Comparing 10 Indoor Air Quality Technologies

The types and amounts of gases, airborne matter and other pollutants determine indoor air quality (IAQ) which directly effects the wellbeing of a building's occupants. Moreover, the variety of indoor air pollutants makes it impossible for any single technology to control them all cost-efficiently. Following is a brief description and comparison of ten basic technologies for the removal of indoor air pollutants.

Indoor Air Quality

People are the greatest source of indoor air pollution. Each person breaths an average 17,000 times per day an air volume roughly that of a coffee mug. Each breath consumes 4 to 5% of the oxygen in the air and expels an equal amount of CO_2. It is the 1,000 ppm limit on indoor CO_2 levels that requires the use of outdoor air or other techniques to dilute it or remove it. Besides human-produced CO_2, indoor air pollution can include bacteria, viruses, dander, dust, mites, pollen, carbon monoxide, carbon dioxide, formaldehyde, smoke and volatile organic compounds (VOCs).

To maintain indoor air quality at acceptable levels, there are three basic processes:

1. Eliminate the pollution source(s) – often impossible
2. Dilute pollutants with outdoor air – can greatly increase energy costs, and
3. Remove pollutants from indoor air – a more popular option.

Following are ten technologies designed to remove pollutants from indoor air:

Comparison of Typical Indoor Air Pollution Removal Technologies

	Mechanical		Ultraviolet		Electronic			Chemical		Biological
Attributes	Particle Filter	HEPA Filter	UVC	Far-UVC	PCO	EPS	Bipolar Ionization	Carbon Filter	Chemical Filter	Biofilter
Primary Mechanism	Filtration	Filtration	UV Irradiation	UV Irradiation	Oxidation	Electrostatic Attraction	Ionization	Adsorption	Oxidation	Bio-degradation
Pressure Drop	Fair	Poor	Good	Good	Good	Good	Good	Poor	Poor	Poor
Particle Size	Fair	Good	Not Applicable	Not Applicable	Good	Good	Good	Fair	Fair	Fair
VOCs	Poor	Poor	Poor	Poor	Good	Poor	Good	Good	Good	Good
Bacteria, Virus, Fungi	Poor	Good	Good	Good	Good	Good	Fair	Fair	Good	Fair
First Cost	Good	Fair	Fair	Not Applicable	Poor	Poor	Fair	Fair	Fair	Poor
Operating Cost	Good	Poor	Fair	Not Applicable	Fair	Fair	Good	Poor	Poor	Fair
Energy Cost	Good	Poor	Good	Good	Good	Good	Fair	Poor	Poor	Poor
Hazardous Waste	Poor	Poor	Good	Good	Good	Fair	Good	Poor	Poor	Poor

Good
Fair
Poor
Not Applicable

Pressure Drop: Good = low
Particle Size: Good = small
VOCs & Bacteria, etc.: Good = high destruction rate
Hazardous Waste: Good = no hazardous waste generated

Mechanical Air Filtration: Particle filters and HEPA filters

Mechanical filters are a universal IAQ technology for removing airborne particulate and debris to protect downstream ductwork and equipment. These filters frequently are made of materials such as polyester, cotton and fiberglass and are usually disposable. “HEPA” (High Efficiency Particulate Air), the most efficient filters, are designated for the control of sub-micron size particles and airborne pathogens.

Ultraviolet Light: UVC and Far-UVC

Ultraviolet (UV) light in the range of 100 - 280 nanometers or “UVC” has been used to improve air and water quality for decades. While UVC does nothing to remove particulate, it is very good at deactivating bacteria, viruses, fungi, etc. Unfortunately, the typical UVC light for IAQ purposes is harmful to humans and can only be used in unoccupied spaces.

Far-UVC is the designation given to a range UVC light between 200 to 220 nanometers. Not yet fully commercialized commercialized, Far-UVC is purportedly much safer for humans than traditional UVC and may offer superior pathogen elimination.

Electronic: Electrostatic precipitator and bipolar ionization

Electrostatic precipitators (ESPs) are very effective (>99%) at removing matter from an airflow. Airborne particulate picks up a charge as it passes through a high voltage grid and is then attracted to grounded metal plates. The particulate buildup on the plates is removed by wet or dry methods. ESPs are commonly used in commercial and industrial applications.

Bipolar ionization is a relatively new technology that uses high voltage electrodes to produce positively and negatively charged ions or hydroxyl radicals that attach themselves to virtually all types of pollution in the airflow. The ions and radicals remove pollutants by 1) breaking them down, 2) causing them to be attracted to solid surfaces or 3) bonding matter together until it is too heavy to remain airborne.

Chemical: Carbon filters, chemical filters and photocatalytic oxidizers

Carbon filters have been used for hundreds of years primarily to filter impurities from water. Activated carbon air filters are effective at removing ozone, VOCs and odors from an airflow because the carbon’s huge surface area removes the pollutants by adsorption.

Chemical filters such as a media impregnated with potassium permanganate and activated alumina are very effective at removing odors, chemicals and VOCs by adsorption, absorption, and oxidation.

Photocatalytic oxidation (PCO) is effective at removing pathogens, VOCs and small particulate. In PCO, a UVC light causes a photocatalyst such as titanium dioxide to release electrons that break up airborne water molecules to form neutral hydroxyl radicals (·OH). These hydroxyl radicals oxidize pollutants and turn them into harmless substances such as water and carbon dioxide.

Biological: Biofilters

Biofilters for cleaning air, force an airflow through a microbe-containing bed of organic material such as wood chips, peat or compost. The microbes decompose organic pollutants such as VOCs and may the same for certain inorganics such as hydrogen sulfide (rotten egg odor) and oxides of nitrogen (NOx). The relatively low first cost and sustainable nature of biofilters may be offset by the extra cost associated with their large size and weight.

Applying IAQ Technologies

Applying IAQ technology to efficiently meet a building’s needs is not a “plug-and-play” effort. ENGIE MEP has the licensed and certified professionals to evaluate, design, install and balance an IAQ solution for your building for years of reliable performance and service.