DEPOSITION OF AIRBORNE SPORES ON SURFACES

The Forgotten Aspect of Mold Remediation

In the mold remediation industry the focus tends to be, understandably, on areas where mold is growing on building materials or contents. The EPA and the New York City (NYC) Department of Health have published guidelines that offer recommendations for personal protective equipment (PPE) and engineering controls based on the amount of visible mold growth in an area. Obviously, visible mold growth needs to be properly addressed. However, physical growth is not the only form of contamination related to mold. Spores released by mold sources can settle on surfaces that are not otherwise contaminated by mold growth. This spore deposition can remain long after the actual mold growth is removed and can continue to cause symptoms if it is not dealt with. In this article, we will discuss (1) how to determine if airborne spore deposition has impacted surfaces, (2) how to clean surfaces that have been impacted by airborne spores, and (3) how to determine if the cleaning was effective in removing the deposited mold contamination.

Since individual mold spores are invisible to the naked eye, simple observation is insufficient to determine if a surface is contaminated with potentially hazardous spores. In order to determine if a surface is clean (uncontaminated) or dirty (contaminated), surface samples must be collected. There are several ways in which this can be done. Tape samples are collected by placing a piece of clear tape, sticky side down, on the surface. After removing the tape it is affixed to a clear microscope slide. The material stuck to the tape is then examined under magnification to determine if spores or other biological matter (*i.e.*, parts of mold organisms other than spores, pollen, insect parts, etc.) are present. Swab samples are collected by rolling a sterile swab over the surface to be tested. The swab is then transferred to a culture medium and any spores resulting in fungal growth are identified. Wipe samples are used to collect dust from a surface onto a cloth or filter paper. The dust is then analyzed by volume of material, by direct microscopy or culture methods. The results are given in spores/gram of dust or colony forming units (cfu)/gram of dust.

A fourth method of collecting surface samples, and the main focus of this article, is the microvacuum sample. Microvacuum samples are collected with a slit cassette, such as the Air-O-Cell made by Zefon, attached to an air pump, such as the Wonder Air. There are several variations of microvacuum sample techniques that are used depending on the specific information that is sought. For example, microvacuum samples can be used as a quick check to determine if wet or water-stained materials are supporting active fungal growth. In such cases the pump is turned on and the cassette is hovered just above the surface to be tested for

approximately 30 seconds. The slide is then removed from inside the cassette and analyzed by direct microscopy. Since microvacuum samples actively pull in material from surfaces, they can give a better indication of surface contaminants than other sampling techniques which rub across a surface. For situations where mold spores may have been spread indoors by dispersal in the air or physical cross contamination, the Air-O-Cell cassette can be used to actually vacuum the surface. Depending on the surface being sampled and the anticipated dust load, two to ten square centimeters of surface area are covered. In these cases sample results are reported as the total percentage of spores as compared to the other constituents of the dust. A listing of spore types in order of preponderance provides additional valuable data.

Once a microvacuum sample has been collected and relative amounts of bioaerosols and other particulates are identified under a microscope, the data need to be interpreted. Since there are nearly always mold spores present in the air it is important to be able to determine if spores in dust are normal or the result of deposition from an indoor source. At Wonder Makers Environmental we have collected and analyzed several thousand microvacuum samples and have observed some obvious patterns during our sample interpretation. From our experience with samples of settled dust with no visible fungal growth, we find that less than 1% fungal spores is normal, meaning the spores are typical background levels and do not indicate an indoor source. Percentages are determined by comparing the amount of spores to the total amount of particulates and bioaerosols on the sample, such as fibers, pollen, and opaque particles. Such dust samples with 1-3% fungal spores are above normal, and often indicate active or former growth in the area of an air supply. Further investigation would be recommended in such cases to identify the source. Samples with greater than 3% fungal spores show the surface sampled has an abnormally high level of spores. This usually indicates the presence of an active indoor mold source contributing to elevated spore counts, which result in high levels of deposition on surfaces.

If it is determined that there is an indoor source with possible airborne spore deposition occurring, the source must be removed. This clean-up must be done utilizing dust control and suppression methods based on industry best practices to prevent further spread of the spores. The correct method depends on the type of surface that is contaminated. A few examples are given here, which can be expanded to fit most finishes and furnishings. Carpet that has spore deposition but not active growth can be cleaned by HEPA vacuuming first, then performing a hot water extraction with a commercial biocidal agent solution (*i.e,*. Microban or equivalent), thorough drying, then HEPA vacuuming again. This HEPA sandwich technique can effectively remove spores from carpeting.

Upholstered furniture is considered a porous material so the techniques described here can be used on other porous materials as well. It should be emphasized that the consensus in the industry is very clear for porous items with visible fungal growth: they should be disposed of.

However, if porous materials, such as upholstered furniture, have residual spore contamination from interior growth on nearby surfaces, cleaning can be effective. To clean upholstered furniture, HEPA vacuum all surfaces very carefully. Multiple passes should be made on each surface of the furniture, with the vacuum attachment moved back and forth, then repeated in perpendicular strokes. If the cushions are removable, take them off and vacuum all sides of the cushions and the surfaces below them. This procedure can be used for most porous objects. However, in cases of extensive contamination, or for items of little value, replacement may be a better solution since porous items can be very difficult to get completely clean.

The third example is electronic equipment. This equipment is considered semi-porous; it has hard surfaces, yet small openings in the surface allow air to enter and exit for cooling purposes. As such, electronic equipment is treated somewhat differently than other semi-porous materials, such as wood. Wood can be HEPA vacuumed, then scraped or sanded, HEPA vacuumed again, and refinished. Electronic equipment should be HEPA vacuumed on the outside, then have compressed air blown into the interior with a HEPA vacuum running near where the air stream exits the equipment. This can be accomplished by using an air wash station to produce air flow. An air wash station can be built by setting up a HEPA vacuum or negative air machine to exhaust into a small area, with another set up directly across from it so that the exhaust from the first machine goes into the intake of the second machine, creating a continuous stream of air to remove spores from surfaces. Wet wipes may also be used on the exterior, though caution should be used to be sure the moisture doesn't damage the equipment.

The fourth example is a counter top. The surface of the counter is non-porous, meaning there are no gaps or holes in the surface. Non-porous items can be HEPA vacuumed and/or cleaned with wet wipes since airborne spore deposition should only be on the surface.

Once the cleaning has been done, its effectiveness must be determined. This is accomplished by another surface sample. If this sample is a microvacuum sample, the amount of spores on the sample should obviously be less than the 1% level mentioned earlier that represents the normal background level. Actually, the sample should have almost no spores on it since it was just cleaned. If there are still appreciable numbers of spores on the sample, additional cleaning may be required. This low tolerance is especially true for target spore types. Target spores are the types of mold that were found as indoor sources. The continuing presence of these target spores can indicate that an additional, unremediated source of mold is still present, requiring further investigation and cleaning. The identification of toxic spores such as *Stachybotrys* or *Fusarium* should also signal the need for additional cleaning. After cleaning, there should be no more than a few outdoor type spores present on the samples.

Once it has been ascertained that the work area has responded to remediation, the project can be considered successfully completed, assuming any visible mold growth has also been remediated.

The project area can then be returned to its original state. When mold remediation contractors and consultants remember that dealing with airborne spore deposition is just as much a part of a project as removing mold growth, everyone benefits.

About the Authors

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