

THE ROLE OF COATINGS IN MOLD AND MILDEW REMEDIATION

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ABSTRACT

The proper use of barrier coating technology as part of the mold and mildew remediation process is discussed, along with the properties the appropriate barrier coating should exhibit. Testing to confirm these properties is discussed, along with some interesting comparison testing on the need for pesticides to achieve mold resistance of the coating's film. Interestingly, the US-EPA has already established independent certified lab tested standards for barrier coatings, this is also discussed.

One of the "newer" hazards facing property owners and managers of residential, commercial, institutional, and industrial structures is mold and mildew infestations. "Newer" is used loosely as mold and mildew (M&M) have been around since the beginning of time. In fact, regulations for dealing with mildew are given in the Old Testament in Leviticus 13. Much has been written and speculated upon as to why this has become such a frequent issue in just the past few years, but this is not the topic of this paper. Nor are the potential health issues from exposure to M&M a topic for this discussion. M&M and their resultant health issues are here and here to stay if proper remediation steps are not taken. As the proper M&M remediation protocol is followed, coatings can play an important cost saving role in many situations. This paper will discuss the exact role coatings should play and the physical properties that are necessary for a coating or coating system to provide the desired long-term protection. Performance testing relevant to the use

of coatings for mold and mildew remediation will also be discussed. The information contained in this article expands on that contained in an earlier article by the authors (Ref. 1).

DEALING WITH THE WATER PROBLEM

As every article dealing with this topic has previously emphasized, proper M&M remediation procedures start with a good understanding of the water issues that led to the M&M infestation. Sometimes this will be an obvious conclusion, such as the floodwaters that have just receded, the burst water line, or the sprinklers and other firewater sources after the fire. Sometimes it may be easy to find, but hard (expensive) to resolve such as an inadequate or nonexistent vapor retarder on a wall or as part of the insulation on cooling lines. And sometimes it will be a frustratingly long investigation process resulting in the discovery of a building envelope weakness such as a roof leak, an improperly flashed window, or even landscaping changes, faults, etc. But this remains the all-important first step in any M&M remediation process. If an M&M remediation project is completed without a full understanding and resolution of the water problem that caused the original infestation, and the remediation process is a success, the owner can consider himself very lucky. The water problem must be understood, and the remediation strategy developed must include dealing with the water problem as the first step...

DEMOLITION AND REPLACEMENT

Once the water problem has been resolved, an inspection should be made of all affected parts of the building. Badly damaged building materials (e.g. water-damaged sheetrock and paneling) should be removed and replaced. Structurally sound building materials that are contaminated with M&M should be evaluated to determine the most cost effective remediation alternative. Removal and replacement may be less costly or preferred by the owner. Removal and replacement can sometimes amount to a virtual total demolition, particularly when supporting structures and foundations are involved. It should be emphasized that remediation-in-place, which will be discussed next, cannot take badly damaged construction materials and make them good again.

REMEDIATION-IN-PLACE

The first step when remediating mold-contaminated, structurally sound building materials is to clean and sanitize the surfaces; though many experts believe that effective and complete sanitization isn't always possible. A variety of products are available for this purpose. But it should be emphasized that porous surfaces are nearly impossible to clean and sanitize such that the M&M will not re-grow in the near future. Examples of such porous surfaces are studs, joists and other wooden framing materials, block and concrete walls and columns, some insulation materials, varieties of sidings, even metal surfaces, etc. When compared to removal and replacement, cleaning and perhaps sanitizing, followed by the application of a mold-resistant coating that acts as a barrier and prevents the re-growth of the existing mold as well as the growth of fresh mold on the coated surface can save a lot of money and, in some cases,

a lot of time as well, which translates into reduced relocation costs.

DESIRABLE COATING CHARACTERISTICS: LONG LASTING BARRIER

The properly chosen coating should be applicable to a variety of surfaces and give excellent long-lasting adhesion. It should be elastomeric in nature, and retain this elasticity forever, moving with the building and never chipping, cracking or peeling, thus locking in place any remnants of the M&M infestation. The properly chosen coating should also function as a water vapor retarder to restrict the migration of water through the coating, thereby minimizing the flow of this key ingredient in the M&M growth process. But the placement of such a coating and the water vapor retarder it creates must be well thought out relative to the overall water management strategy of the remediation. And of course the properly chosen coating should not allow the airborne toxins from M&M to pass through. This creates the ideal barrier for a mold and mildew remediation. It should have passed a testing protocol insuring its long life (20+years).

Perhaps the most important feature of the properly chosen coating is that it must resist the growth of M&M on its surface. Most of the coatings sold for this service achieve this resistance by incorporating an EPA-registered pesticide within the coating. Even though the pesticides used are EPA-registered, some of them are considered unsafe for use in specific applications such as HVAC systems, which results (or should result) in their being classified as "restricted use" pesticides. More importantly, there are recognized health risks associated with the use of some, if not most, EPA-registered pesticides. Most pesticides have a low but finite volatility, which means that they escape

into the air within the buildings in which they are used. One of the leading mildew-resistant encapsulants contains IPBC (3-iodo-2-propynyl butyl carbamate), which has been shown by research in recent years to cause allergic reactions among some people exposed to airborne IPBC (Ref. 2). Ironically, some cases of allergic reactions to this particular pesticide have been reported by multiple occupants of sites where this coating system was used as part of an IAQ improvement effort. Another leading product contains chlorothalonil, which is considered by the EPA to be a likely carcinogen. It is also a strong sensitizer. Many, if not most, pesticides used in mold-resistant coatings are organic compounds that contain halogens (fluorine, chlorine, bromine and/or iodine). These compounds are as notorious for causing allergic reactions as they are efficacious as pesticides.

A much safer alternative is to use a coating that meets all of the other requirements and also provides mold and mildew resistance without the use of a pesticide. A number of coatings formulated to pass the ASTM test for mold and mildew resistance without the aid of pesticides were tested by an independent testing laboratory and shown to provide mold resistance comparable to that of the pesticide-containing coatings currently being sold and used. If a greater level of mold resistance is desired, consideration should be given to the use of a high-gloss topcoat, which doesn't soil as readily and is easier to clean. Finally, if the use of a pesticide-containing coating is deemed necessary to provide a maximum level of mold resistance in a particular application, consideration should be given to using a coating product that contains a halogen-free pesticide. Our experience has been that in more than 99 percent of the

thousands of M&M remediation projects on which pesticide-free coatings have been used, the use of such coatings has provided more than enough mold resistance and has thereby avoided the risks attendant to the use of pesticide-containing coatings. To provide good, long-lasting adhesion, it is recommended that the mold-resistant coatings be applied over a penetrating-stabilizing and adhesion promoting primer. What value are the coating and all these important tested properties without good long lasting adhesion?

COMPARATIVE MOLD-RESISTANCE TESTING OF COATINGS

An independent testing laboratory carried out comparative testing in 2002 of the mold resistance of several pesticide-free coatings, two leading pesticide-containing coatings and one halogen-free pesticide containing coating. Two parameters were tested, adhesion and mold resistance. The mold resistance testing was carried out in accordance with ASTM D-3273, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber, which describes how to set up and run a mold/mildew cabinet, essentially a humidity cabinet into which various strains of M&M are intentionally introduced and allowed to freely propagate; and ASTM D-3274, Standard Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation, which instructs one on how to coat a panel and subject the panel to the mold cabinet's conditions, then how to evaluate the results after a 4-week exposure time. This test is intended to represent for mold and mildew exposure what weathering cabinets do for predicting the long-term life of a coating under normal weather conditions, and what salt spray and humidity cabinets do for

predicting the life of a coating on metal surfaces. In this test, two leading pesticide-containing products, one containing IPBC and another containing chlorothalonil were tested side by side with pesticide-free coating alternatives and one containing a pesticide that is halogen-free. All of the pesticide free materials were applied over a penetrating-stabilizer/adhesion promoting primer. This mold resistance testing is part of ASTM E-1795, the standard for lead-based paint encapsulants that are expected to last for at least 20 years, including mold resistance under average mold growth conditions.

The results of this testing after the 4 week test period as called for by ASTM D-3273/D-3274 were that there was no staining on any of the panels, all receiving perfect passing grades. Since this round of testing led to no visible differentiation, all panels were returned to the cabinet for a second round of testing, 2-times the required residence time (or 8 weeks). Again all passed with no staining observed. So they were all re-introduced to the cabinet for a third round, 3-times the required residence time (or 12 weeks). After this round of testing, some minor differences were finally visible. The pesticide-free coatings including the one with a higher gloss and the Chlorothalonil containing coating showed a trace to slight growth, while the coating with a halogen-free pesticide and the IPBC containing coating had no growth. Also, interestingly, IPBC containing coating, though stain-free, had completely yellowed. Subsequent investigation has revealed that yellowing over time is characteristic of IPBC-containing products; what isn't known is if the process that leads to the yellowing

causes any deleterious effects on coating performance. Subsequent testing has shown that the satin-finish and gloss-finish versions of the pesticide-free coatings provide even better mold and mildew resistance than the flat option.

It is with these results in mind that we have recommended against the addition of pesticides to coatings used in M&M remediations in at least 99 percent of the situations we have encountered. What can this extremely minor performance difference offer to offset the potential health risks associated with the use of pesticide-containing coatings, the possible need for public notification when used in schools, hospitals and other public facilities, and the possible requirement that pesticide applicators will have to be trained and certified/licensed? Note these are all FIFRA (federal insecticide, fungicide, rodenticide act) based regulations.

The same independent testing laboratory also carried out comparative adhesion testing in accordance with ASTM D 4541, Pull-Off Strength of Coatings Using Portable Adhesion Testers. Again the pesticide containing coatings were tested along side the pesticide-free options, though in most cases the pesticide free options included the adhesion promoting primer. The results for mold resistance and adhesion follow. You will note the use of the primer nearly doubles the adhesion compared to the products containing IPBC and chlorothalonil, over unprimed surfaces as they recommend. Again, what good are all these other film properties if the film does not stick well, stay flexible, and do so for a long time?

SUMMARY OF MOLD RESISTANCE AND ADHESION TESTING

COATING	ASTM 3273- 3274, 4WKS	8 WKS	12 WKS	ASTM D 4541 ADHESION PSI
CHLOROTHALONIL CONTAINING	OK	OK	TRACE- SLIGHT	200
IPBC CONTAINING	OK	OK	TOTALLY YELLOWED	150
PESTICIDE FREE FLAT OVER PRIMER	OK	OK	TRACE- SLIGHT	320
PESTICIDE FREE, SATIN	OK	OK	TRACE	*
PESTICIDE FREE, GLOSS	OK	OK	TRACE	*
HALOGEN-FREE PESTICIDE	OK	OK	NONE	*
PESTICIDE FREE FLAT, NO PRIMER	OK	OK	TRACE- SLIGHT	240

*: adhesion expected to be similar to the 320 PSI as primer is involved.

OTHER PERFORMANCE TESTING

As mentioned earlier, there are a number of other desirable coating characteristics, besides mold-resistance, that relate to the ability of a coating to provide long-term protection. For instance barrier properties, elastomeric properties, and weathering properties are equally important. These basic pesticide-free options, consisting of the penetrating-stabilizer (primer) and flat and satin protective skin (topcoats) have been extensively tested in connection with their use for abating lead-based paint (LBP) and asbestos-containing materials (ACM) in accordance with the EPA's recommended ASTM protocol, and these test results indicate that this same coating system will provide the necessary coating characteristics for long-term protection (20+ years) when used for remediating ACM, LBP, and M&M. The key physical properties and the appropriate tests for confirming a coating's performance as an encapsulant for M&M are summarized below.

KEY PHYSICAL PROPERTIES: MOLD AND MILDEW ENCAPSULANT

KEY PROPERTIES:	ASTM:	COMMENTS:
Adhesion	D-4541 D-3359	Confirms adhesion as much as 5-10x that of some house paints
M&M resistance	D-3273 D-3274	Confirms coating has mold and mildew resistance.
Water vapor retarder	D-1653	Cured film effectively creates a water vapor retarder.
Corrosion inhibited for metal surfaces	B-117 D-4585	Tested for use on multi-metal surfaces in salt spray and humidity cabinets, 1500+ hr.
Flexibility (elastomeric properties)	D- 522	Coating will remain flexible over time, will never chip, crack or peel.
Weathering	G- 53	Passes accelerated weathering and aging tests, indicating an expected life of 20+ years.
Other hazards: ACM, LBP, Mercury vapors, CCA, Radon, etc.	E-1795 E-84 etc.	US-EPA accepted for use in abating Lead-based Paint (LBP) and Asbestos Containing Materials (ACM).

A coating that has this testing lineage is guaranteed to perform all the roles any M&M situation can require of it, and continue to perform these roles for an extended period of time (i.e. 20 or more years in most cases). Because this coating system has been tested and approved for use in abating other surface hazards, it can be used for dealing with multiple hazards; this is not the case for other mold-resistant encapsulants. As regards other coating materials that are sold as mold-resistant encapsulants, very little testing has been conducted other than the ASTM D-3273/D-3274 mold-resistance test, which probably accounts for why no warranty is provided with most of the other encapsulants currently on the market.

CASE HISTORIES

Some representative examples of the use of this coating technology are as follows:

- A veteran's home of early 1900's construction uses boilers and hot water heat and an insulated piped delivery system through out the complex. In recent years chillers were added and the same distribution system used for cooling. The insulation was inadequate on the now cool lines during hot muggy summer days, dew point was reached within the insulation, and wonderful black mold growth formed on the insulation throughout the multi-building structure. The local department of health cited the establishment. The bid to remove and replace the insulation was \$160,000. This amount was obviously not in the budget, and the projected timing of this lengthy project was not acceptable to the Department of

Health. Also concerns existed that the problem may return. Encasement-based coatings were installed for \$60,000 including labor. The mold resistance and water vapor retarding capability of the coating (remember the source of the water vapor in this case moves from the outside in) together with the ability of the coating system to abate asbestos containing materials were critical to this application. This was one of the rare projects where in a few remote areas a special gloss topcoat containing a halogen-free non-restricted use pesticide was used. We like the logic for this use. In all the common areas or in the patients' rooms, the standard pesticide-free encasement system was used. In a few mechanical rooms, where the conditions are nearly always dirty and humid, the pesticide-containing overcoat was added. The fact that this coating system also is accepted for abating ACM insulation was considered a plus to this project, too.

- HVAC plenums with interior lined ductwork are common targets for cleaning as part of an M&M remediation-improved IAQ effort. Cleaning interior lined ductwork involves moving a "thwapper" through the duct along with HEPA-vacuuming, but obviously this does not thoroughly clean these porous surfaces. In one particularly large job the bid for removal and replacement of the insulation was over \$150,000. Encasement coatings were installed for \$65,000. Critical to this project was adhesion to metal hold-down straps, filling voids along these straps, and

sealing interior corners. The corrosion inhibiting primer, self-adhesive tape, and polyester reinforced scrim fabric were important additions to this encasement coating system for dealing with the metal surfaces and filling/sealing the various gaps. Perhaps more important than savings of nearly 3x versus removal and replacement is that this coating approach yields a washable surface, should conditions of this nature start to return in 10-20 years.

- Another HVAC-based contributor to IAQ issues is drain pans. Drain pan is a misnomer as they usually are designed to retain 1/4-1/2 inch of water. This makes for an excellent breeding ground for a wide variety of unfriendly biological entities, forcing facility engineers to chuck bleach into the pan at some frequency, or if they are really sophisticated, little disks of biocides. In all cases halogens are introduced to an aqueous environment on a metal surface, which leads to accelerated corrosion rates of the pan. But what else are they to do? We have seen galvanized pans that, after being allowed to dry out, have a significant layer of white powder, the zinc sacrificially coming off due to the corrosion process. And in some areas red rust is apparent, meaning you are now past the galvanized layer. And some even have pinhole leaks in the red rust areas. These HVAC systems are not made with removal and replacements of the pans in mind, making this option an extremely expensive alternative. "Do nothing" may lead to expanding IAQ problems as the

leaking progresses. Certainly the addition of the corrosion-catalyzing biocides cannot be halted. A 3-step process for solving drain pan issues such as these is a power wash or scrub using water and Chlor*Rid soluble salt remover to get the metal surface ready for coating, then application of a primer containing corrosion inhibitors, then the submersible grade epoxy topcoat. This entire process costs \$1.20/sqft or less for materials, and constitutes a much lower cost alternative than any other possible solutions.

- After the floods in the Red River Valley of MN and ND, many properties had significant water damage, and M&M infestations followed rapidly. In one case a historic and still functioning courthouse had a basement with asbestos containing insulation in bad shape, lead-based paint coming off the walls, and M&M on all the surfaces, seemingly coming out of the block walls. First, all surfaces were power washed. Then pesticide free encasement coatings were spray-applied to all surfaces, taking full advantage of its approvals for all of these hazards. Nearby another building was left in its flooded out state for years, then considered for renovation to accommodate a bank. Environmental audits found significant M&M presence plus contamination due to types of living things that are found in pigeon poop. All non-structural members were demolished, and all structural supporting members were power washed and sanitized. M&M was still found after this and even more iterations of cleaning and

sanitizing, showing again the difficulty in effectively cleaning and sanitizing a porous surface. Some “experts” will recommend “sanding” as the alternative for these porous surfaces to remain, examples being block and brick walls, support beams made of wood and metal, etc. The practicality of this alternative is just as futile as it sounds. Exactly when do you stop sanding? In this project all remaining surfaces were encased with pesticide free coatings, acceptable clearance samples were immediately attained, and the project moved forward.

- An elderly couple’s residence in KY had reached a point during an M&M infestation in the crawl space of their home that they had to move out for health reasons. Investigations led to the discovery of a pinhole-sized leak in the water feed line to the icemaker. Abatement activities followed as all infested non-structure bearing materials were removed, and all structure-bearing surfaces were sanitized. Clearance could not be attained. Re-cleaning and sanitizing followed numerous times, with similarly negative results at obtaining clearance. The insurance company was reputedly ready to give up and write a \$150,000 check when the contractor learned about pesticide free encasement coating technology for these issues. For less than \$500 of coating material, the previously mold stained surfaces were coated, acceptable clearance sampling results were obtained, and the couple returned to their home.

ADVANTAGES

The advantages of pesticide free encasement coating materials for the remediation of mold and mildew may be summarized as follows:

1. SAFER - Passes ASTM D 3273/D-3274 without a pesticide: avoids potential risks of allergic reactions to pesticides.
2. Does not require EPA registration for any uses.
3. Does not require applicator certification/licensing.
4. Does not require parental notification before being used in schools.
5. Suitable for use in HVAC systems and on all interior and exterior surfaces.
6. Class I Fire-Rated (ASTM E-84), low smoke and flame spread.
7. Extensively tested and approved for use on LBP and ACM – tough, long-lasting system for dealing with single or multiple hazards. Superior adhesion.
8. Same coating system for all surface hazards.
9. Long-term corrosion protection when used on metal with less surface preparation.
10. Water vapor retarder.
11. Radon barrier.
12. Limited product warranty for up to 20 years.

REFERENCES

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