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WHY MOLD AND OTHER ILLS ARE FOUND IN A CRAWL SPACE

There is so much hype about mold in homes these days that we want to take a look at the problem from a practical and technical point of view.

Mold is everywhere! In the air we breathe, in the food we eat, even on the clothes we wear. There are over 100,000 different kinds of mold, some (about 400) are dangerous (e.g. Stachybotrys). There are also beneficial molds, and without them we would not have penicillin or blue cheese. When you search the Internet for "mold" you get almost 10 Mio hits, of which about 100 have educational value. Nothing seems to be safe from mold.

On any given day, there are up to ten thousands mold spores in a cubic yard of air. Most people can tolerate this, maybe sneeze a little, but for the unfortunate few, who are allergic to mold spores, this can be very unhealthy. Since these little organisms are most likely older than mankind and better mutated, it seems that we have to follow their rules and not ours!

What does mold and mildew need to survive and grow?

- They need moisture
- They need a nutrient
- They can be dormant for a long time by forming spores.

Inside a house we can control the moisture. Air conditioning helps almost all the time. We cannot take the nutrients away. We can only "poison" these nutrients (on various surfaces), but that might cause other health problems.

Controlling **moisture in the crawl space** it is an entirely different matter. Crawl spaces are most commonly used in the Southeast, which has high summer humidity and lots of moisture in the soil (clay). Nutrients are everywhere (wood structures, dust particles in the insulation and in the soil). Mold spore counts in crawl spaces are always high, up to 10 times higher, than in outdoor air.

Note: we are not talking about catastrophic floods. Crawl spaces, basements and sheet rock walls saturated with water need special attention.

Almost all southern states building codes concerning crawl spaces are geared towards preventing wood rot (termites) and not mold. Natural ventilation is considered adequate as long as there are enough wall openings. Application of a vapor barrier (6mil plastic) will allow the builder to reduce the number of openings. The specified minimum height of 32 inches is not enough to create sufficient airflow. However, almost all the crawl spaces we have seen with a clearance of more than 4-5 feet have very few problems. Unfortunately, there are many crawl spaces, where the clearance is 2 feet or less, measured between the joist and the ground. If

you factor in the HVAC ducts, there is often no wiggle room left. Many HVAC units completely dissect the crawl space and choke it. Sunken living rooms are always a problem, unless the builder planned specifically for it.

The worst problems we see regarding blocked airflow is with building additions (e.g. sun rooms), where old foundation walls are left standing. Porches or patios built over a crawl space are usually not waterproof and can cause lots of moisture problems. Almost all decks can create problems, since the soil stays wet and moist much longer underneath it. That moisture easily finds its way into the crawl space!

In general wood rot can be avoided if the wood moisture content is kept below 20% and/or 50°F. The balance of 20% wood moisture at 70°F temperature in the crawl space corresponds to 89% relative humidity. If the wood is kept dry 10 out of 12 months during the year it can resist decay for a long time. Not all woods used in construction have the same resistance to decay. Pine, which is mostly used today, is considered only slightly resistance or even non-resistance.

Let's take a look at a completely sealed crawl space: They are now widely promoted and in theory not a bad idea. However, if built correctly, you might as well spend the money for a full basement.

A retrofit for an existing home is very difficult, because of missing outside drain lines and good waterproofing. If you have gas fired equipment (HVAC air handlers, water heaters) inside the crawl space, even the experts agree that a sealed crawl space might not be a good idea.

For that reason and others the modern gas fired HVAC unit have an external fresh air supply. This is usually "apparent" by two lateral PVC pipes extended to the outside of the crawl space wall, the second being the chimney.

In the US there are over 25 Mio existing homes with a crawl space and at least a third of them are in need of a solution.

Let's examine a **typical southeastern older home**:

The house was built in 1979 as a "spec house" and has a footprint of about 1,200 sqft with a connected two-car garage. At the time the County had virtually no trained building inspectors and the builders did not know, or did not want to know what good building practice is:

- No water drainage away from the house (water infiltration after heavy rains)
- No foundation water proofing
- No vapor barrier
- Condensation line from two HVAC units drained onto the crawl space floor
- Attic (under roof) was not ventilated
- Inefficient foundation vents were installed. Garage and half of the back side had no vents
- Crawl space is very shallow, in many areas less than 2 feet

What was easy to correct:

- Installed a French drain and sump pump on the inside and tried to divert the water away from the house as good as possible. Still, water penetrated after a very heavy rain, but at least there was no standing water anymore.
- Extended the HVAC condensation line to the sump pump.
- Put down a vapor barrier that covers about 90% of the dirt.

But the crawl space still lacked adequate cross air circulation! A properly designed and controlled ventilation system will keep the wood moisture under the critical level of 20% to avoid decay.

But what about mold and mildew in a crawl space?

Many articles written about mold and mildew are in relation to the living quarters. What we try to do in this essay is to relate these problems to homes with a crawl space.

Most recommendations are to lower the humidity to 40-60% in order to stop mold and mildew from growing. This might be possible inside the house, but impractical if not impossible in the crawl space.

In a crawl space a humidity level of 75% is considered very dry and corresponds to a wood moisture of only 14.5%, which would be considered very good during the summer. Depending on soil conditions and geographic location 85-95% humidity is more likely during the summer months. This means that mold is growing and releasing spores all the time. **It also means for all practical purposes that you can only reduce the mold growth to a minimum but never eliminate it completely.** Reducing the moisture in the air and on the surfaces helps. Any kind of water leak or a film of water from condensation is an absolute no-no. Water leaks can be caused by the HVAC ducts or in colder areas (mountains or at the coast) when the crawl space is cooling down too much during the nights.

Ventilation, by exchanging the inside stale air, with fresh outside air is the only measure we can recommend. This is especially important after a mold mitigation or in a new house to prevent the mold from establishing or re-establishing itself.

In our opinion there is only one way of getting rid of the mold (or most of the mold) and that is by a chemical treatment that should be applied as yearly as possible. There are already a number of treatments on the market which claim not to be harmful to people and the environment.

Why are we “qualified” to talk about mold and mildew? We are seeing so many crawl spaces with problems. Here is a list of issues that will contribute to mold problems: (in the order of severity)

- HVAC condensate lines or pumps not working (or not properly installed) and spilling water onto the ground
- Dryer connections loose or broken
- Yard sprinkle systems too close to the house and running too long
- Old walls left standing when an addition was built
- HVAC ducts loose at manifold or at the floor register
- Heavy sweating from the HVAC ducts and coolant lines (insufficient or old insulation)
- Not enough wall vents
- Low decks covering many wall openings
- Porches vented into the crawl space
- Many dead corners (or even zones) with poor air circulation
- Shrubs growing too close to the house
- Water and sewer leaks
- Incorrect installed (or missing) filter doors in the HVAC
- Wall vents below grade level, usually covered with debris
- Wall vents closed

- Wall vents of poor design

If the living quarters were completely separated from the crawl space (or basement) the mold issue for people with allergies would most likely be tolerable. The problem is that the crawl space is very much “connected” to the house. If you look at above list the first thing that should raise a **red flag is the HVAC system**.

If the HVAC system is getting affected by mold (mold in the ducts), it is very difficult to eliminate, short of replacing or fumigating all the ducts. Installing the best air filters you can buy and replacing them often will help. Make sure the ducts have no leaks (or have fallen off) so no additional mold spores can get into the system. And of course the leaks hardest to detect, are the worst. These are leaks in your air return system, which will suck in air from the crawl space, due to the negative pressure created by the fan! Make sure any air filter doors in the air handler are properly closed (if applicable).

If you install a new HVAC air handler, ask for a variable speed motor for the fan and a feature called “high efficiency moisture removal”.

Commercial building guidelines for HVAC (from ASHREA) ask for 15cfm of fresh air per occupant. The same is recommended for residential homes. 99% of all HVAC systems in homes in the US do not have the means to do that. It is available, but I doubt your local dealer has such a system in stock. It is basically a desiccant air exchange unit and has to be installed properly into the return duct.

ASHREA guidelines suggest a 2 Pa (pascal, 254Pa = 1” H₂O) overpressure in any room. That is a very small overpressure but will help to keep the moisture from penetrating. However, such an overpressure has to be mechanically generated and “normal” residential HVAC systems are not equipped to do that.

For more info on the subject of running the HVAC system properly check:
<http://fsec.ucf.edu/bldg/science/mold/index.htm> (University of Florida)

For example running the HVAC at a higher temperature (78°F) is more efficient to remove moisture inside the house than a temperature setting of 70°F.

Have all the “connections” to the first floor sealed off (e.g. foam material). This includes all pipe and electrical connections, as well as around the HVAC floor registers. Open up all the doors on the first floor to equalize the pressure thus, not creating a negative pressure in a closed of room, which could “suck up” air from the crawl space.

Make sure that the condensate from the air handler is drained properly. If your air handler has a small external sump pump frequent checking is advised. As indicated before, these pumps (and their faulty installations) are the number one cause of moisture problems in the crawl space). One way of checking on the outside of the crawl space is to let the condensate spill into a container during the cooling season during the summer. If the container does not fill up you have a problem. By the way, the water collected can be used to water your plants.

Other problems, which can be easily corrected:

Dryer vents: If your dryer is not located close to an outside wall you may have a problem. Long exhaust pipes have a tendency to clog and are not efficient for the dryer; it will take 2 to 3 times longer for the dryer to finish the job. These pipes are especially vulnerable if a plastic hose is

installed between the dryer and the pipe. The plastic hose gets hot and may break after a short time. The dryer may be more efficient after breaking the hose, but will dump all the hot moist air into the crawl space. Easy check: Run the dryer and make sure you have a good, warm airflow coming out of the vent on the outside of the house. Traces of lint in that area are actually a good sign. Too much lint: check the screen of your dryer. This can be a fire hazard, because the lint will also get close to the heating elements of the dryer and can catch fire.

Wall vents: Install automatic vents (activated by temperature). Such vents have the biggest openings, are relative inexpensive, and you will not forget to open them in the summer. Make sure all openings are free of debris!

Water leaks: They can be easily corrected but are hard to detect. If you have flexible PVC pipes (for your fresh water) you want to make sure that all the joints are watertight. Sewer - and waste water pipes under the bathrooms are most prone to leaks, and they are usually caused by faulty installation.

Poor ventilation: The secret to good air circulation is a well established cross ventilation from one side of the crawl space to the other and by flushing all the dead corners. A natural cross air circulation can **only** establish itself with wind or a breeze “pushing” against the house and creating a pressure difference from one side to the other. Without wind nothing moves under the house! Intake and exhaust power fans have the same affect! However, these fans have to be controlled properly. You don’t want to let these fans run, when the outside air is hot and humid. The worst appliance to control moisture in a crawl space is an inside humidistat.

Shrubs: Cut shrubs back to leave at least a one foot gap to the wall.

Sprinkler Systems: Closest sprinkler head should be more than 4 feet from any wall. Don’t run the system every day. Reduce the length of time the system runs. If the soil stays soggy you are not doing your crawl space (and plants) any favor.

More tips about molds:

http://fcs.tamu.edu/housing/healthy_homes/indoor_air_quality/index.php (University of Texas)

Summary: If you are allergic to mold you will have to take extra precautions when you buy (or rent) or build a house.

If want to err on the safe side, go for a ventilation system in your crawl space with 5-8 air exchanges per hour when running. When using power fans make sure they are properly controlled and cannot make matters worse by blowing hot humid air into the crawl space.

Never allow the fans to be controlled by an inside humidistat. The fans will run guaranteed 24/7 and pulling in all that warm humid air in the summer.

Any crawl space with less than 2 feet in height or wall openings below grade is almost a sure candidate for moisture problems.