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MOLD CONTROL TREATMENTS FOR WOOD

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Summary

In the past five years, mold growth in the home has become a major area of concern in both the United States and Canada. Regulatory agencies have made mold a top indoor air quality issue; there are thousands of mold-related lawsuits pending; and many insurance companies have reduced or eliminated coverage for losses related to mold. Although consumer hysteria over mold in the home has somewhat abated since its peak in 2002, it is by no means fading away. In fact, the consuming public has made up its mind that mold growth on wood and wood-based building products is unacceptable. While some producers of wood-based building materials have chosen to either ignore or deny these concerns, a growing number of progressive manufacturers are looking at the mold issue as an opportunity rather than as a threat. They are producing and warranting mold-protected building materials such as framing lumber and OSB. Fungicides have historically been used to protect wood and wood composites against decay fungi, but many of the most widely used fungicides such as CCA, ACQ, CA and borates have limited efficacy against mold, except at very high loadings. The preservatives of choice for mold control include those often used in the protection of paints and coatings. They generally work best in combinations, providing a broader spectrum of protection. Mold control treatments are applied by a variety of methods including surface spray, integral, and diffusion treatments. These new protection systems are offering wood-based building materials manufacturers the opportunity to address a potentially negative issue involving wood and opening up new markets for value-added products.

1. Introduction

Human beings and mold fungi have peacefully coexisted in close proximity for millions of years. Although mold in the home is not a new phenomenon (The Book of *Leviticus* addresses several remedies for mold contamination in one's house), recent publicity from some high profile lawsuits has elevated the mold issue to one of significant concern for wood-based building materials manufacturers. This paper addresses a number of key issues relating to recent anxieties over mold contamination in the home. These include: What's driving the need for mold protection? What causes mold growth? How is mold resistance evaluated? How do you prevent mold growth? and Where are mold control treatments being used today? In the Introduction to its 2003 Annual Report, the APA states that "Mold, decay and other moisture-related problems remain among the greatest current threats to marketplace acceptance of engineered wood products." A growing number of progressive wood-based building materials manufacturers are taking a proactive stance to this potential threat by offering products with built-in mold resistance.

2. Factors Driving the Need for Mold Protection

In five short years, mold in the home has gone from being a nuisance to what many consider to be a major health hazard giving rise to allergic reactions, asthma attacks and even toxic syndromes. A recent report issued by the Institute of Medicine of the National Academies of Sciences (Butler et al., 2004) found inadequate evidence linking mold to some of the more serious health risks, although it did find sufficient evidence of links associating mold exposure to some breathing problems, including asthma in sensitized persons. In spite of this lack of evidence linking household molds to a number of severe health hazards, it is clear that many stakeholders in the mold debate are taking the health issue very seriously. These include regulators, attorneys, insurance companies, builders, retailers, the media, and, most importantly, the consuming public.

From a regulatory standpoint, the U. S. Environmental Protection Agency and state regulators have begun to focus on indoor air quality (IAQ) as part of their mission for clean air (Ross, 2004). Primarily fueled by worries over mold growth, 2003 will be remembered as one of the most active years for IAQ state legislative initiatives. Last year 27 state legislatures considered more than 60 pieces of IAQ-related legislation with 18 becoming law. In 2004, so far, according to MoldUpdate.com, some 22 pieces of mold legislation have come before 14 state legislatures. Many of these bills concern protecting homeowners and homebuyers from mold-infested residences.

Mold-related claims continue to be the subject of numerous lawsuits in the U. S. Although mold litigation reached a high point in 2002, it is by no means fading away. According to the Insurance Information Institute, there are currently 10,000 mold-related lawsuits pending in the U. S., and several high profile awards have emboldened plaintiffs' attorneys to pursue further litigation. Some are looking at mold as the new asbestos. Parties who may be impacted by mold litigation include developers, building owners and managers, architects, engineers, realtors, contractors, builders and building materials suppliers. For example, a regional lumber and window supplier in Kansas recently won a lawsuit, being found not liable for mold in an allegedly leaking house (Campbell and Badgerow, 2004). However, even coming out on the winning end of a lawsuit can be a financially debilitating experience. Litigation transactional costs can be very expensive since they often involve expert witnesses, complex investigations and multiple plaintiffs. A key lesson learned from the asbestos experience is that an ounce of prevention is often worth many pounds of cure. Taking proactive measures such as pretreating wood products for mold resistance can go a long way in convincing judges and juries of a building materials manufacturer's concern for product stewardship.

Mold continues to create havoc in the insurance industry as well. Claims are piling up due to the aforementioned flood of mold-related lawsuits coupled with a strong real estate market. Premiums across the U. S. and Canada have risen from 6-15% per year. Significantly, insurance companies in 43 states have convinced regulators to allow them to partially or entirely exclude mold-related claims from their policies. This effectively removes insurance companies from the crosshairs of future lawsuits, opening the door for other "deep pockets" defendants to take their place.

Home builders are another group which takes mold issues seriously. According to a recent survey taken by Louisiana State University (Shupe and Vlosky, 2004), 67% of home builders say they have taken measures to prevent mold in the homes they build. Many have been known to reject loads of wood-based building products which arrive on site in a moldy condition.

Lumber retailers, including some of the "big box" stores have reacted to public apprehension over mold and have instituted what amounts to zero tolerance policy for mold on the building products they carry.

The media continues to exploit public fears about mold by publishing exposés on so-called mold horror stories. Mainstream outlets such as CBS news, *The New York Times* Sunday Magazine, and *Redbook* Magazine are a few of the sources of stories about mold infestation in homes in the past few years. Celebrities such as Erin Brockovich, Ed McMahon, Bianca Jagger and Michael Jordan have all been involved in high profile mold litigation in recent years. These stories and others serve to fuel the public perception that the mold problem is out of control.

Public perception about the risk of mold exposure may ultimately be the single most important driver for the need for mold protection. As noted by the second century Greek philosopher Epictetus, "People are disturbed, not by things, but by their view of them." Mold may well be more of a perception of risk than an actual physical peril, but at the end of the day, perception trumps reality. Wood products manufacturers have not only litigation to fear if they ignore the mold issue, but the loss of markets as consumers move to non wood-based building materials which are perceived by the public to be mold resistant.

3. Factors Leading to Mold Growth

Many articles and texts have been devoted to the study of mold and mechanisms of mold growth. For the purposes of this presentation, it is sufficient to note a few basic characteristics of mold. Compared to other fungi, they are relatively simple, which makes them comparatively robust. Unlike decay fungi, which are usually either brown or white, mold fungi come in a variety of colors including red, orange, blue, green, black and white. On wood they often appear as spots or fuzzy masses. They typically grow on surfaces and do not physically degrade the structure of wood. Like all fungi they are spread through airborne spores, and because of this, they are literally found everywhere.

Mold fungi have four fairly simple requirements for growth. They require oxygen, which is, of course, almost everywhere. Although mold spores have been found from the Arctic to the tropics to the Antarctic, they generally thrive best at temperatures in the range of 10-35° C (50-90° F). Unfortunately, these are the temperatures where humans thrive best as well. Moisture is an important requirement for mold growth. Mold will grow on wood at a moisture content of 18-20%. At 30% moisture content, mold will flourish. Finally, mold feeds off of nutrients, often in the form of sugars or starches. Synthetic materials such as soaps, plasticizers and surfactants also serve as nutrients for mold. Cellulosic materials such as wood, paper and wood composites like OSB provide a plentiful source of sugars and starches for mold growth. Other common substrates for mold include drywall, paint, wallpaper, carpets, fabrics, and ceiling tiles. Mold can grow on seemingly inert substrates such as plastic, glass and ceramic tiles due to its ability to live off of the micronutrients deposited on these surfaces in the form of soap scum, dirt, etc.

4. Methods for Evaluating Mold Resistance

Reliable test methods are important as a means of screening and evaluating the performance of mold-resistant treatments. Since the growth of mold on wood has only recently become an area of major interest, many mold test protocols and methodologies are still largely in the development phase. Laboratory tests include those carried out in pans or petri dishes, a plastic tub test developed at Michigan Technological University, and a mold box test which was developed at Forintek and is now being considered for standardization by the American Wood-Preservers' Association (AWPA).

In the test being considered by the AWPA, samples of wood or wood composites are suspended in a chamber where temperature and relative humidity are controlled to provide ideal growth conditions for mold. The chamber also contains a bed of soil to provide a nutrient medium and a fan to provide air circulation. Mold spores are introduced into the chamber, and the circulating air subjects the test samples to direct exposure to the mold spores. Samples are visually evaluated for surface mold growth every two weeks for a period of eight weeks. An acceptable treatment would be one which allows no more than 10% mold growth on the surface of the treated sample after eight weeks in the chamber.

Field tests for evaluating resistance to mold growth on wood and wood composites are also in development. Most commonly used is the stack test where treated and untreated boards or panels are stacked outdoors to simulate shipping, storage and construction site conditions. In some cases, plastic or paper wraps are used to cover the test panels. For accelerated testing, extreme environments such as Florida or Louisiana are used to provide the best conditions for rapid mold growth. Again, samples are evaluated visually for mold growth with a score of 10% or less of surface growth being considered acceptable.

5. Preventing Mold Growth on Wood

As noted above, mold fungi have four basic requirements for growth: oxygen, ideal temperature, moisture and nutrients. Oxygen is not easily removed from the environment. Temperatures promoting mold growth are prevalent outdoors in most of the U. S. and Canada (at least in summer) and indoors wherever there is human habitation. That leaves moisture and nutrients as the main targets of control.

Most efforts in controlling mold growth have focused on containing moisture levels. Outdoors, the major challenge is to protect building materials from the elements during shipping, storage and the construction process. Plastic or paper wraps are often utilized as protective coverings for bundles of lumber or panel products stored at the job site. They can be effective unless the wraps are torn and moisture gets inside creating a greenhouse effect which accelerates rather than slows mold growth. In any case, it is virtually impossible to totally protect building materials from rain, snow or high humidity before the structure is framed-in.

Indoors, control of moisture can be even more problematic. Faulty design, improper construction techniques and plumbing leaks can all result in intrusion of moisture within the building envelope, which in turn can lead to mold growth. Once inside the walls, mold can be very difficult to eradicate. Remediation is expensive and not always effective.

Wood provides an ideal substrate for mold growth because it holds moisture readily, and it is rich in nutrients such as sugars and starches. Eliminating these nutrients from wood would appear to be a challenge. One method is to coat or clad the wood with a material such as metal, plastic or a polymeric coating. This works as long as the cladding or coating does not itself allow mold growth. However, it also serves to mask the wood which is not always desirable. A better way to eliminate mold growth on wood or wood composites is to block the nutrients from being ingested by the mold fungi. This can be accomplished through the use of fungicides.

Most fungicides are not contact killers of mold. They work by interfering with the metabolic process controlling the fungi's ability to digest the nutrients in wood. The mold essentially "starves" because it can no longer access its food source. Fungicides have been used to control decay fungi in wood since Biblical times. Ancient Egyptians also used them to help preserve mummies. Many preservatives which are efficacious against decay fungi are not that effective against surface mold, except at very high loadings. This group includes CCA, ACQ, CA and borates. The fungicides designed for mold control often contain active ingredients which are used as mildewcides in paints and coatings. Some commonly used active ingredients for mold control include IPBC, Propiconazole and Isothiazolones. These materials can be combined for broader spectrum activity, and they are sometimes coupled with inert ingredients which serve as adjuvants or synergists such as quaternary ammonium compounds, amines and TANO (trialkyl nitrogen oxide) compounds.

6. Treatment Methods

The basic methods of application of mold-resistant preservatives to lumber and panel products are *surface barrier* treatments, *integral* treatments and *penetrating barrier* treatments.

As the name implies, surface barrier treatments are applied to the substrate surfaces, usually as liquids which are sprayed on. Since mold growth is primarily a surface phenomenon, this method is a very efficient means of providing protection where it is needed. All surfaces must be coated to provide a full envelope of protection. Surface treatments are clear and essentially invisible once dry. Sometimes a dye is included to mark their presence. Surface treatments are effective as long as the envelope of protection is not breached. This can occur by cutting or puncture of the surface or severe abrasion causing removal of the coating.

Integral treatments provide protection throughout the entire thickness of a wood composite product. They are introduced during the composite manufacturing process. Usually the preservatives are combined with the wood furnish (strands or flakes) before final fabrication. They are generally more costly than surface treatments, but they provide protection throughout the entire thickness of the treated product rather than just the surface. They can also contain active ingredients to provide decay and insect resistance where these properties are desired.

Penetrating barrier treatments are a promising newer method of introducing wood preservatives to lumber and panel products. They are essentially a hybrid between surface treatments and integral treatments, offering the best properties of each method. In addition to organic fungicides, they also contain borates. Borates have the unique property of being able to diffuse into lumber and panel products when they are exposed to moisture or high humidity. They are applied by in-line spray. Some of the organic components remain close to the surface to provide protection against mold, while the borates and other organics, when activated by moisture or humidity, penetrate through the entire thickness of the product. This provides interior protection against decay and termites, as well, if insecticides are added.

7. Conclusion

In a period of just five years, mold growth in the home has evolved into a major concern for homeowners and homebuyers attracting the attention of legislators, litigators, insurance companies, builders, building product manufacturers and the consuming public. Whether or not mold in the home poses an actual physical peril for most homeowners, the overriding perception is that it presents an unnecessary risk. Progressive manufacturers of lumber and panel products for home construction are taking a proactive stance to this potential threat to their market by offering products with some degree of built-in mold resistance. To allay any concerns over exposure to "harmful" chemicals, they are utilizing fungicides with excellent human health and safety profiles which are already found in many household products, including paints and coatings. The fungicides are incorporated either through in-line spray application, integral combination with the wood furnish (in the case of wood composites), or a novel penetrating barrier technique. The penetrating barrier is a surface application which imparts protection throughout the thickness of the substrate when activated by high humidity or moisture. Test methods for both the laboratory and the field are currently being developed to help evaluate the overall effectiveness of these treatments.

These new treatments are offering building materials manufacturers the opportunity to address a potentially major issue while at the same time opening up new markets for value-added products.

8. Literature

Butler, D.A. and N. M. Clark. 2004. *Damp Indoor Spaces and Health*. Committee on Damp Indoor Spaces and Health. Institute of Medicine, National Academies of Sciences. National Academies Press, Washington, D.C.

Campbell, K. and J. N. Badgerow. 2004. Avoiding and Defending Against Mold Suits. Door & Window Maker Magazine, Volume 5, Issue 8, October 2004.

Ross, A. S. 2004. The War on Mold: New Treatments Aiding in Fight Against Ancient Fungus. Engineered Wood Journal. Fall 2004.

Shupe, T. F. and R. P. Vlosky. 2004. A Comparison of U.S. Home Builder and New-Home Homeowner Perceptions and Concerns About Mold. Woodframe Housing Durability and Disaster Issues, Las Vegas, NV, October 4-6, 2004.