- IAQ Improvement
- Germicidal Irradiation
- Energy Savings
- Green Building Benefits

# UV Treatment in HVAC and Other Industries for SARS and Similar Viruses

Ultra-Violet Germicidal Irradiation

*“In this age of globalization, the smarter and healthier buildings require high-performance air engineering solutions.*

*Today, is the need for businesses to make a switch to best engineering practices and promote environmentally responsible products and services.”*


## Who We Are

***Ensuring Quality, Retaining Trust***

We, Ensavior Technologies Pvt. Ltd., are engaged in the promotion of Air Purification Solutions with a vision to provide you with clean, fresh, odourless and purified air to make every place comfy and homey for you. We design, build and install the products and systems using cutting edge technologies based on scientific breakthrough that help clean, filter and purify the air by expelling particulate matters, removing organic and inorganic odours, gaseous pollutants, microbes, allergens, bacteria, viruses, and VOCs.

We engage in the project right from the conceptualization stage and help in right selection, optimum design and implementation of most energy-efficient products. Besides that, we ensure on-site job training to project managers, facility managers and operators so that the systems are operated in most efficient and simplest manner. Based on the needs of the project, we also undertake the operation and maintenance of the system for which we have back up of spare parts and trained manpower.

Every project for us is a golden opportunity for continuous improvement and swift growth. This results in maximum cost-effectiveness, efficiency, and productivity for our customers.

The technologies used are:

- Ultra-Violet Irradiation (UVGI)
- Photo-Catalytic Oxidation (PCO)
- Gas Phase Filtration
- Cold Plasma
- Ionizers (Unipolar & Bipolar)
- Electrostatic Precipitator (ESP)
- Ozonisation
- Adsorbents and Catalysts
- Biological Treatments
- Special Media Filtration

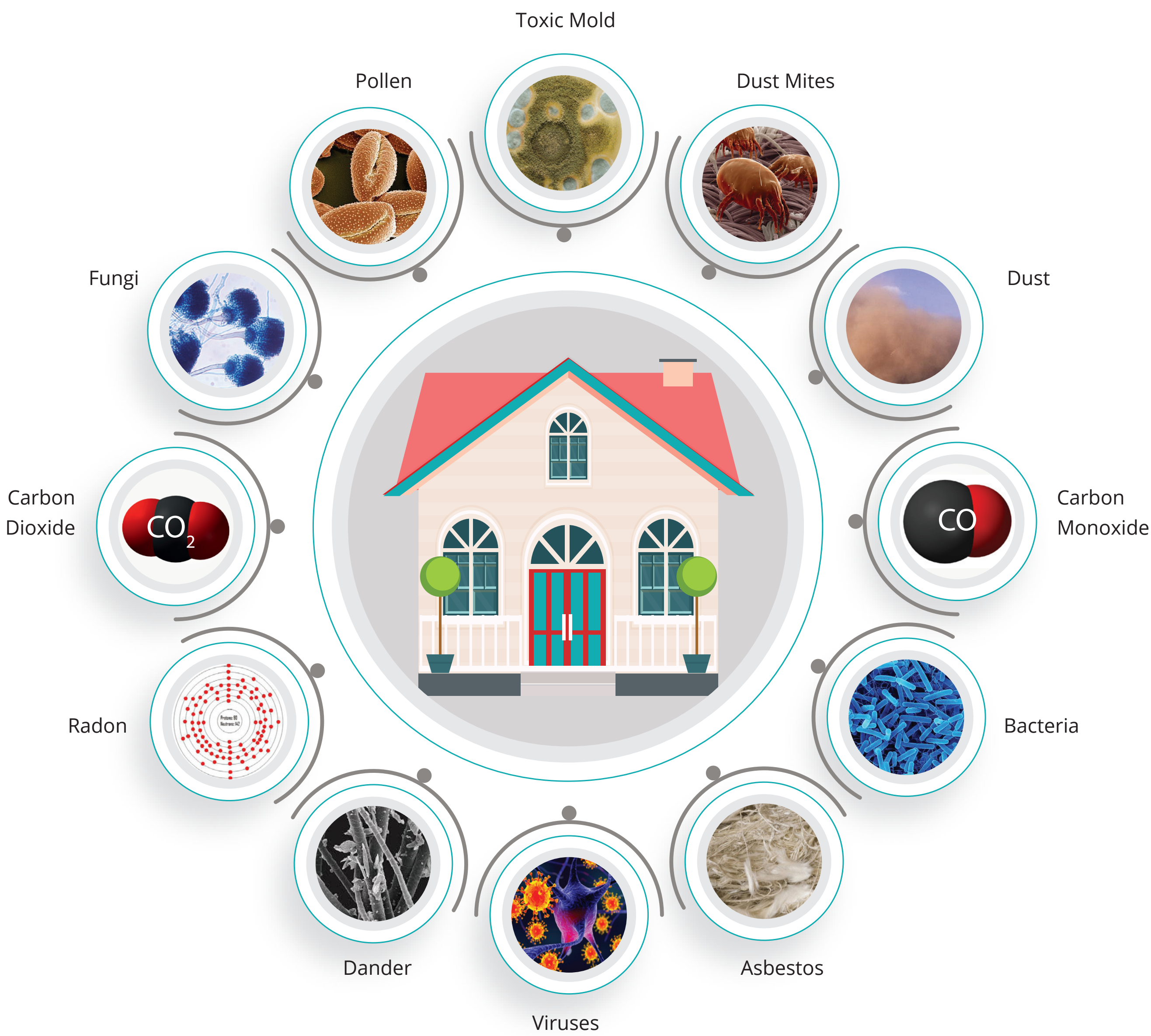
## Importance of Indoor Air Quality

Indoor air quality (IAQ) is one of many factors that determine building functionality and economics.

A building with good IAQ is more desirable place to work, learn and conduct business as it affects building occupants and their ability to conduct their activities and creates positive or negative impressions on them. IAQ directly affects occupant health, comfort and productivity. Serious health impacts resulting from poor IAQ include - Legionnaires' disease, lung cancer from radon exposure, and carbon monoxide (CO) poisoning.

More widespread health impacts include increased allergy and asthma from exposure to indoor pollutants, molds and other infectious diseases that are transmitted through the air, and "sick building syndrome" symptoms due to elevated indoor pollutant levels as well as other indoor environmental conditions. These more widespread impacts have the potential to affect large number of building occupants and are associated with significant costs due to health-care expenses, sick leave, and lost productivity.

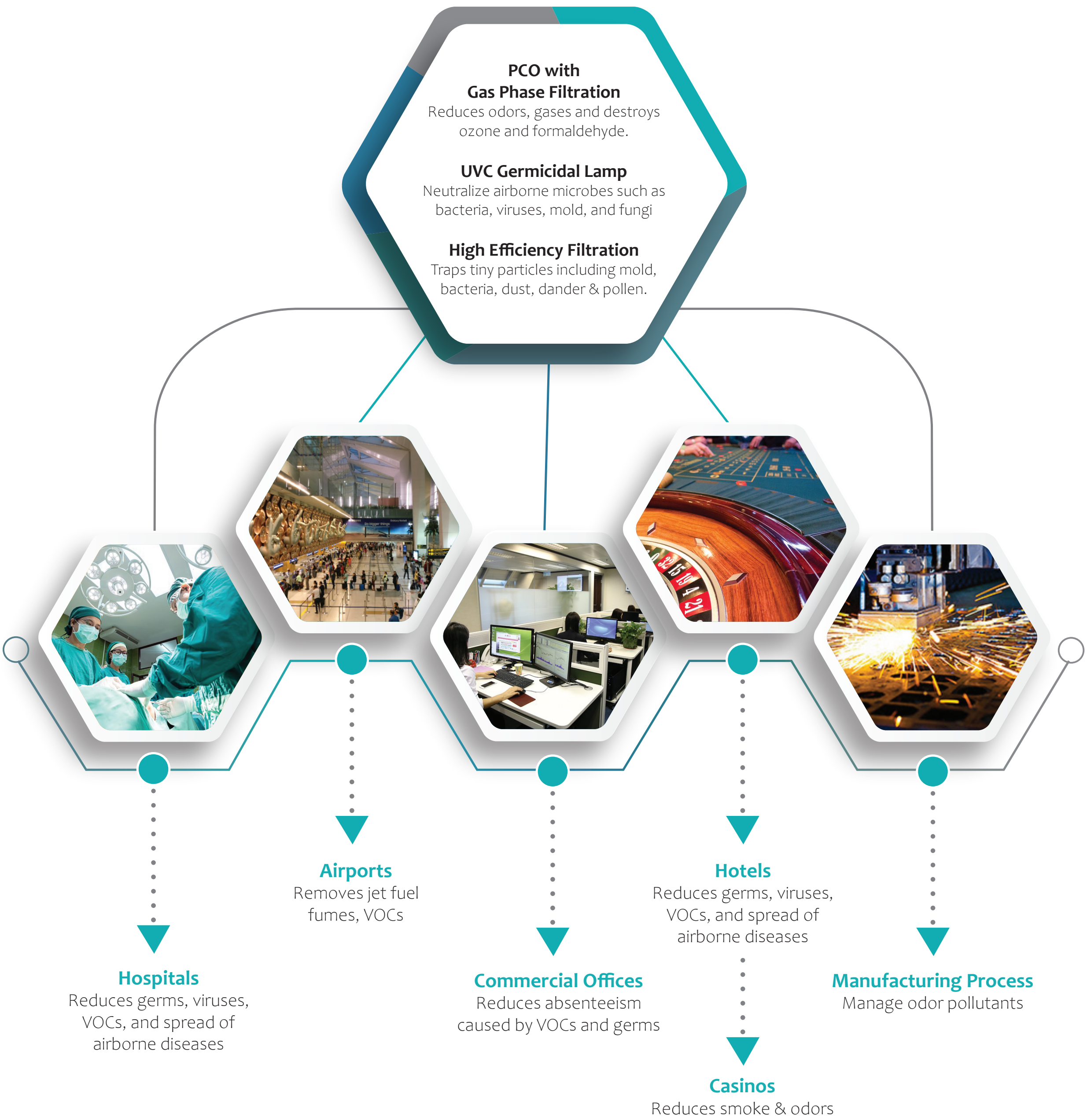
## Contaminants Affecting the Indoor Air



## Solutions for Industries

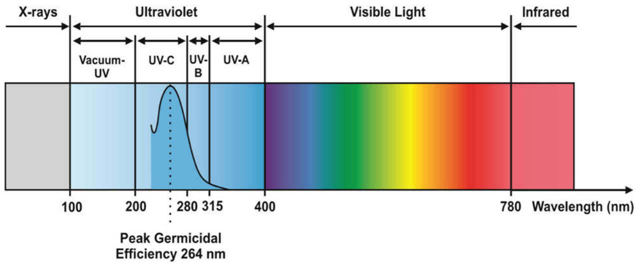
Each project has special air quality needs and challenges, hence we offer a comprehensive solution that is customizable, scalable, effective and robust. Our advanced technology combines high output UVC germicidal irradiation with a state-of-the-art photo-catalytic oxidation process that reduces VOCs and odors. PCO combined with gas phase and high efficiency filtration provides a complete solution for clean, pure, odor-free air and a healthier, people-friendly environment.

### Fresh, Clean, Pure Air



## Ultraviolet Solutions

### *The Electromagnetic Spectrum*

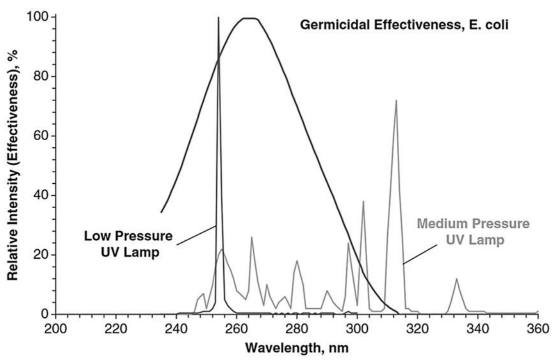



- UV-A — the most abundant in sunlight; responsible for skin tanning and wrinkles
- UV-B — primarily responsible for skin reddening and skin cancer; also used for medical treatments
- UV-C — naturally blocked by the earth's ozone layer and is the germicidal wavelength

The spectrum of ultraviolet light extends from wavelengths of about 100–400 nm. The subdivisions of most interest include UVC (200–280 nm), and UVV (187 nm). Although all UV wavelengths cause some photochemical effects, wavelengths in the UVC range are particularly damaging to cells because they are absorbed by proteins, RNA, and DNA. The germicidal effectiveness of UVC is illustrated in the figure, where it can be observed that germicidal efficiency reaches a peak at about 260–265 nm. This corresponds to the peak of UV absorption by bacterial DNA.

The sun delivers specific UV wavelengths that destroy and deactivate chemical contaminants that are introduced into the atmosphere. Our UV lamp produces the same UV wavelength the sun produces, UVC (Germicidal 254nm) and UVV (Oxidizing 187nm) are produced using quartz glass.

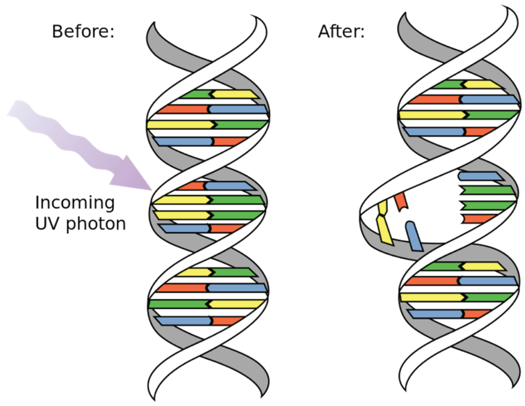
Ultra-violet (UV) energy kills or inactivates microbes (viral, bacterial and fungal species). UV energy attacks the DNA of a living cell, penetrating the cell membrane, breaking the DNA structure of the micro-organism, inhibiting reproduction. UVC is effective in destroying biological contaminants and odours such as mould, bacteria and viruses. UVGI has been used as a supplement to mechanical ventilation to inactivate airborne infectious agents to protect the health of building occupants.




*Germicidal efficiency of UV wavelengths, comparing High (or medium) and Low pressure UV lamps with germicidal effectiveness.*

Low pressure mercury vapour lamps radiate about 95% of their energy at a wavelength of 253.7nm, which is coincidentally so close to the DNA absorption peak (260–265 nm) that it has a high germicidal effectiveness.

UVGI inactivates micro-organisms by damaging the structure of nucleic acids and proteins at the molecular level, making them incapable of reproducing. The most important of these is DNA, which is responsible for cell replication. Absorbed UV photons can damage DNA in a variety of ways, resulting in the organism's inability to replicate or even its death. An organism that cannot reproduce is no longer capable of causing disease. UVGI effectiveness depends primarily on the UV Dosage delivered to the micro-organism.




*Ultraviolet photons penetrate the cell wall of micro-organisms and alter their DNA structure such that the micro-organism is unable to reproduce or infect.*

Vacuum Ultraviolet (UVV)-based processes are used for environmental remediation such as air cleaning, wastewater treatment, and air/water disinfection. When UVV irradiation, photolysis, photo-catalysis, and ozone-assisted oxidation are involved at the same time, it results in the fast degradation of air pollutants because of their strong oxidizing capacity.

Both UVC and UVV wavelengths can work together to destroy biological and chemical contaminants that continually circulate within the building. Depending on the application, UVC, UVV or a combination of both wave lengths are used to achieve the desired results.

### *Applications of UVGI*

- Air-conditioned Offices and Residential Buildings
- Hotel Rooms, Restaurants, Sewage Treatment Plants and Kitchen Exhausts
- Hospitals – OPD, Doctor Chamber, Patient Rooms, Operation Theatres and Laboratories
- Manufacturing facilities of Foods and Pharmaceutical products
- Cold Storage and Refrigerated spaces for storing of fruits, flowers and vegetables etc.
- Industrial Kitchens, Auditoriums, Airports, Cinema Halls and Shopping Malls.

### *Strategy to Address Infectious Aerosols*

**ASHRAE recommends UVGI as one strategy to address infectious aerosol disease transmission.**

Coronaviruses are members of the Corona *viridae* group and contain a single-stranded, positive-sense RNA genome surrounded by a corona-like helical envelope. Coronaviruses have a size range of 60-140nm, with a mean size of 0.10 microns. Table summarizes the results of studies that have been performed on Coronaviruses under UV exposure, with the specific species indicated in each case. The D value indicates the ultraviolet dose for 90% inactivation. The range of D values is 7-241 J/mt² the mean of which is 67 J/m², should adequately represent the ultraviolet susceptibility of the SARS-CoV-2 virus.

*Table – Summary of Ultraviolet Studies on Coronavirus*

| Microbe | Dose (D) J/m² | UV k m²/J | Base Pairs kb | Source |
|---|---|---|---|---|
| Coronavirus | 7 | 0.35120 | 30741 | Walker 2007[a] |
| Berne virus (Coronaviridae) | 7 | 0.32100 | 28480 | Weiss 1986 |
| Murine Coronavirus (MHV) | 15 | 0.15351 | 31335 | Hirano 1978 |
| Murine Coronavirus | 29 | 0.08079 | 31335 | Saknimit 1988[b] |
| Canine Coronavirus | 29 | 0.08079 | 29278 | Saknimit 1988[b] |
| SARS Coronavirus COV-P9 | 40 | 0.05750 | 29829 | Duan2003[c] |
| Murine Coronavirus (MHV) | 103 | 0.02240 | 31335 | Liu 2003 |
| SARS Coronavirus (Hanoi) | 134 | 0.01720 | 28751 | Kariwa 2004[d] |
| SARS Coronavirus (Urbani) | 241 | 0.00955 | 29751 | Darnell 2004 |
| **Average** | **67** | **0.03433** | | |

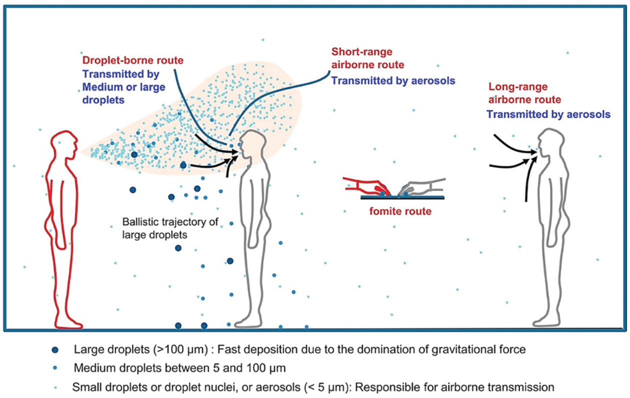
**Ref**: Kowalski, Wladyslaw & Walsh, Thomas & Petraitis, Vidmantas. (2020). 2020 COVID-19 Coronavirus Ultraviolet Susceptibility. 10.13140/RG.2.2.22803.22566.

## Airborne Spread of Infectious Agents

### *In Indoor Environment*

Airborne transmission of infectious agents involves droplets that are expelled by sneezing or coughing or are otherwise distributed into the air. Although the liquid/vapour around the infectious agent evaporates, the residue (or droplet nuclei) may remain in the air for long periods, depending on such factors as particle size, velocity, force of expulsion, particle density, infectivity (i.e., viability of the micro-organism when exposed to the environment and its ability to cause infection when a susceptible host is subsequently exposed), humidity and rate of air flow. Airborne spread of infectious agents is directly relevant to the airborne route, and indirectly to the droplet-borne and fomite routes.

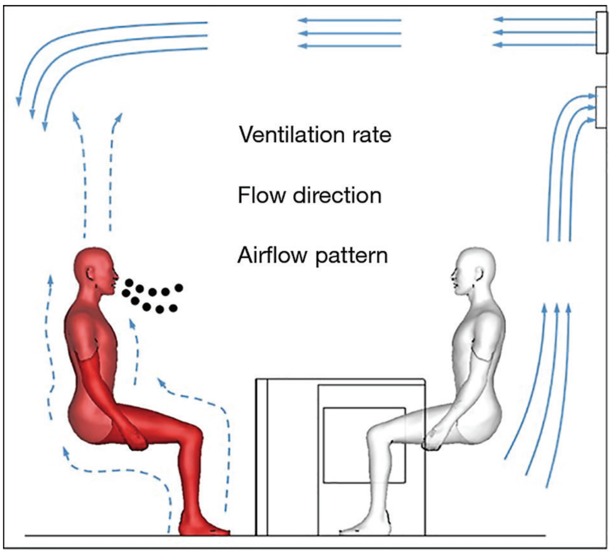
The role of air-conditioning and ventilation, in preventing airborne infections has drawn extensive attention since the SARS outbreak. The mechanism of dispersion of airborne droplets/droplet nuclei in space, the risk estimation of airborne infection, the role of airflow rate, the impact of airflow pattern, etc. are the elements affecting the airborne transmission.




*Small droplets (<5 µm), called aerosols, are responsible for the short & long-range airborne route, and indirect contact route. Large droplets are responsible for the direct spray route and indirect contact route. (Source: Am J Infect Control. 2016 Sep 2;44(9 Suppl))*

### *UVGI Applications and System Types*

| Application | Type of UVGI System | Disinfection Type |
|---|---|---|
| Health Care | Surgical Site Infection Control | Air & Surface |
| | Isolation Wards & Rooms | Air |
| | General Hospital Areas | Air |
| | Emergency Rooms | Air & Surface |
| | TB Clinics | Air |
| | Equipment Disinfection | Surface |
| Commercial Buildings | Bio-defense | Air |
| | Mold Growth Control | Surface |
| | Respiratory Disease Control | Air |
| | Building Remediation | Surface |
| Residential | Allergen & Pathogen Control | Air |
| | Mold Growth Control | Surface |
| Hotels | Allergen & Pathogen Control | Air |
| | Mold Growth Control | Surface |
| Schools | Respiratory Disease Control | Air & Surface |
| Airplanes | Respiratory Disease Control | Air |
| Ships | Disease Control | Air and Surface |
| Laboratories | Bio-hazard Control | Air & Surface |
| Animal Facilities | Airborne Bio-hazard Control | Air |
| Libraries & Museums | Mold Growth Control | Surface |
| | Allergen Control | Air |
| Sewage & Waste Facilities | Bio-hazard Control | Air & Surface |
| Food Industry | Bio-contamination Control | Air & Surface |
| Agricultural Industries | Bio-hazard Control | Air & Surface |
| Industrial Facilities | Bio-hazard Control | Air & Surface |




*Three key elements of air movement affecting the airborne transmission. (Source: J Thorac Dis 2018;10 (Suppl 19):S2295-S2304)*

# UV System Design Criteria

UVC system design relies on performance data from lamp, ballast, fixture and the experience of system designers. UVGI effectiveness depends primarily on the UV dosage (μJ/cm²) delivered to the micro-organisms:

$$D_{UV} = Et$$

where $E$ is the Average UV Intensity in μW/cm², and $t$ is the exposure time in seconds (note that 1 J = 1 W/s).

The ASHRAE 2012 Standard and its recommendation are followed for calculating UV Intensity at coil surface and In-duct system. The formula is:

$$E = \Phi/(2\pi LA)$$

***Where***:

- ***E*** : UV intensity in W/cm²;
- Φ : UV Wattage of UV Lamps;
- Л : Pi;
- ***L*** : Length of lamp (cm);
- ***A*** : Distance between Lamp & Coil surface (cm).

A key difference between surface decontamination and airborne inactivation of organisms is exposure time. The basis of determining the radiant energy levels are as follows:

- Length of Exposure
  - If target is stationary, length of exposure is high.
  - If target is moving, length of exposure is low.
- Intensity of Source
  - Type of UVC lamp/Electronic Ballast/Mounting Assembly/ Lamp placement.
- Distance from Source to Surface
  - Closer the surface, higher the intensity and vice versa.
- Air Velocity
  - Useful to calculate and determine the length of UV Exposure for the moving particle.

UVGI is used as a supplement to mechanical ventilation to inactivate airborne infectious agents, to protect the health of building occupants. UVC lamp systems, that kill 70 to 95% of all microbes in the air, can be deployed in the following areas:

### *UVGI System Configurations to Help Mitigate Viruses*

- On AHU Coils and Drain Pan for Cleaning the Supply Air
- In Supply / Return Air Ducts
- Wall Mounted Upper-Room Air Disinfection
- Portable Hand-Held Surface Cleaner

### *Hospital Wide Application Areas of the UVGI System*

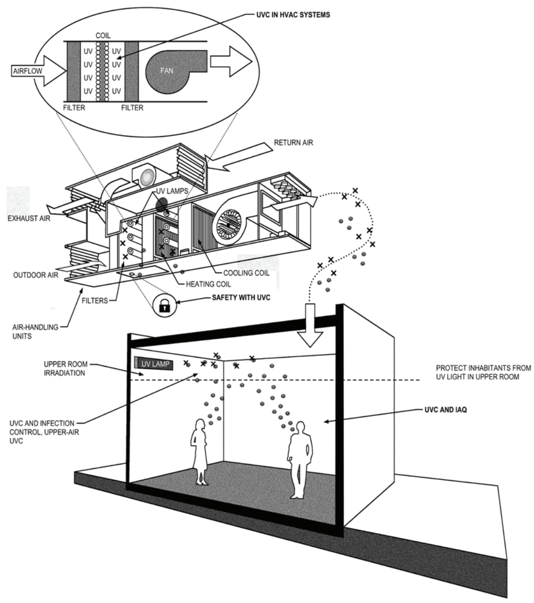
- Operating Rooms, ICU / CCU
- Doctors Cabin
- Patient Rooms / Wards
- Out-Patient Waiting Areas

# Surface Disinfection

### *AHU Coil and Drain Pan Irradiation*

Application of UVC is becoming increasingly frequent as concerns about indoor air quality increase. UVC is now used as an engineering control to interrupt the transmission of pathogenic organisms. UVC lamp devices and systems are placed in air-handling systems and in room settings for the purpose of air and surface disinfection. Control of bio-aerosols using UVC can improve indoor air quality (IAQ) and thus enhance occupant health, comfort, and productivity.

HVAC systems can promote the growth of bacteria and mold-containing bio-films on damp or wet surfaces such as cooling coils, drain pans, plenum walls, humidifiers, fans, energy recovery wheels, and filters. Locations in and down-stream of the cooling coil section are particularly susceptible because of condensation and carryover of moisture from coil fins.




***Applications of UVC to Control Micro-organisms in Air and on Surfaces (ASHRAE 2009)***

Cooling coil fouling by bio-films may increase coil pressure drop and reduce airflow and heat exchange efficiency. Filters capture bacteria, mould, and dust, which may lead to microbial growth in damp filter media. As the growth proliferates, a filter's resistance to airflow can increase. This can result in more frequent filter change-outs and increased exposure to microbes for maintenance workers and building occupants. As airflow and coil performance degrades, so does the air quality in occupied spaces.

Aluminium or other highly reflective material reflectors on the UVC lamps, can improve the overall reflectivity of the inside of the air handler and thereby reflecting UVC energy back into the irradiated zone, thus increasing the effective UV dose and the UVC system performance.

Conventional methods for maintaining air-handling system components include chemical and mechanical cleaning, which can be costly, difficult to perform, and dangerous to

*UVC Lamp Assembly Arrangement for AHU Coil Cleaning*

maintenance staff and building occupants. Vapours from cleaning agents can contribute to poor air quality, chemical runoff contributes to groundwater contamination, and mechanical cleaning can reduce component life. Furthermore, system performance can begin to degrade again shortly after cleaning, as microbial growth reappears or re-activates.

UVC applied in air-handling units, complements conventional system maintenance procedures and has shown to be effective in reducing air-side pressure drop and increasing air-side heat transfer coefficient of wetted cooling coils.

### *Safety*

Human exposure to UVC light may result in unnoticed eye (cornea) damage and skin (sunburn) damage. While these effects are mostly temporary, they can still be very painful.

Most materials, including glass and plastic, attenuate UVC radiation. Maintenance personnel should wear protective clothing, eye wear, and gloves when dealing with lamp replacement tasks to protect against broken lamps and accidental UV exposure.

### *Additional Safety Considerations*

- Dispose of used lamps in accordance with regulations regarding mercury content.
- Air ducts should be fully enclosed to prevent UV leakage.
- All access doors and panels should have warning labels posted on the outside.
- Interlocks should be installed such that opening any door to a UV lamp chamber will turn off the lamps.
- The UV lamp chamber should have a view-port large enough for the UV state to be viewed from a distance outside the chamber Specially for AHU application.
- Educate installation and maintenance workers on equipment hazards and safe practices.

## Air Disinfection

### *In-Duct Cleaning*

Environmental conditions within an air-duct promotes the growth of biological contaminants (viz. mould). This contamination eventually spreads down the ductwork and into the living spaces.

The in-duct UVGi System is designed to maximize airborne kill of dangerous pathogens such as viruses, bacteria, and mold spores. This duct-mounted UVGI system is designed for intensive air-stream UVC irradiation. The system features multiple UV high-output germicidal UV lamps which sterilize airborne biological contaminates as they pass by. The In-duct UVGI system is fully customizable and can be configured to fit a wide variety installation parameter.

The desired exposure time for adequate dosage in ductwork is an important design criteria. When there is limited time of exposure due to the velocity of the moving air-stream, more than one UV light unit may be required to achieve adequate exposure time. The primary variables important to the design configuration of a UVGI system include: air duct dimensions (W x H x L); airflow rate; UV lamp specifications (viz. UV power, arc length, lamp radius); lamp quantity and locations; duct reflectivity; and filtration.

When the air-stream disinfection is the approach, then having the most amount of UV production possible is the preferred method. This can be achieved by using high output (HO) UV lamps. The average irradiance for a typical air duct application should range from 1,000 to 10,000 μW/cm$^2$ depending on the microbe to be inactivated and operating conditions such as air temperature, air velocity, and humidity.

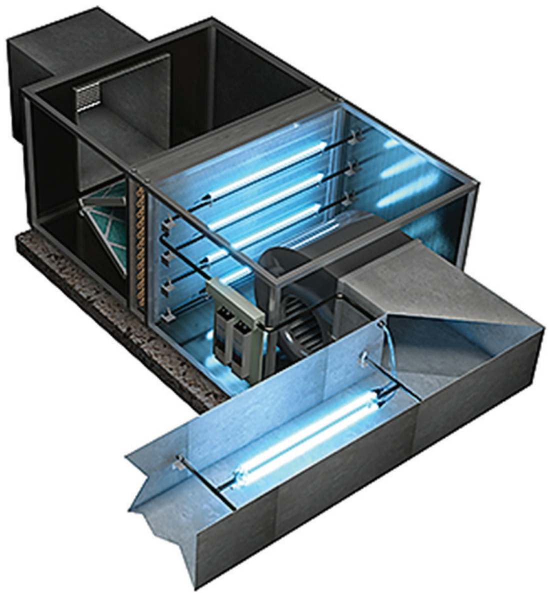


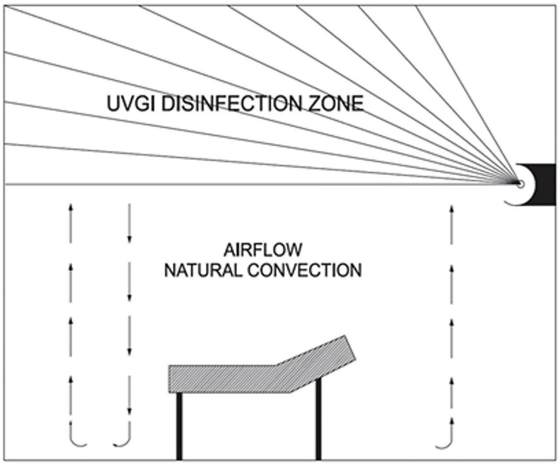
*Illustration showing the AHU Coil cleaning and Duct cleaning arrangement in a HVAC system.*

*(Source: https://www.achrnews.com/articles/128955-uv-and-air-purification-effectively-contain-airborne-pathogens)*

## Upper-Air Disinfection

### *Wall Mounted Upper-Air Disinfection*

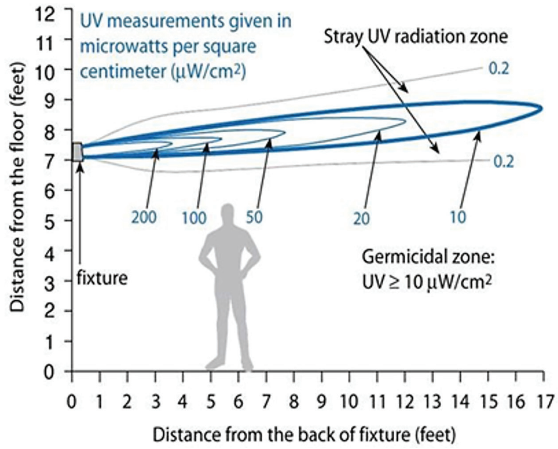
The primary objective of Upper-Air UVC placement and use is to interrupt the transmission of airborne infectious pathogens within the indoor environment. The source of these infectious organisms may be infected humans, animals, or bio-aerosols. There are at least two transmission patterns: within-room exposure such as in a congregate space, and transmission beyond a room through corridors and by entrainment in ventilation ductwork, through which air is then recirculated throughout the building.




*Installation in a Room of Wall Mounted System*

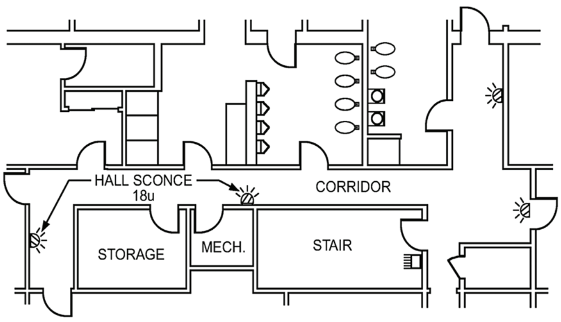
Numerous experimental studies have demonstrated the efficacy of Upper-Air UVC. Effectiveness has also been established for inactivating tuberculosis, reducing measles transmission and the interruption of influenza transmission within a hospital.

*Wall Mounted Upper-Air UVC Device Installed in a Hospital*




*UV Intensity Distribution in a Room with Wall Mounted System*

Upper-Air UVC devices are designed to generate a controlled UVC field above the heads of occupants and to minimize UVC in the lower, occupied area of the room. Settings appropriate to upper-air UVC placement include congregate spaces, where unknown and potentially infected persons may share the same space with uninfected persons (e.g., a medical waiting room or homeless shelter). Common corridors potentially used by unknown infected persons in a medical facility would also benefit from Upper-Air UVGI fixtures. Upper-Air UVC also covers situations where untreated recirculated air might enter an occupied space.




*Wall Mounted Upper-Air UVC Devices Covering Corridors (ASHRAE 2009)*

The device consists of UVC lamps installed in a specially designed reflector assembly; the whole system is to be mounted on a wall to create a UVC beam directed to the ceiling. Natural convective currents take microbes to upper level which are effectively eliminated by the germicidal action of UVC. It is very helpful to the patients and even more to the health care workers.

### *Upper-Air UVGI System Benefits*

- Effective control against secondary air borne infection, including drug resistant pathogens.
- Works 24/7 without affecting occupants of the space.
- Cost effective system.
- Does not require any air-conditioning/ventilation system.
- No secondary contaminants are produced.
- Maintenance free system.
- Safeguards patients and health care workers.

## Disinfection and Sterilization of N95 Masks

### *Rationale*


Shortages of personal protective equipment (PPE), including medical N95 masks, are forcing hospitals, care centres and first responders across the country to, reuse their limited supply of these critical resources during this unprecedented pandemic crisis. The lack of crucial protective devices puts health care workers at increased risk of infection by the virus, which causes the disease.

To extend the stocks of N95 masks and reduce risks associated with reuse of untreated, contaminated N95 masks, we developed a surface decontamination system involving ultraviolet germicidal irradiation (UVGI).

### *Ultra-Violet Germicidal Irradiation*

UVGI has shown promise as an effective method for inactivation of viruses and bacterial spores on N95 mask material; however, UVGI cannot inactivate all the pathogens due to shadow effect.

UVGI protocols should be implemented, with validation of the delivered UVGI dose to the mask, it is likely that UVGI inactivates virus on the outer layers of non-shadowed regions of the N95, based on results from similar viruses, but not confirmed directly for SARS-CoV-2. UVGI treatment should be viewed as risk management rather than complete decontamination.

UVGI can be safely administered when appropriate safeguards are in place:

### *UVGI System Safety*

It is not safe to be in the room, while UVC disinfection is ON:

- Direct exposure to UVC can cause hazard to skin and eyes.
- Anticipated to be a human carcinogen.

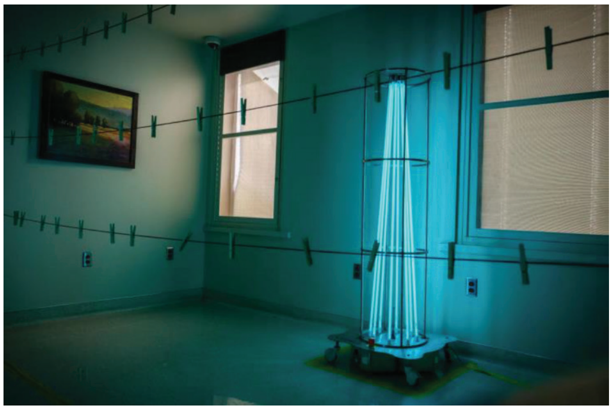
### *UVGI System Benefits*

- Provides residue free disinfection, so there is no concern over dangerous residues that need to be wiped down or neutralized after the disinfection process.
- Disinfection times are fast.
- No need to isolate rooms from HVAC systems or seal doors.
- Cost to run UV systems is very low.

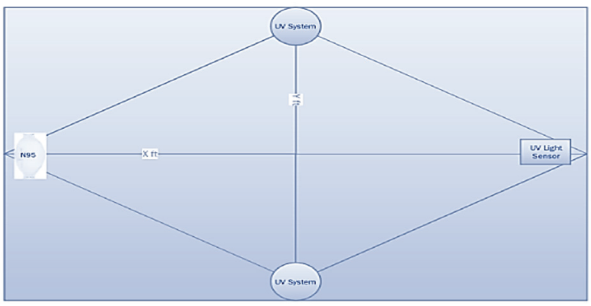
### *UVGI System Setup*

UVGI exposures of 1 J/cm2 are capable of decontaminating influenza virus on N95 masks and exposures as low as of 2-5 mJ/cm$^2$ are capable of inactivating coronaviruses on surfaces. It is recommended that 60 mJ/cm$^2$ and 300 mJ/cm$^2$ exposure from room sensor for masks decontamination be used. It is important to note that for setup, UV sensor readings of 60 mJ/cm$^2$ represent a total mask exposure dose of 180 mJ/cm$^2$ to 240 mJ/cm$^2$ and a sensor reading of 300 mJ/cm$^2$ represent a total mask exposure dose of 900 mJ/cm$^2$ to 1200 mJ/cm$^2$ depending on mask placement on the mask hanging lines. In our decontamination process, used N95 masks are subjected to UVGI at a sensor exposure of 300 mJ/cm$^2$.*

Single-stranded RNA viruses, are generally expected to get inactivated by UVGI exposure of 2-5 mJ/cm$^2$. The UVGI exposure chosen exceeds the amount of exposure needed to inactivate the virus and provides a wide margin of safety for surface decontamination.



*Installation in a Room*
*(Indicative only, the system may differ)*




*UV System placement in a room*

** Study conducted by University of Nebraska Medical Center, USA*

## Catalytic Air Purification

***PCO with Gas Phase Filtration***

It is an advanced process by which volatile organic compounds (VOCs), bacteria, molds and fungus are destroyed by incorporating photon and ultraviolet (UV) energy activating a catalyst thereby creating the photo catalytic oxidation (PCO) process.

UVPCO often utilizes a honeycomb configured, reactor coated with titanium dioxide ($TiO_2$ or titania) as the photo-oxidative catalyst. This design potentially can have high conversion rates with low pressure drop making it suitable for use in building HVAC systems.

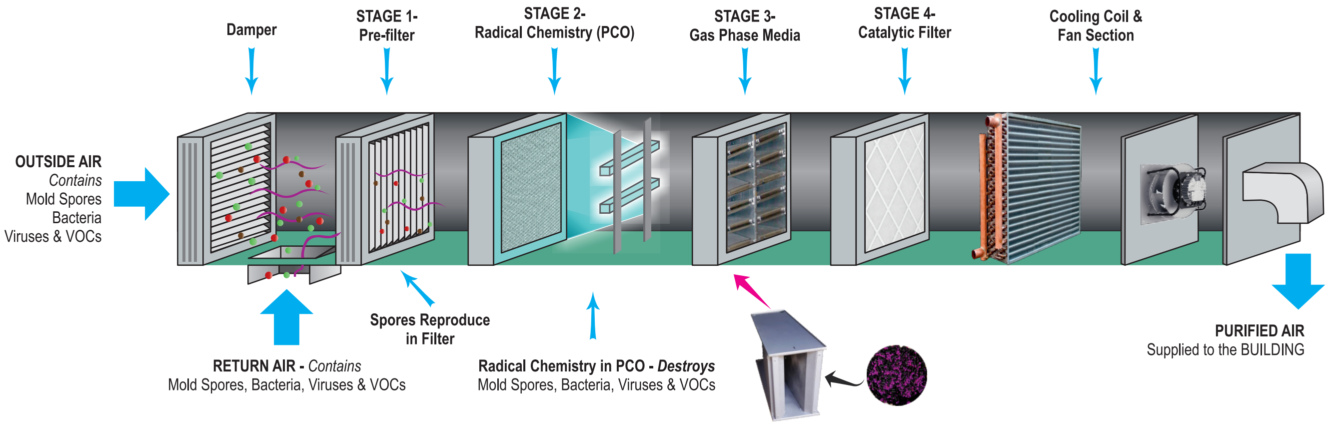
The coated screen is irradiated with UV light near 254 nm UVC. Air containing organic pollutants flows through the screen , where the VOCs adsorb on the catalyst. The UV light interacting with the catalyst in the presence of oxygen and water vapor, produces hydroxyl radicals. Hydroxyl radicals are highly chemically reactive and, in-turn, breakdown the adsorbed VOCs, ideally producing only carbon dioxide and water as bye products.

Gas Phase Filtration with Photo-Catalyst Oxidation systems are tailored precisely to your needs and operate with the highest efficiency. The multistage design allows for selection of the required filters in a specific sequence to meet the requirements of each application.

- Destroys moulds, viruses, bacteria and allergens etc.
- Maintains desired levels of particulate matter
- Efficient regeneration of media
- Flexible design, Easy to retrofit
- Adequate controls for safety
- No harmful emissions
- Reduces all odorous and hazardous air pollutants
- Provides very high single-pass efficiency of gas removal
- Prevents corrosion / breakdown of electronic equipment

***Optional Equipment***

- Differential Pressure Monitoring System
- VOC Sensors
- Lab Analytical Services




### *Stage 1 – Pre-Filtration*

Air entering the system passes first through a MERV 8 high-efficiency particulate filter, which captures many of the larger biological contaminants and small airborne particles such as mold spores and pollen.

Bag Pre-Filters are provided with 95% efficiency (MERV 14, EU 8), bag filter made of 100% dual layer synthetic fibers to capture finer particulates.

### *Stage 2 – Radical Chemistry (PCO)*

Viruses, odors, VOCs and micro-organisms are exposed to a high-intensity ultraviolet light. This UV radiation penetrates micro-organisms such as fungi, bacteria and viruses and damages their DNA bonds, sterilizing them.

This air passing through a panel coated with titanium dioxide ($TiO_2$), when subjected to ultraviolet photons, creates hydroxyl radicals. The radicals oxidize gaseous organic compounds, e.g. odors and VOCs

### *Stage 3 – Gas Phase Media*

The system media panel is uniquely designed to continually renew itself and has a very long life, under normal use.

Media is in the form of granular pellets that are made of binders and activated alumina or other elements. Potassium permanganate is used as media, as it boosts the adsorption rate for a longer duration. The filtration media generally targets contaminants such as sulphur oxides, hydrocarbons, formaldehyde, organic acids, hydrogen sulphide, nitric oxide, and VOC's.

### *Stage 4 – Final Filters*

Final set of pleated disposable fiber matrix filters are provided with 30% efficiency (MERV 8, EU 4), to capture any left over elements.

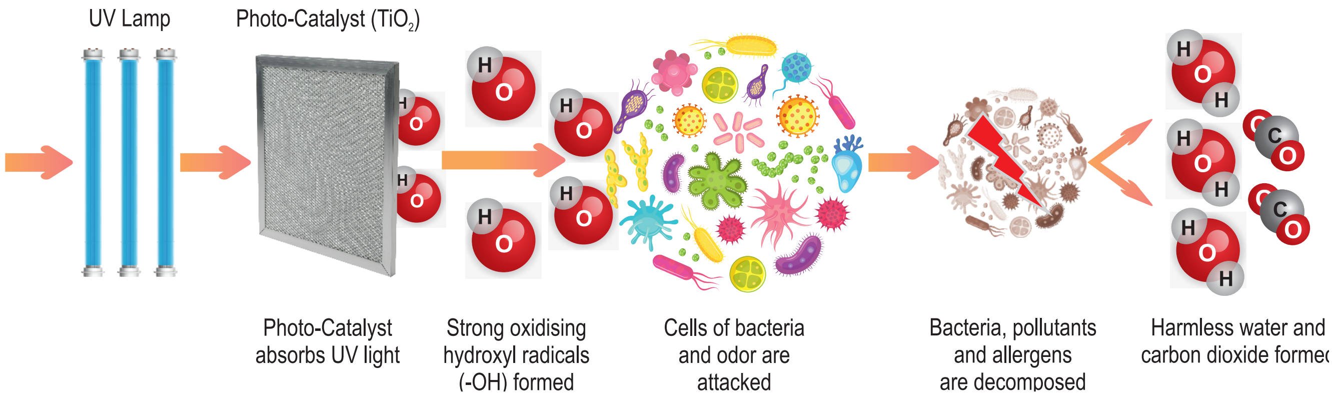
> *"Volatile Organic Compounds (VOCs) are emitted as gases from certain solids or liquids. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoor. Elevated Concentrations of VOCs can persist in the air long after use of the VOCs containing product is completed. No standards have been set for VOCs in non-industrial settings."*
>
> *Source: U.S. Environmental Protection Agency*

## Photo-Catalytic Oxidation

Photo-Catalytic Oxidation (PCO) is a reaction that occurs when Titanium Dioxide ($TiO_2$) is exposed to ultraviolet (UV) light rays. VOCs, gaseous contaminants, and odors gets converted to odorless, harmless water vapor and Carbon Dioxide when they come into contact with the catalytic surface making the air ultra purified.

The titanium dioxide catalyst is activated by UV light which neutralizes biological contaminants such as bacteria, viruses, mold and fungi. When used properly, PCO is a powerful element ideal for controlling air quality.

## Principle of Photo-Catalytic Oxidation




### Deactivates

**Biologicals**

Viruses | Bacteria

Fungi | Mold

### Eliminates

**VOCs**

Paint | Pesticides

Chemical | Solvents

### Reduces

**Odors**

Cigarettes | Garbages

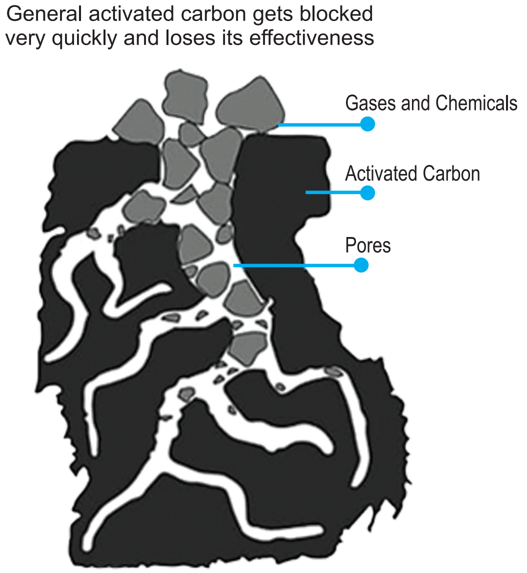
Kitchens | Bathrooms

## Adsorbent Media

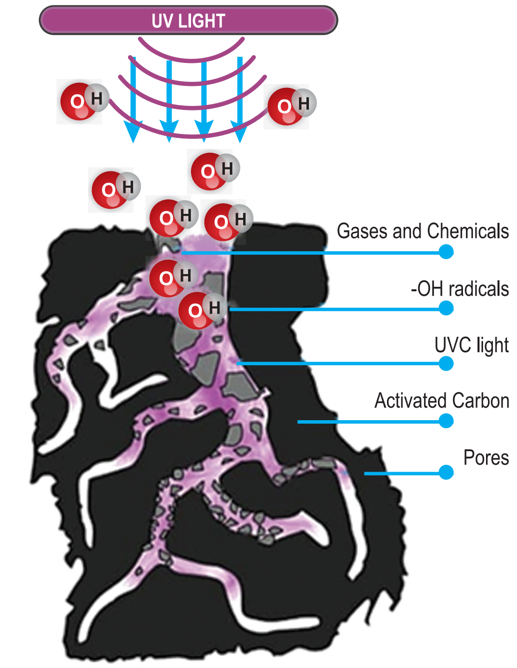
Chemical media, both granular and fluted type is used in a range of combination – activated alumina/carbon impregnated with various impregnants majorly Potassium Permanganate ($KMnO_4$), Phosphoric Acid ($H_3PO_4$) and Potassium Hydroxide (KOH).

## Self Rejuvenating Activated Carbon with UV/PCO

General activated carbon can not adsorb at a stable equilibrium. In the presence of UVC+PCO unstable equilibrium is achieved.




Activated carbon adsorbs gases and chemicals




Activated carbon adsorbs gases and chemicals much better with UVC light whilst -OH radicals neutralise them.

- Activated carbon pores are blocked in a very short time.
- Activated carbon traps the gases and chemicals using UV and -OH radicals resonance time in order to neutralize them, thus keeping the carbon pores clear.

Ensavior Technologies Pvt. Ltd.

Plot No 3, Block A, Ground Floor,
Sector 19, Dwarka,
New Delhi-110075, INDIA

+91-11-47350382
+91-98215 88330
+91-70420 88338
+91-97111 54372

info@ensavior.com
www.ensavior.com

Bangalore | Kolkata | Mumbai | Singapore

CIN: U72900DL2011PTC222724