a lot of rainwater leakage. But what does a little bit or a lot mean? It's best not to have rainwater leakage get into wall cavities. That's why you need drainage planes (building papers, housewraps, or foam sheathing) to direct water from window and cladding leaks down and out of walls.

You shouldn't choose your above grade cavity insulation based on a mold risk perspective. However, all of this changes below grade. Don't use fiberglass or cellulose below grade on the inside of basement or crawl space assemblies. Use only rigid foams that are semi-permeable (no foil facings). Why the difference below grade? You can't dry to the outside below grade and the surfaces are a lot cooler both in the summer and in the winter

Leaky windows are also a problem. If a small leak into a cavity that you can't see continues over a long period of time a problem will develop if the cavity can't dry quickly. It's even worse if the wall isn't designed to dry at all. That's why you need pan flashings. Same for doors – doors leak too. Pan flashings under doors and windows collect water from window leaks and safely direct the water away from the wall assembly.

Leaky windows are more of a problem than leaky roofs. Why? Roofs don't often leak into small-enclosed cavities (i.e. walls). And you typically see a roof leak right away, so you can fix it before mold has time to grow.

Health Effects and Risk

Mold, especially mold spores are everywhere outside. Mold is on everything we build with and everything we bring into a building. Remember we build outside. We turn a piece of the "outside" into the inside as the construction process progresses. Therefore mold will also be inside. And remember it's often wet outside. What's worse is that construction is also a wet process. It is not possible or practical to have a mold free building. Just like it is not possible to have a mold free outside. We just don't want a lot of mold inside and we don't want any mold that is actively growing. We especially don't want a lot of mold or mold that is growing where you can breathe it.

We're not sure what "a lot" means, but we are pretty clear about the "growing" part. We're also not sure about the "where you can breathe it" part either because we don't know where that is with certainty.

We humans share the planet with mold. They were here

before us and they will likely be here after us. We pretty much have gotten along reasonably well with mold these past 100,000 years we humans have been around. So what has changed recently? Why the mold hysteria and why now?

We notice things more now. And we expect and demand more. Fewer of us are dying in wars and from disease and hunger. When you are starving and are in fear of getting your village burned and pillaged you don't worry about mold. In North America we've conquered most of the really bad diseases like smallpox, typhoid fever, cholera, malaria and bubonic plague. We're now working on the lesser diseases like heart disease, cancer, allergy and asthma.

We've always had some moldy buildings. But more recently we are building with different materials in different ways that lead to more mold and different mold. We use paper faced gypsum board instead of plaster and lath. We use OSB instead of wood boards or plywood. We use much more insulation. We have air conditioning. We stick ceramic tile on green colored paper-faced gypsum in bathrooms. We have wall-to-wall carpets. For these reasons we not only have more mold in buildings, but we also are more likely to notice that mold. The typical person also spends more time indoors now than 50 years ago.

Allergy to some molds is clearly a problem for individuals with a predisposition (tendency) to developing allergy. We do not know how much exposure to mold is necessary to initiate the allergic response to mold. Once the allergy has developed, however, exposure to very small amounts of mold (the allergen) can cause symptoms. Some people with allergy to mold only have problems with itchy eyes, runny nose and sore throat; others also have asthma and can develop breathing difficulties when exposed to mold.

Asthma affects lots of people, and some molds are triggers for asthma. The mold-asthma connection is really the heart of most of the mold worries. What is not proven is whether exposure to mold can lead to the development of asthma. The more we study asthma and mold, the more we discover about how mold affects us. It is beginning to look as if some of these mold effects are not particularly nice. We're not quite sure yet if it's really bad, or just a little bad for many of us. Clearly some individuals tolerate exposure to high levels of mold without any apparent adverse health effects.

If mold were as bad as some say we would have to ban farming; all composting would be a superfund site; you couldn't cut your grass without a respirator; and most of us would already be dead. On the other hand there is something clearly behind the mold issues from at least the circumstantial evidence side. At present though, the science is really quite thin and we mostly have stories – anecdotal evidence.

In addition to allergic disease, mold can cause infectious disease in some people. Most of these people are more susceptible to infections because their immune (defense) system has been weakened by other diseases such as cancer or HIV (AIDS) or by medical treatment. Transplant recipients (heart, lung, kidney) receive medicines to prevent rejection of the transplanted organ that also weakens their immune system. These individuals are at increased risk for acquiring fungal infections; the mold can actually grow inside their bodies. In some cases, fungal samples taken from the patient's body were identical to fungal samples taken from the hospital room occupied by the patient. In these unusual, fortunately rare cases, we can be fairly certain that the patient became infected by the fungus growing in the hospital. In most cases of disease allegedly cause by mold, no such conclusive evidence is available. There also are a few fungi that can cause infections in healthy people, but these fungi rarely grow inside buildings.

Some molds also make powerful chemicals called mycotoxins that are released under special circumstances. We think that these mycotoxins are directed against other types of mold and bacteria. For example, we use the drug penicillin to fight certain bacterial infections; penicillin is a mycotoxin produced by Penicillium mold. Another mycotoxin, cyclosporin, is a power immune suppressant that we use to treat patients who have received transplanted organs. There are many other mycotoxins that we know much less about. Some of these have been implicated as the cause of illness in people who have lived in very moldy houses. The press has reported stories about individuals who allegedly died or were made very sick from mold; powerful mycotoxins have been implicated. However, we currently do not have the technology that allows us to measure mycotoxin levels in blood or tissue. Therefore we can neither measure exposure nor say with certainty what is responsible for the symptoms or disease.

Unfortunately there is too much about mold and its possible effects on human health that we do not know. We do not know what constitutes "a lot of mold" or whether a short brief exposure to "a lot of mold" is worse than chronic exposure to "a small amount of mold." This is complicated by difficulties in determining exposure levels when mold is definitely present in a building. Just because you have mold in a house doesn't mean that you have been exposed to the mold. And when we mean exposed we mean that mold or a piece of that mold or mold spores or mycotoxin has gotten into your body by inhalation (breathing) or ingestion (eating) or absorption through your skin. The mere presence of mold in a house does not constitute exposure to that mold. And even if some mold has gotten into your body it doesn't mean your going to get sick. And if you do get sick it doesn't mean you are going to stay sick. Or that you are going to be permanently affected.

Even if you have symptoms that are consistent with exposure to mold that does not definitely mean that you have actually been exposed to mold. Your symptoms could be due to lots of other things besides mold. The fact that you have a disease diagnosed clinically (by a real doctor) caused by mold and that you live in a house with that particular type of mold does not mean that you got sick because of exposure to the mold in the house you live in. It could have happened somewhere else. Of course if you have lots of that type of mold all over your house in locations where it easy to breathe a lot of it and you have a clinically diagnosed disease linked to that particular type of mold the probability is pretty high that you got sick because of exposure in your home – but we couldn't absolutely positively say for sure.

Most mold disease stories are just stories at this particular time. The science is really thin at this time. Over time the science is going to get pretty tight. Science will

probably say that yes lots of some bad molds can make some people really sick. We will get pretty good ideas at how much of what type of mold in what type of person is bad. We don't know this yet. We will actually get medical tests that will say this person was exposed to this type of mold. We don't have these types of tests yet – except under extremely limited situations (we find the mold growing inside of someone).

Now even if the science on the medical side gets good, we still have huge uncertainties. The problem of assessing actual exposure is also quite difficult.. It is almost impossible to track mold or prove that mold has gone from a specific location into your body. We can find mold on a surface. We can find mold in the air – sometimes. But we can't prove that the mold on a surface got into the air and then once in the air it got in your nose. And even if we could show that the mold in the air got in your nose, it's almost impossible to show that the mold in the air or in your nose has a toxin or enough of a toxin to make any difference.

The press has widely reported on the couple in the Pacific Northwest who burned their house down after settling their law suit for water damages to the building only. There was no money for "pain and suffering" and health effects. This house had really stupid construction problems. It had a wet crawl space containing leaky ductwork. It also had leaky ductwork in the attic. The leaky ductwork in the crawl space and in the attic caused the house to have a huge negative air pressure – it sucked. It sucked the moisture and mold out of the crawl space and into the house. Also the roof leaked, the walls leaked, and the roof was not vented. We were surprised that the house could actually be burned because it was so wet. Were the people sick because of mold in their house? Were they in fact sick? It's hard to tell. Do we believe it? In this case we do because we are familiar with the house. But we certainly couldn't prove it.

That big expensive Texas mold law suit is particularly instructive. The judge would not allow testimony on the causal relationship between mold and health effects because the information relating to mold and health effects would not pass the Dalbert test ("junk science" test). No scientific consensus exists at present on the health effects of mold. The Texas case involved a huge expensive house that had a leaking pipe that for really stupid reasons did not get fixed and the house got really moldy and really wet. The money went to rebuild the house to get rid of the mold, not to the couple who owned the house because they were sick. The jury also punished the insurance company for not fixing the water problem promptly and cleaning up the mess.

How did the court decide that the house was moldy? Easy, you could see the mold on everything and you could smell it. The costs were based on what it would cost to throw out the moldy stuff and replace it with stuff that was not moldy. Plus a quantity of money to punish the big bad insurance company – or at least get their attention.

Bottom line, living in a moldy house is not a good idea. We wouldn't do it. Your customers shouldn't live in moldy houses. But most of the health effects are uncertain and unproven. And there are no standards for mold levels or consensus on risk. How do we know if a house is moldy? If you can see it or smell it. How do you know when you are clean? You can't see it or smell it.

Prudent avoidance is the best course of action. Build houses to minimize the likelihood of water problems. When water intrusions or leaks occur, dry the building quickly to prevent subsequent mold growth. Fix the underlying problem that caused the water problem. If mold is detected, clean it up quickly and safely; then fix the water problem that caused the mold.

Strategies

What we want to prevent is having mold germinate, grow or amplify inside. We want to prevent mold reservoirs from becoming established inside. And most importantly, if we have a reservoir inside, we don't want the mold, or pieces of mold migrating from the reservoir throughout the house.

Generally, but not always it is better to have less mold inside than outside. The problem is that in the winter there is usually no mold outside (it's cold, mold doesn't like cold) and it is really difficult to measure or decide what "more" or "less" is.

Also, it is desirable to have the same types of mold inside as you have outside and in the same percentages. But it is difficult to measure percentages and even more difficult to decide when the percentages are really statistically (meaningfully) different.

In general most people think it's bad to have more mold inside than outside and to have this inside mold different from the mold you find outside.

Risk Areas

(In order of decreasing risk)

Leaky Plumbing

- Don't put pipes of any kind in exterior walls. Not supply pipes, not waste pipes.
- Get rid of green board (paper faced gypsum board with green paper) in wet areas – use cement board.
- Don't ever put water heaters in attics or on the second floor. Put water heaters on a concrete slab – in a basement, in a garage or inside on a slab-on-grade near a drain with the floor sloping to the drain.
- Install a condensate drain under air handlers to collect water that drips from the coils. The best location for air handlers is inside the conditioned space on a slab near a drain just like the water heater.
- The same goes for the clothes washer. Don't put clothes washers on the second floor. Those rubber hose connections are awful. Expect a leak. Drain the water that will inevitably leak with a floor drain in a laundry. Locate a water shut off for the clothes washer than can be accessed easily without having to move the clothes washer. Same thing for the water heater. Dishwashers leak. Drain them with a drain pan. Assume everything can and might leak, sooner or later.

Site Grading

- Drain/slope grade away from building.

- Drain/slope driveways, decks, porches, patios away from building.

Crawl Spaces

- Don't build crawl spaces. If you must build a crawl space build it in a conditioned manner like a "mini-basement". Insulate the perimeter with rigid insulation, don't insulate between the floor joists. Install a sealed continuous ground cover. The best crawl space is one filled with concrete and called a slab.

- Don't vent crawl spaces to the outside. Since crawl spaces communicate with the rest of the house, treat them as part of the house. They should be conditioned and dry.

Ductwork in Slabs

- Ducts leak. Don't put ductwork in slabs or under slabs. Pipes in slabs or under slabs leak allowing soil gases to get into the pipes. You can never fix them. In the summer they condense air.

Sand Over Poly Under Slabs

- Don't put sand or pea gravel over polyethylene under a concrete slab. Always put the concrete in direct contact with the polyethylene. Sand becomes a reservoir. Pea gravel becomes a plenum negating the value of the polyethylene.

Insulated Basement Foundations

- Insulate on the outside if possible. If you insulate on the inside use only rigid semi-permeable foam. Don't insulate with "blanket" insulation or polyethylene covered insulation in stud walls. These walls can only dry to the inside; impermeable materials such as polyethylene prevent drying.
- Don't use fibrous insulation below grade. Garden apartments are the biggest concern. Interior air gets behind the insulation and condenses in the summer time.

Leaky Windows and Doors

- Pan flash all openings. For slab-on-grades depress the slab at door openings.

Interior Vapor Barriers

- No polyethylene interior vapor barriers except in very cold climates (8,000 heating degree days or greater).
- No foil faced reflective insulation on the interior of masonry walls (this is a Florida issue). Use semi-permeable foam on the inside of masonry walls.

Leaky Walls

- Drainage planes under all cladding systems in all climates except with masonry walls (i.e. Florida).
- Two layers of material under all stucco walls (foam and a paper; or two layers of paper).
- Brick veneers need through-wall flashing at bay windows.

Leaky Roofs

- Flash, flash and flash. Inspect, inspect and inspect.

HVAC Leaky Ducts

- Don't put ducts in exterior walls or in vented attics or vented crawl spaces.
- Don't put air handlers in garages. If you ignore our advice and still put them in vented attics or in garages, always test ducts for tightness (i.e. test every installation so that it leaks less than 5 percent of the total air flow provided by the air handler.)

Internally Insulated Ducts (ductboard)

- Don't use ductboard. You can never clean ductboard. It gets dirty and it gets wet and it grows mold.

Window Condensation

- Get rid of single glazed aluminum non-thermally broken windows except in south Florida.
- Use double-glazed vinyl frames. Stay away from wood frames unless clad with aluminum or vinyl.
- Add controlled mechanical ventilation to all houses (outside air duct to return side of air handler).
- Install fans in all bathrooms and toilet rooms and vent them to the exterior.
- Install kitchen range fans that are vented to the exterior. Do not install recirculating range fans.

General

- Use foam sheathings – they don't absorb water. Use borate treated OSB for wall sheathing (not necessary for roof or floor sheathing) – stay away from CCA treated products. For treated plates, use borate treated plates, avoid CCA. Back prime all wood trim. Seal end cuts. Back prime all wood based siding. Get rid of as much exterior wood trim and wood siding as possible. Get rid of wood siding unless you are going to back prime and back vent it. Go to aluminum, molded plastics, fiber cement, etc.

Mold Testing

Don't test for mold. If you see it or smell it you have it. You don't need to know what species it is to deal with it. You should deal with all mold exactly the same way. Fix the water problem that caused it. Replace the water damaged materials. Clean up the mold, dust and mold spores.

If for some inexplicable reason you decide to test for mold insist that the report contains only the following things:

- Who did the test and when?
- Where were the samples taken and how?
- How were the samples analyzed?
- What the results of the analysis are?

The report should contain absolutely no interpretation.

It should not say the results are good or that the results are bad. It should not say what molds are bad or what molds are good. It should not say anything except what is noted above. There are no standards addressing acceptable levels or unacceptable levels. There are no standards that say this is clean or this is dirty.

How do you know if you have cleaned up well enough? Common sense. You can't see the mold anymore on the surfaces that were originally moldy. Then do the white glove test for everything else. No dust. Clean everything else for dust and everything else will be clean of mold.

Mold Clean Up

Follow the New York City guidelines for buildings that are occupied or for buildings that are closed in and have carpet but are not yet occupied. Read those guidelines.

For everything else, use soap and water and elbow grease. If the mold doesn't wash off of gypsum board, remove the contaminated area. But, tape plastic over it before you cut it out. For rotted wood, cut it out. For moldy wood, clean it with soap and water and elbow grease. Do not sand it. If you have to sand it to clean it, it's not mold, it's rot. If it's rot, cut it out and get rid of it. Put everything in plastic as you cut it out. Don't carry material throughout the house unless it is bagged. Wood may be permanently stained (discolored) after you've cleaned it. It this bothers you, paint it with latex paint (because latex paint breathes).

We want to avoid spreading mold spores and mold body parts during the clean up. Think of mold spores and mold body parts as ultra-fine drywall dust. Keep the dust down. Keep it contained. Bag the stuff and toss it out. Turn off the furnace or air conditioner before you do anything.

For areas that are more than 10 square feet (approximately) hang some plastic sheets to contain mold and dust in the immediate area. Do this the same way you would do a renovation involving lots of plaster cutting and sanding. Except do it carefully. And wear a mask. And use gloves. Use a N95 mask. You can get it at most home improvement stores.

To be real slick, get a small saw with a vacuum attachment and hang the vacuum out a window. Or get a vacuum with a HEPA filter.

When you clean, vacuum everything with a HEPA filter equipped vacuum. Damp wipe with one time use rags. Get rid of the dust. If you are unsure about the carpet, toss it out and replace it. Put it in a bag first before you drag it through the house.

Do not sand wood in an attempt to remove mold: use soap and water and elbow grease.

Bleach is NOT recommended as part of the clean-up. Why? Remember, clean-up means mold removal. To remove the mold, it is not necessary to kill the mold. Bleach is an irritant to eyes, skin and the respiratory tract (nose, throat and lungs).

Develop a policy and train your people. The policy should have a couple of components:

- How to handle mold during construction before a house is closed in.
- How to handle mold during construction after a house is closed in but before interior finishes such as carpet are installed.
- How to handle mold during construction after a house has interior finishes such as carpet but before it is occupied.
- How to handle mold after a house is occupied.
- How to respond to customers concerns and questions about mold.

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