
OZONE GENERATORS AND INTERIOR MOLD REMEDIATION

A Recipe for Disaster

As an instructor for mold remediation and indoor air quality investigation classes I am frequently asked about the effectiveness and appropriateness of using ozone generators during mold remediation. Many students are coming from the fire restoration industry where ozone generators are often used to remove smoke odors from contents. For other students the questions about the effectiveness of ozone for mold work are prompted by equipment vendors who indicate that ozone generating machines are perfect for the task. The potential benefit of resolving the toughest mold problems by simply plugging in a machine that “kills mold dead” sounds too good to be true – and it is!

Some Basic Science

Ozone is a naturally-occurring gas. As part of the upper levels of our atmosphere it protects our planet from harmful wavelengths of solar radiation. But in an interesting turnabout, when ozone is present near the surface of the earth it is a harmful pollutant. Ozone’s dual identity as both friend and foe is based on its chemical properties; it is a molecule composed of three atoms of oxygen linked together. Ozone is different than the life-giving oxygen that we breathe in that the basic oxygen molecule contains only two linked atoms. Ozone’s third oxygen atom is more weakly bound than the other two, allowing it to detach from the ozone and reattach to molecules of other substances, a process known as chemical reaction. It is ozone’s propensity for chemical reaction that makes it so intriguing as a potential fungicide and dangerous at the same time.

Ozone’s molecular makeup and resultant chemical reactivity is the source for many of the marketing euphemisms that are used to sell air cleaners that incorporate ozone generators. Ever since the manufacturer of Alpine Air Cleaners was successfully sued by the Federal Trade Commission for false advertising for claiming health benefits associated with ozone, marketing professionals have tried to avoid using the “O” word. Instead, potential buyers are enticed with such terms as “pure air”, “energized oxygen”, “activated oxygen”, “atomic oxygen”, or “excited oxygen”. The terms “springtime fresh” and “removes harmful odors” are often used to fool the potential buyer into thinking that the reactive nature of ozone is somehow healthy.

As is often the case, in this type of marketing literature the truth is the first victim in the effort to separate consumers from their money. Claims are often made that *activated oxygen* will break down most chemicals into simple by-products such as carbon dioxide and water. According to the proponents of ozone generators the amazing benefits are so great that *atomic oxygen* will not

only remove the musty odor associated with mold, but will kill the mold as well. Not surprisingly, such promotional literature fails to mention the risks of ozone use even as it overstates the benefits. Pets, indoor houseplants, rubber gaskets, plastic coatings such as electrical wire insulation, fabrics, artwork and other materials and contents in buildings can all be damaged by exposure to ozone.

Then there is ozone's effect on humans since its chemical reactivity does not stop when it enters the body; it continues to release the extra oxygen atom, which damages cells. This released oxygen atom is an oxidizer, the opposite of an anti-oxidant that we might take to improve health. Even low levels of ozone can damage the lungs and other parts of the respiratory system. Exposure to ozone often leads to chest pains, asthma attacks and a number of related breathing problems. Permanent damage can occur from long-term contact, including degradation of the body's ability to fight respiratory infections.

These well documented scientific and medical facts form the basis for a number of health standards related to ozone. Four different government agencies have restrictions on ozone exposure, including the Food and Drug Administration (FDA), the Occupational Safety and Health Administration (OSHA), the National Institute of Occupational Safety and Health (NIOSH), and the Environment Protection Agency (EPA).

A Focus on Restoration and Mold Remediation Projects

As noted earlier, the most widely accepted use of ozone in the restoration industry is to neutralize smoke odors. This is generally done in specially-built chambers where the ozone level can be monitored and controlled. Contents are moved in and the chamber is sealed before ozone is introduced for an extended period of time, often overnight or longer. No one is allowed in the chamber while the ozone is circulating. At the end of the processing period the air in the chamber is exhausted and the materials are flushed with fresh air before restoration technicians enter and handle the contents.

Whether such a process is effective on mold-contaminated contents is questionable. To have an impact on biological contaminants, such as bacteria and mold, those organisms must be exposed to ozone levels five to ten times higher than the various public health standards allow. This forces any contractor wishing to use ozone as a decontamination process for contents to move them to ozone chambers, as is done currently with fire-damaged contents. However, a 1997 study showed that even high levels of ozone were not sufficient to impact biological contaminants embedded in porous materials. While that study focused on porous materials such as HVAC duct lining and ceiling tiles, anecdotal data from many professionals in the field supports the contention that even ozone chambers are not effective at killing mold if it is growing on things like clothes and shoes.

With the use of ozone in occupied areas out of the question, a push was mounted by some manufacturers to have ozone generators incorporated into isolated remediation areas to ensure that all the mold was dead. For a while it was somewhat common to see mold remediation specifications call for flooding the work area with ozone for 24 to 48 hours following the gross removal and cleanup. The problems and resultant lawsuits caused by this practice were enough to put a relatively quick end to such job requirements.

In one memorable case our organization was contacted to assist with the mess that was a direct result of ozone being used as the final step in a mold remediation project. The stage area of a gym/auditorium was isolated with plastic barriers so that mold-contaminated drywall could be removed from two walls. The remediation was finished on Friday so that the school could be totally evacuated over the weekend while ozone generators were run in the work area. School personnel also decided to use this downtime to refinish the gym floor since the evacuation would keep people off the floor while it dried. Unfortunately, the ozone degraded many of the barrier seals and infiltrated into the gym that Friday night. On Saturday when a technician arrived to check the condition of the mold project, even his respirator could not screen the horrible odor. A smell, best described as a cross between a skunk and burning cabbage, had permeated most of the building, including the adjacent library. It was later theorized that the ozone had reacted with the pinene in the floor finish. Several weeks of cleaning and air scrubbing, coupled with a building bake out, were necessary to bring the school to a habitable state.

Although this may sound like a one in a million occurrence, there is good scientific evidence documenting such adverse reactions. Studies in 1992, 1994, and 1996 all proved that when ozone reacts with chemicals it often produces irritating and even harmful by-products. Even when ozone breaks down long chain hydrocarbons the results may not be favorable. Odor reduction may be achieved in such situations with the consequence of increasing other volatile organic chemicals such as aldehydes and formic acid.

The Verdict Is In

Anyone considering using ozone for mold or indoor air quality restoration efforts does so at his or her own risk. Professional restoration contractors should avoid the hype and understand that ozone has a limited role in the industry. It needs to be closely controlled and monitored for those activities in which it is effective, such as smoke deodorization. The use of ozone generators is not the magic wand that is going to eliminate the tough work of mold remediation—the careful removal of mold-contaminated materials from indoor environments.

Anyone interested in more detailed information regarding this topic should visit the EPA's website at www.epa.gov/iaq/pubs/ozonegen.html to view a document entitled "Ozone Generators that are Sold as Air Cleaners: An Assessment of Effectiveness and Health Consequences".

About the Author

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This article was published in the April 2005 issue of *Cleaning and Restoration* magazine.