

## AIR PURIFICATION SYSTEMS

The goal of air purification is to remove contaminants from the air we breathe. Considering we breathe 23,000 times a day and move around 435 cubic feet of air, this is a major concern. Indoor air pollution is now considered by the EPA and Congress a major environmental health problem. Mold once considered just an unpleasant product of nature is now believed to be the cause of many respiratory diseases. Most colds and viruses are caught indoors by airborne germs. Indoor air pollution, left unchecked, can lead to sick buildings. With today's technology, indoor air pollution is no longer a necessary evil of today's tightly built, energy saving buildings. Indoor air pollution has a wide scope of symptoms, which generally include the following:

- Headaches
- Fatigue, Dizziness
- Eye Irritations
- Asthma Attacks
- Memory Loss
- Depression
- Skin Irritations
- Sinus Infections

### 2003 mold damage claims might hit \$1 billion

New York - Mold damage claims will hit \$1 billion again in this year, according to the McGraw-Hill Construction newsletter. One article quotes a national insurance expert as saying that mold will trigger about 300,000 damage claims nationwide this year. According to the expert, the average mold-damage claim is \$20,000 per homeowner and \$200,000 per commercial property owner.

- Breathing Problems
- Colds, Flu and Viruses

The traditional method of indoor air filtration is to force the room air through an HVAC duct filter, usually consisting of simple fiberglass or open-cell foam fibers, that are capable of removing only particulate matter over 10 microns in size. Microbes and polluting gases pass right through the filter, and in fact, the dust and dirt build-up on the filter can act as a breeding ground for bacteria, mold and fungus. In order to properly decide on an air purification device, we must first identify the problem and then prescribe the technology for the solution. Indoor air pollution consists of three major categories:

**Particulates** - These consist of minute solids drifting in air currents. Particulates consist of dust, dander (skin flakes), soot, pollen, and smoke particles. Size range: .001 to 1,000 microns.



**Microbes** - These are bacteria, germs, viruses, fungi, spores and mold. Size range: .001 to 10 microns.

**Gases/Odors** - Indoor gases, such as benzene, formaldehyde, chloroform, hydrogen sulfide, ammonia, etc., are released from furniture, cabinets, carpets, cleaning chemicals, copy machines, insulation, insect sprays, hair sprays, etc. Size range: .0001 to .001 microns.



**Air purification technologies consist of the following:**

- Filters
- Ionizers

- Ozone Generators
- Ultraviolet Light Rays
- Photohydroionization (PHI)

## FILTERS

In general, filters permit some pollutants to pass with the air flow. The higher the efficiency or density of the filter, the lower the air flow and higher restriction to the blower.

### HEPA Filters:

HEPA stands for high efficiency particulate air filter. HEPA filters utilize a powerful blower to force the air through a very tight membrane to achieve high efficiency particulate filtration. They are very efficient in the filtering of air that passes through the filter. They filter to .3 micron. They require filter changes. The filter can act as a breeding ground for bacteria, mold and fungus. They do not remove odors, gases, pesticides, viruses, and many bacteria. They reduce air flow due to the tight pores of the filter. They are generally not used in central systems, and are sold as stand-alone units only.

### Carbon Media Filters:

Carbon filters consist of carbon impregnated filter fabric or granulated carbon. These filters usually have a foam or fabric filter to hold the media. Carbon has the unique capability of acting as a physical filter trapping particulate, and on a chemical basis by reacting with some odors and some of the heavy gases.

### Fiber/Foam Filters:

Fiber or open-cell foam filters rely on the air passing through a matrix of foam cells or fibers of fiberglass, wire, plastic or cloth. Typically, these filters only stop medium to large particulate.

## IONIZERS

### Electrostatic Precipitators:

Electrostatic Precipitators have been used by industry for many years to clean up smoke stack emission of particulate. They operated by electrically charging a field between metal plates. The air is charged with an electrical charge similar to static electricity. The charged particulates collect and coagulate on a second set of charged plates where they build up and fall to a collection tray. They require frequent cleaning and only filter the air that passes through the filter. The particle build-up can act as a breeding ground for bacteria. Some manufacturers install UV lights to kill these bacteria.

### Negative Ion Generators:

Negative ion generators have been used by industry for years to remove particulates from the air and to neutralize the effects of excess positive ions. Negative ions are produced electrically and travel through the air until they attract airborne particulate and coagulate the particulates until they are too heavy to drift and settle to the floor. They are very effective on removing smoke from the air. They travel throughout the entire room and purge all the air of particulate, not just the air that passes through a filter. They drop the particulates to the ground. They must be in each room as the ions cannot effectively travel through HVAC ducts. Some manufacturers claim negative ions can make you feel better. We find no credible studies to confirm this as it is a very subjective topic. The following is a comparison of indoor air quality systems for

HVAC contractors utilizing filterless system of Ozone and UV light:

- UV Germicidal Lamps
- UV Ozone Lamps
- Corona Discharge Ozone Systems
- UV Catalytic Oxidation Systems
- Photohydroionization™ System
- PHI Cell

## Ultraviolet Light and Ozone

Ultraviolet Light and Ozone are receiving a lot of attention concerning indoor air quality. Both are nothing new. They have been used for decades in hospitals, medical applications and the food industry. We will outline each of the technologies used by the HVAC contractors and discuss the pros and cons of each.



### UV-C - Germicidal Lamps

These are rapidly becoming very popular as an easy fix for the air conditioner coil mold problem. This is the most prevalent cause of the building

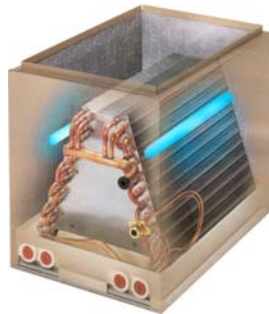
mildew smell you get when you enter an air-conditioned sick building. UV-C (254nm) lamps are basically similar to sun lamps and are typically only effective on microbials that pass by within a few inches of the lamp or areas where the light is shining directly on for extended periods of time, such as the air conditioner coil (see article in HVAC News - yellow highlighted).

**Pros:** Low cost, easy installation, and effective on suppressing mold growth on the coil.

**Cons:** Not effective at killing airborne mold unless numerous lamps are used (see article) only effective on the surface of the coil that is in direct light. This leaves much of the coil with no treatment. Does not provide ongoing room protection. Most UV systems install a glass UV mercury bulb without protection from breakage. A broken bulb could release mercury, a potential environmental and health hazard.

Minimum of two lamps must be used to cover at least one-quarter of the coil surface (the upper half of the outer coil). For one-half coverage, three to six lamps must be used. 100% coverage is not practical.

According to "Proper Design of an HVAC Bacteria Control System" by James Hart P.E. In order to have a 90% kill rate on a very basic bacteria (Bacillus Subtills), you would need 47 30" UV lamps placed in 95' of duct 12" x 30". This is obviously beyond the ability of most homes.



### UV-C - Ozone Lamps

UV lamps in the 185nm range produce low-level ozone, just as the sun does, which is very effective in odor, microbial and VOC's reduction.

**Pros:** Low cost, easy installation, and effective on mold, smoke, odors and bacterial. The ozone gas travels through the house to provide ongoing treatment, unlike the UV-germicidal lamps where only the air that passes within inches of the bulb is treated.

**Cons:** Ozone is a concern to some people. Improper systems

could produce ozone levels exceeding Federal guidelines. Ozone does not work on all odors and VOC's. Most UV systems install a glass UV mercury bulb without protection from breakage. A broken bulb could release mercury, a potential environmental and health hazard.



### Corona Discharge Ozone Systems

These systems simulate lightning with a corona electric arc or spark. Strong ozone is produced by converting the oxygen (O<sub>2</sub>) to ozone (O<sub>3</sub>).

**Pros:** Low cost. Ozone effective on odors, bacteria, VOC's and mold.

**Cons:** Air is 80% Nitrogen and 20% Oxygen. These units convert Oxygen to Ozone. They also convert the Nitrogen to Nitric Acid and Nitric Oxides, which causes maintenance problems due to corrosion. They produce high concentrations of ozone, usually well over Federal safe limits as well as air-borne Nitric Oxides. These systems typically will require expensive monitors to control ozone levels. Also, arcing (sparking) can be a noise and safety concern.

Note: Corona Discharge Ozone Units should never be used for air purification in occupied areas, as they will usually exceed Federal safety limits of ozone.

### UV Catalytic Oxidation Systems

This system utilizes a Titanium grid as a catalyst for UV-C (254nm) germicidal light. Air that passes through the grid and comes in contact with the catalyst is purified by Hydroxyl Radicals that are formed on the Titanium grid. Also, the UV-C light rays kill microbials that pass by them.

**Pros:** Effective on the air that passes through the system for mold, bacteria and VOC's.

**Cons:** Expensive, large, substantial installation, and not effective on odors. Only treats the air that contacts activated target surfaces as it passes through the unit. Most UV systems install a glass UV mercury bulb without protection from breakage. A broken bulb could release mercury, a potential environmental and health hazard.



### Photohydroionization™ System



This is an advanced oxidation system that consists of a UV-Ozone producing bulb (185nm) targeted on a catalyst target, which produces low-level ozone. Hydro peroxides and super oxide ions

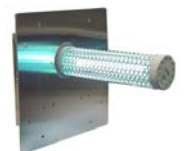
**Pros:** Low cost, low maintenance (yearly), and easy installation. Not only does this process treat the air that passes through the device, it sends low-level ozone (.04 ppm), hydro peroxides and super oxide ions into the room for complete coverage.

(Note: The Federal limit for ozone devices is .04 ppm.)

**Cons:** Ozone is a concern to some people even when it is within federal safety limits. Most UV systems install a glass UV mercury bulb without protection from breakage. A broken bulb could release mercury, a potential environmental and health hazard.

### PHI Cell™ (Photohydroionization™ Cell)

This is the latest advanced oxidation technology that consists of a proprietary, high-



intensity broad spectrum UV tube (100 - 300nm) in a hydrated catalytic matrix cell (Quad-Metallic). Low-level ozone is produced in the cell, the majority of which is converted into airborne hydro peroxides, super oxide ions, ozonide ions and hydroxides. The UV bulb is encased in a protective poly tube to prevent any glass or mercury breakage/leakage. Also, the entire assembly is encased in a protective metal cell.

**Pros:** Low cost, no maintenance (25,000 hour life, 3 year

warranty), easy installation, airborne hydro peroxides, super oxide ions and very low-level ozone (.01 - .02 ppm\*) travels through the house providing 24-hour protection against airborne mold, bacteria, viruses, odors and VOCs. The cell also acts as a germicidal lamp and treats the air that passes by it. The cell has a built in fiber optic which acts as a remote indicator. **Cons:** None

(\*Note 1: Federal safety limits are .04 ppm. At .01 - .02 ppm this is not considered an ozone device.)

### HVAC Comparison Summary

	UV-C Germicidal Lamp	UV-C Ozone Lamps	Corona Discharge Ozone Systems	UV-C Catalytic Oxidation Systems	Photohydroionization™	PHI Cell™
Designed for HVAC Systems	Yes	Yes	Yes	Yes	No	Yes
Provides whole house air purification	No	Yes	Yes	No	Yes	Yes
Keeps mold from growing on AC coil	Yes	?	?	No	Yes	Yes
Reduces odors, VOC's, bacteria, viruses and mold throughout the house	No	?	?	No	Yes	Yes
Low initial cost	Yes	Yes	No	No	Yes	Yes
Low installation cost	Yes	Yes	No	No	Yes	Yes
Reduces microbials by over 90% throughout the house	No	?	?	No	Yes	Yes
Provides a broad range of disinfection	No	No	No	Yes	Yes	Yes
Low maintenance	Yes	Yes	No	?	Yes	Yes
Low power consumption	Yes	Yes	No	?	Yes	Yes
Meets Federal ozone safety guidelines	Yes	?	No	Yes	Yes	Yes
Has the broadest range of effectiveness	No	No	No	No	No	Yes
One unit will service an HVAC System	No	Yes	Yes	Yes	?	Yes
UV bulb is protected from breakage & mercury contamination	No	No	N/A	No	No	Yes
Has 3 year warranty 25,000 hour life	No	No	No	No	No	Yes
Provide point of source microbial reduction sneeze test	No	No	No	No	?	Yes