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ASHRAE Position Document on

**LIMITING INDOOR MOLD GROWTH AND
MANAGING MOISTURE IN BUILDING
SYSTEMS**

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Executive Summary

Mold growth in buildings can have a negative impact on indoor environmental quality and durability of building components. As the world's building stock continues to grow and scientific and public awareness of moisture and mold increases, there has been an increase in reports of moisture and mold issues. Heating, ventilating and air-conditioning (HVAC) systems are not the sole cause or the sole remedy of these issues, and, in fact, the performance of the building envelope is often a central cause. Air conditioning has become more prevalent and when such systems are well-designed and properly operated, they can contribute to reducing the likelihood of moisture and mold growth and help address these issues when they occur.

ASHRAE has a direct interest with key aspects of these issues. Several ASHRAE committees, including technical and standards committees related to ventilation, thermal performance, system performance and environmental health, have been addressing these issues.

ASHRAE's position is that

- integrated building design, construction, operation and maintenance contributes to limiting mold growth within buildings by addressing all aspects of moisture management.
- excessive moisture indoors contributes to other environmental stressors in buildings.
- managing the sources of water or water vapor within an area is an essential first step in reducing mold growth. In areas where water or water vapor cannot be avoided, the selection of building materials should reflect this reality.
- HVAC systems can, in a limited but critical role, contribute to controlling conditions that can lead to mold growth and can help address it when it occurs.
- the properties of building materials related to moisture and mold must be taken into account during design, construction, operation, and maintenance.
- variations in building use and occupancy affect building performance and can create conditions beyond the ability of the building and its HVAC system to manage moisture. HVAC systems have a key role to play in the control of indoor humidity once excessive moisture sources have been eliminated.
- an indoor moisture analysis at both full and part load and consideration of independent humidity management are essential parts of any HVAC design.
- moisture management strategies can be effectively integrated with energy efficiency strategies to enhance building sustainability.

ASHRAE is committed to

- providing collaborative expert information on mold and moisture control.
- working with stakeholders to contribute to reasonable, scientifically acceptable and effective moisture and mold control initiatives within government and non-government institutions.

- supporting the development of standards and guidelines on the design, construction, operation and maintenance of buildings that reduce the potential adverse impact of mold or moisture on health, comfort and energy.
- supporting research for limiting indoor mold growth and managing moisture in building systems to develop and advance HVAC technologies and tools that minimize impact on the environment while enhancing performance, cost-effectiveness and safety criteria.
- encouraging design, construction, operation and maintenance of buildings to limit mold growth and manage moisture.
- helping educate industry, public and stakeholders to understand the complex and multidisciplinary nature of these issues and their solutions and, in particular, the limitations of HVAC systems alone in addressing them.

The Issue

The key issue in limiting mold growth in the indoor environment is to manage the availability of moisture (NYC, 2008; US EPA, 2001). Mold cannot grow without sufficiently available moisture, present in cellulosic materials and spores or other mechanisms of amplification in place. Since the latter two conditions are ubiquitous, moisture management is critical (ASHRAE, 2009a). Where rainwater, groundwater and plumbing leakage can occur; where condensation can occur; or where hygroscopic materials can absorb significant moisture from the air, mold can become a serious concern. Moisture management in one form or another is required to avoid such issues (US EPA, 2001).

Mold is ubiquitous in the environment. It only becomes a significant concern, however, when conditions are right for it to propagate (IOM, 2004; WHO, 2009; ASHRAE, 2009b). When it does it may cause concerns for occupants in a variety of ways. Molds can cause decomposition and degradation of materials, produce mycotoxins or irritating substances or merely be aesthetically displeasing. Regardless of the specific impact, moisture management is usually the most effective means of controlling mold growth.

The issues for stakeholders who are prudently trying to avoid future problems are different than the issues for stakeholders who are trying to address a known or suspected mold problem.

Background

Ubiquitous in nature, fungi perform an active role in the decomposition of organic material and the natural recycling of nutrients from wood, wood-products and vegetation in the environment. Fungi also are used in industry (biodegradation), pharmaceuticals (antibiotics) and food production (cheese, alcoholic beverages). Fungi are microscopic organisms that form visible colonies or other structures when growing on a suitable material with adequate moisture under favorable environmental conditions.

Mold is a term used to describe a broad range of fungi. Mold reproduces through the production of microscopic spores that are dispersed by wind, rainfall and physical disturbance. A mixture of fungal types that are mostly derived from botanical sources is generally present in the outdoor air and in the air in well-maintained dry buildings. However, mold can colonize and grow in indoor environments that are affected by excess moisture. The management of water or moisture is a key limiting factor for mold growth in buildings. Ineffective water management can result in elevated concentrations or the predominance of some fungi species that have been associated with indoor air quality (IAQ) concerns (ASHRAE, 2009a; Bornehag C.-G, et.al., 2005).

Evaluating conditions where mold amplification is observed or suspected requires thorough investigations to avoid inaccurate conclusions and recommendations (US EPA, 2001). Remediation of existing problems may require combined technical, medical and communications expertise, therefore ASHRAE members play a necessary but partial role in comprehensive responses to existing problems.

ASHRAE Role

ASHRAE is the primary organization for the technical aspects of design, construction and operation of HVAC systems and building envelopes. ASHRAE has a long history of developing standards, guidelines, design guides and special publications that provide design criteria that are in part intended to help limit mold growth within buildings. In addition, ASHRAE, through its conferences and network of chapters, provides seminars and programs, focuses on technical information and disseminates information on good design practices to limit mold growth.

Failure to address the impact of moisture in buildings is a frequent contributor to mold growth in buildings. While no cognizant authority has established threshold limit values for contaminants associated with mold growth, extensive mold growth has been associated with IAQ complaints including odor or irritation. It is important to note that comprehensive moisture and mold management requires a three-phase approach: prevention, mitigation and remediation. In addition, communication with concerned parties is always critical in effective management approaches.

ASHRAE's primary focus is the design of systems that limit and manage moisture accumulation within buildings. An integrated approach is required and specific technical information cannot be taken out of context. ASHRAE's technical expertise should be utilized in the development of any standards or guidelines addressing moisture and mold management. As the key professional and technical organization for HVAC, ASHRAE contributes to a better understanding of the technical means to control indoor humidity and its interaction with the building envelope in an environment in which sources and tolerances for mold and moisture are changing. Building solutions can best be achieved through an integrated systems approach that incorporates thermal envelope properties and local conditions with HVAC systems.

ASHRAE intends to provide leadership in developing expert guidance on the management of moisture within buildings through developing standards, technical publications and research. ASHRAE intends to provide expert guidance in controlling environmental conditions related to HVAC with specific emphasis on humidity control, moisture removal and integrating moisture management with energy efficiency.

Sustainability in buildings has led to rapidly changing approaches to buildings and their systems and may require innovative technical approaches to moisture management. ASHRAE accepts the role to provide guidance on appropriate moisture management practices through integrated building design, construction, operation and maintenance to limit mold growth within buildings. ASHRAE further accepts the role to educate its membership and policymakers on the key issues and their resolutions with respect to moisture control in buildings.

ASHRAE recognizes a key role in collaborating with other institutions and organizations that have specific expertise in areas related to mold and moisture, including, but not limited to, health professionals, component and materials manufacturers, occupant and consumer groups and regulatory agencies.

Review of Key Literature

The World Health Organization (WHO, 2009) and Institute of Medicine (IOM, 2004) recently reviewed the literature related to the potential health impact of damp/moldy buildings and generally agree that there is sufficient epidemiological evidence from studies conducted in different countries and climatic conditions to show that a subset of occupants of damp or moldy buildings, both homes and public buildings, are at increased risk of experiencing respiratory symptoms, respiratory infections and exacerbation of asthma. Although not many intervention studies are available, their results show that resolution of dampness problems leads to a reduction in potential adverse health outcomes. (Fisk et al, 2007; Akpinar-Elci et al, 2007; Kim et al, 2007; Park et al, 2006; Ebbehøj et al, 2005; Bornehag et al, 2005; Nevalainen and Seuri, 2005; Mendell and Heath, 2005; Bornehag et al, 2004.)

Building envelope engineering and technology, building pressurization issues and HVAC systems, all of which are a prime concern for ASHRAE, are crucial in moisture management in buildings. The conditioning of air often includes the addition or removal of moisture. As a result, portions of HVAC equipment and components are often wet. The HVAC system provides a method of moisture control and is a critical building system that requires diligent moisture management. The building envelope must be able to manage moisture and be engineered and constructed so that it works in concert with the HVAC system design and performance.

Ongoing Studies and Research

ASHRAE is supporting research to develop and advance high performance, cost-effective and safe HVAC tools and technologies that limit mold growth and manage moisture in buildings while achieving low environmental impact.

Research in moisture control in buildings through the HVAC system is currently on-going in several countries. The primary focus of this research is to be able to achieve desired indoor humidity levels in the most energy-efficient manner. Such research programs include the following:

- Energy efficient cooling and dehumidifying coils
- Run-around coils and heat pipes
- Desiccant dehumidification systems
- Decoupled ventilation systems such as DOAS (Penn State University), single coil twin fan system (National University of Singapore), personalized ventilation system (Technical University of Denmark, National University of Singapore, Syracuse University, Hong Kong Polytechnic University, etc.)

Recommendations

ASHRAE holds a position that

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- excessive moisture indoors contributes to other environmental stressors in buildings.
- managing the sources of water or water vapor within an area is an essential first step in reducing mold growth. In areas where water or water vapor cannot be avoided, the selection of building materials should reflect this reality.
- HVAC systems can, in a limited but critical role, contribute to controlling conditions that can lead to mold growth and can help address it when it occurs.
- the properties of building materials related to moisture and mold must be taken into account during design, construction, operation, and maintenance.
- variations in building use and occupancy affect building performance and can create conditions beyond the ability of the building and its HVAC system to manage moisture. HVAC systems have a key role to play in the control of indoor humidity once excessive moisture sources have been eliminated.
- an indoor moisture analysis at both full and part load and consideration of independent humidity management are essential parts of any HVAC design.
- moisture management strategies can be effectively integrated with energy efficiency strategies to enhance building sustainability.

ASHRAE recommends that further research be conducted on

- methods and tools for predicting moisture and mold problems.
- moisture-related material properties.
- innovative systems for independent humidity control.
- occupant impacts on moisture production and humidity acceptability.
- methods for controlling mold growth in high moisture environments such as natatoriums, locker rooms, and greenhouses.
- minimizing the energy utilization of humidity control systems.
- quantifying the threshold limits of human reaction to molds.

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- supporting research for limiting indoor mold growth and managing moisture in building systems to develop and advance HVAC technologies and tools that minimize impact on the environment while enhancing performance, cost-effectiveness and safety criteria.
- encouraging design, construction, operation and maintenance of buildings to limit mold growth and manage moisture.
- helping educate industry, public and stakeholders to understand the complex and multidisciplinary nature of these issues and their solutions and, in particular, the limitations of HVAC systems alone in addressing them.

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