YORK

Nano-TiO_2 Indoor Disinfection Technology

Frequently Asked Questions

(updated on March, 2005)

What is Photocatalytic Oxidation?

When photocatalyst Titanium Dioxide (TiO_2) absorbs Ultraviolet (UV) radiation from sunlight or illuminated light source (fluorescent lamps), it will produce pairs of electrons and holes.

The electron of the valence band of Titanium Dioxide becomes excited when illuminated by light. The excess energy of this excited electron promoted the electron to the conduction band of Titanium Dioxide therefore creating the negative-electron (e-) and positive-hole (h+) pair. This stage is referred as the semiconductor's ' **photo-excitation** ' state.

The positive-hole of Titanium Dioxide breaks apart the water molecule to form hydrogen gas and hydroxyl radical. The negative-electron reacts with oxygen molecule to form super oxide ions. This cycle continues when light is available.

This process is similar to photosynthesis, in which chlorophyll captures sunlight to turn water and carbon Dioxide into oxygen and glucose..

What is Titanium Dioxide?

Titanium Dioxide is the naturally occurring oxide of Titanium, chemical formula TiO_2. Approved by the laboratory of the United States Food and Drug Administration (FDA),

Titanium Dioxide is considered a safe substance and harmless to human. It is commonly used in paint, printing ink, plastics, paper, synthetic fibers, rubber, condensers, painting colors and crayons, ceramics, electronic components along with cosmetics.

Many studies have been published on the use of Titanium Dioxide as a photocatalyst.

What is Nano-Titanium Dioxide?

Titanium Dioxide and Nano Titanium Dioxide are totally two different materials. Titanium Dioxide is mainly used as white pigment for paint and cosmetic industry and most in micron particle size.

Nano Titanium Dioxide is divided into ANATASE and RUTILE grade and are mainly used for sterilization effect.

ANATASE Nano TiO_2 is commonly called nano photocatalytic powder. It will react with UVA light. The combination of ANATASE TiO_2 and UVA will produce photocatalytic reaction.

RUTILE Nano TiO_2 is commonly known as inorganic anti bacteria powder. It is generally added in chemical fiber and natural fiber to make textiles anti bacteria. RUTILE Nano TiO_2 will only kill bacteria by contacting it. It is more effective than ANATASE Nano TiO_2 and doesn't require any UVA.

For maximum efficiency, York combines ANATASE and RUTILE TiO_2 into the formulation with particle size as fine as 8 Nanometer.

What is Ultraviolet?

Ultraviolet is divided into three bands which are UVA, UVB and UVC.

UVA Commonly referred as black light - Long wave UV (320-400nm)
Necessary for surface organisms and transform Cholesterol to Vitamin D
Effect dermis - 37%penetrates to 0.06mm
Not blocked by glass
Least excited photon
Therapeutic with a photosensitizer

UVB Commonly referred as sunburn - Mid wave UV (290-320nm)
Reach the earth surface and damage humans and ecosystems
Effect epidermis - 90% absorbed in first 0.03 mm
Blocked by most barriers including glass and plastic
Very excited and most biologically active photon
Theurapeutic independently1000 times more erythematous than UVA

UVC Commonly use to sterilize instruments - Short wave UV (200-290nm)
Absorbed by ozone layer and will not reach earth to cause ill-effects
Most excited photon
Not as commonly used therapeutically
Germicidal

What are the benefits of photocatalyst treatments in air purification?

When Nano-TiO_2 catalyst is irradiated by the low intensity UV-A, a reaction occurs which leads to the generation of Hydroxyl Radicals and Super-oxide Ions. Hydroxyl Radicals are among the strongest oxidizing species, even much stronger than Chlorine, Ozone, and Hydrogen Peroxide. They act as very powerful disinfecting agents by oxidizing the cells of microorganisms.

YORK Nano TiO_2 Photocatalytic Process uses UV-A to activate TiO_2 coating and generates free hydroxyl radicals (• OH) and super-oxide ions (O_2 • -).. It seizes carbon and hydrogen component in the air in addition to those often exists in organic compound like virus and Volatile Organic Compounds (VOC); therefore effectively kills airborne pathogens, oxidized air pollutants and decomposed them into harmless Carbon Dioxide (CO_2) and Water (H_2O).

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BENEFITS OF PHOTOCATLYTIC

- Destroys micro and marco organisms
- Neutralize odors
- Decompose VOCs and bioaerosals
- Oxidation of organics to CO_2 and H_2O
- Environmental Friendly (No generation of secondary pollutants)
- Long service life
- Low maintenance requirements

How does Photocatalytic Oxidation compare to other common air purification technologies?

There are typically the following ways of purifying and disinfection of indoor air.

HEPA (High Efficiency Particle Arresting) Filter
Most widely known method for purifying air. Depending on the filter finess, it can clean up to 99.99% of particulate in the air with proper air circulation. They are not effective on treating odor, mold, mildew, bacteria, and other fungi.

Electrostatic Precipitation
Another filtration system with a negatively charged surface is used to attract particulate. In comparison to most HEPA systems it is more effective in trapping smaller micron particulate and effective in clearing smoke from the air. Low levels of ozone may be produced which can neutralize most mold, mildew, bacteria, and other fungi that comes in contact with the filter.

Ionization
Generally there are two types of ionization technologies – corona discharge and plasma discharge. Both method have the same effect of dispersing negative and positive ions. The ions attracted suspended particles and other pollutants and then forming cluster which becomes too heavy and falls to the ground. An issue of this technology is that ionizers produce ozone and its by-product nitrous oxide.

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Ozone

Ozone generators clean air using a high voltage electrical charge which changes oxygen to ozone. When the concentration of ozone is high enough, gas molecules and certain microorganisms such as mold and spores are destroyed. However, it is difficult to remove air contaminants at healthy ozone concentration levels. On the other hand, this technology produces unpleasant ozone smell and unhealthy by-product.

UV Germicidal Lamps

Ultraviolet-C kill germs, microbes and spores by altering their DNA. Unfortunately, this means that human being too can be negatively affected by UV-C ray. This can bring about serious health problems including respiratory and cardiovascular disorder, blindness and even cancers. Another side effect of intense UV-C is the production of ozone at unhealthy level.

Photocatalysis

Using UV light to react with a catalyst resulting in oxidation. This photocatalysis combined with the natural humidity in indoor air creates hydroxyl radicals and super oxide ions that are effective in combating bacteria, fungi, odors and VOC. This method is also a pro-active approach that goes to the source for treatment.

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	HEPA Filter	Electrostatic	Ozone	UV	Ionizer	Photocatalysis
Mold	Poor	Good	Good	Good	Poor	Excellent
Bacteria	Poor	Good	Good	Good	Poor	Excellent
Dust Mites	Poor	Poor	Poor	Good	Poor	Excellent
Gases	Poor	Poor	Good	Good	Poor	Excellent
Odors	Poor	Good	Good	Poor	Good	Excellent
Smoke	Good	Good	Good	Poor	Excellent	Good
VOCs	Poor	Poor	Good	Good	Poor	Excellent
Pet Dander	Good	Good	Good	Good	Good	Excellent

What are the differences with YORK Photocatalytic Oxidation (PCO) versus other TiO_2 product available in air purifiers and air conditioners?

- YORK offers the most comprehensive range of air purifiers and air conditioning products with photocatalytic oxidation using Nano TiO_2 including room air purifiers, car purifiers, min-split air conditioners, packaged air conditioners, fan coil units, air handling units and retrofits into existing systems.

- YORK photocatalytic oxidation product are all equipped with YORK Nano-light, which offer an optimized disinfection efficiency with the Nano-TiO2 filter in the system.

- There are vendors claimed certain level of disinfection efficiency. Some of them are using laboratory setup of components to conduct the test. For YORK, all air disinfection efficiency tests were conducted in Guangzhou Microbiology Laboratory based on the market available finished product.

- While most of the PCO applied by other vendors are purely based on Nanotechnology, YORK's implementation is a combination of Nanotechnology and Photochemistry.

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- YORK Nano-TiO_2 can go as fine as 8nanometeer while most of the competitors uses 20-30nm particle size.

- While most other PCO products are only based on one layer of Nano TiO_2 coating, YORK patent pending technology provides second layer of coating acting as photocatalytic enhancer. This results in generation of more photons and creates more free hydroxyl radicals and superoxide ions that increases the disinfection efficiency.

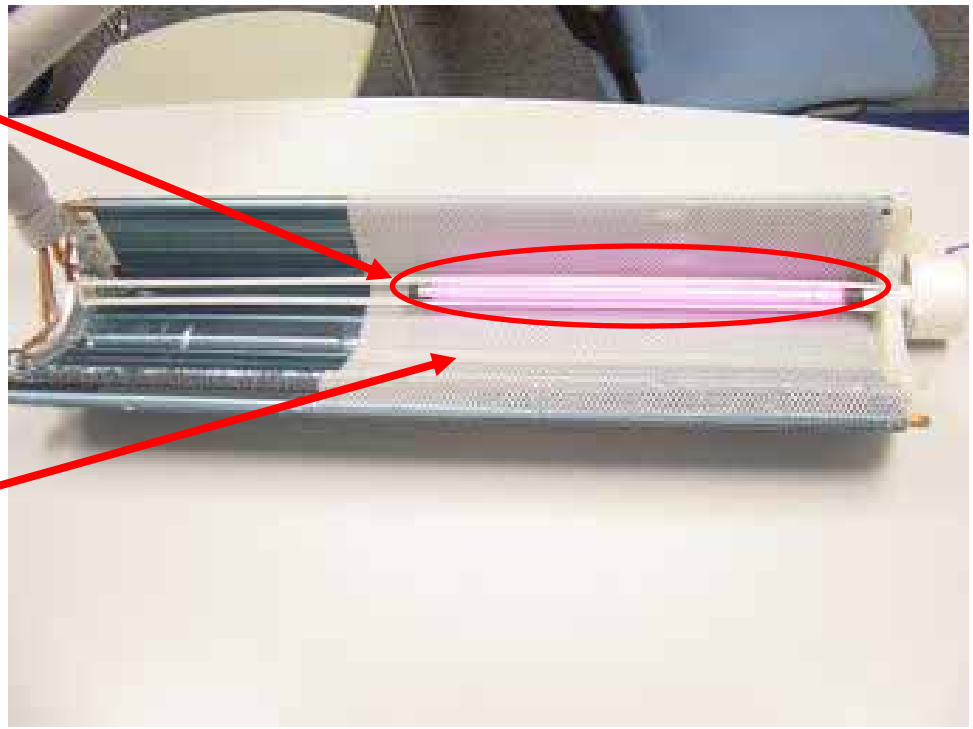
- Disinfection efficiency are relating to the surface area of Nano-TiO_2 as well as the intensity of UV-A light . YORK products achieve highest disinfection efficiency by providing larger Nano-TiO_2 coating surface as compared to most product available in the market.

- In mini-split air-conditioner “ULTRA”, YORK Nano-light is probably the most powerful UV-light available in the market, some vendors use UV-A LED instead of fluorescent light. For duct unit and airside products, the design is based on multiple Nano-lights which offer not only higher intensity but also redundancy for reliable operation.

What are the typical TiO_2 Mini-split Air Conditioners available today?

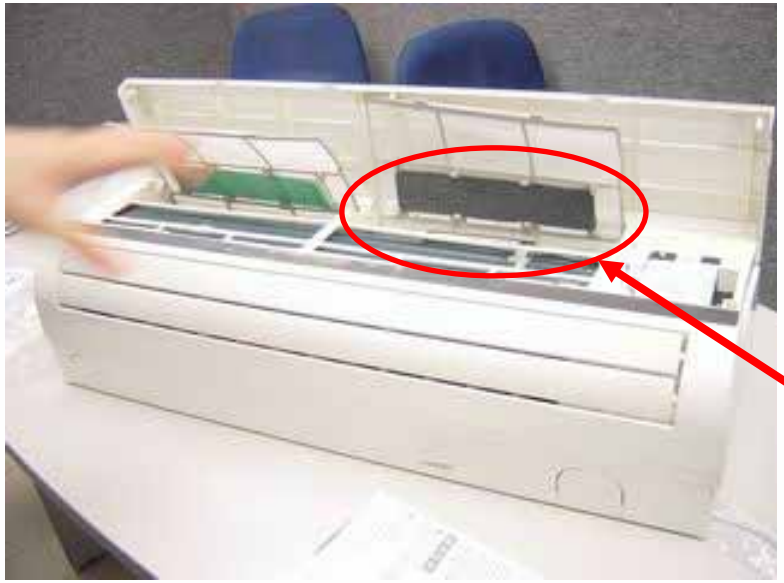
Internal Construction of YORK Nano-TiO_2 Mini-split Air Conditioner

Nano-light tube



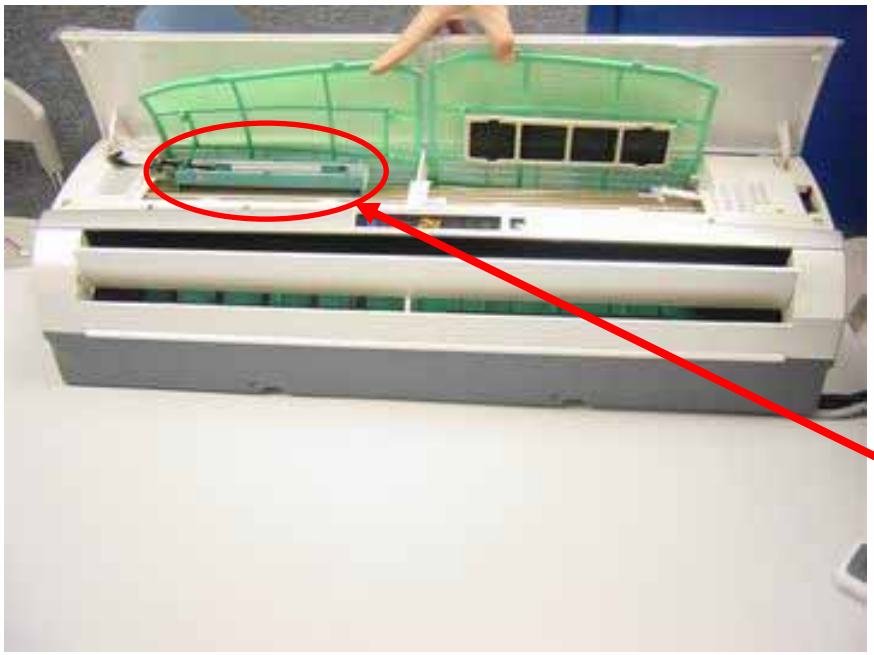
Nano-TiO_2 coated filter

HAIER Disinfection Light Mini-split Air Conditioner
Location of TiO_2 photocatalyst filter



HAIER TiO_2 photocatalyst filter

MIDEA Total Health Mini-split Air Conditioner
Location of UV light disinfection unit



UV light disinfection unit

Brightness & Length of UV Light tube of YORK and HAIER

YORK Nano-light tube: 30CM

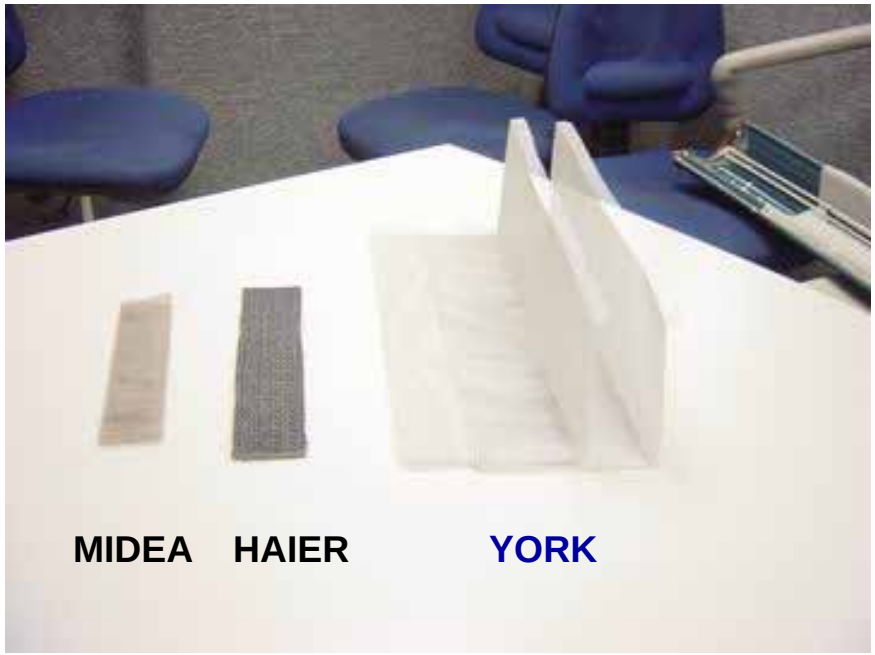
HAIER UV LED lamp: 0.8CM

Brightness & Length of UV Light tube of YORK and MIDEA

YORK Nano-light tube: 30CM

MIDEA UV light tube: 9.5CM

TiO_2 filter mesh of YORK, HAIER and MIDEA



YORK (2 layers): 35CM x 30CM
HAIER: 22CM x 5.5CM
MIDEA: 18CM x 5CM

Note: YORK has unique more area, angled twin-layer TiO_2 filter mesh ensures highest disinfection efficiency.

Can TiO_2 Photocatalytic Oxidation kill SARs?

The ability to prevent SARS is not proven due to the unavailability of testing facilities and the potential health hazard to testing personnel.

What about Anthrax?

In the war against airborne-anthrax, TiO_2 technology has been used by the US Government in many offices in the United States including NASA now use a boxlike machine bolted to their ceilings. This machine draws airborne anthrax spores into it and destroys them. Tests have revealed that as many as 93% of Anthrax spores are wiped out. Surviving spores are sucked back in guaranteeing total destruction.

Will the disinfection efficiency of YORK Nano TiO_2 be affected by humidity or temperature change?

At normal indoor condition, there will be no effect on disinfection efficiency.

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Will air volume,
and TiO_2 surface area
affect the disinfection efficiency?

YORK Nano-TiO_2 airside systems are designed for maximum comfort and disinfection efficiency.

York Nano-TiO_2 air purifiers are designed to achieve high efficiency at high fan speed.

What is the lifespan of YORK Nano-light tube and how can they be replaced?

YORK Nano-TiO2 Indoor Disinfection Technology uses long-lasting Nano-light that lasts up to **10,000 hours** when used under normal conditions. However, in reality this figure is only a cautious estimate used to satisfactorily meet customer expectations and leave no room for discrepancies when used in varying conditions. Accelerated life tests prove that YORK Nano-light lasts from 8,000 to 10,000 hours under extreme conditions, clearly illustrating that the life span can be much higher under normal conditions.

For mini-split air-conditioners, a clearance of 400mm at the left hand side should be allowed for replacement of YORK Naon-light.

For duct type Nano-TiO_2 unit, access by side withdrawal of the TiO_2 filter mesh.

For unit mounted type Nano-TiO_2 indoor unit, access at the front by removal of TiO_2 filter mesh .

It is recommended that YORK Nano-light to be replaced every 12 months to ensure maximum disinfection efficiency.

How long is the lifespan of the Nano-TiO2 filter mesh? How to main it?

During the Photocatalytic Oxidation Process, TiO_2 is not consumed, so YORK Nano-TiO_2 filter mesh in the air disinfection unit requires no replacement.

Whenever there is dust particles on the TiO_2 mesh, use air or dry towel to blow away the dust, or use a wet towel to clean it.

What will be generated when
YORK Nano-TiO_2
Indoor Disinfection Technology
oxidizes and decomposes pollutants?
Is there any secondary pollutant?

Result of pollutant decomposition

Pollutant		Decomposition Result			
		H_2O	CO_2	O_2	N_2
Ammonia	$NH_3+6OH \rightarrow N2+6H_2O$	●			●
Acetaldehyde	$CH_3CHO+6OH+O_2 \rightarrow 2CO_2+5H_2O$	●	●		
Acetic acid	$CH_3COOH+4OH+O_2 \rightarrow 2CO_2+4H_2O$	●	●		
methane	$CH_4+4OH+O_2 \rightarrow CO_2+4H_2O$	●	●		
Carbon monoxide	$CO+2OH \rightarrow CO_2+H_2O$	●	●		
Nitric oxide	$2NO+4OH \rightarrow N_2+2O_2+2H_20$	●		●	●
Formaldehyde	$HCHO+4OH \rightarrow CO_2+3H_2O$	●	●		

Generated CO_2, water vapor, oxygen and nitrogen are harmless and low-concentration. There is no new pollutant generated and the level of CO_2 generated are absolutely negligible.

What is Indoor Air Pollution?

Research indicates that people spend approximately 70 ~ 90 percent of their time indoors, where they are exposed to polluted indoor air that may cause irritation of the eyes, nose, and throat, headaches, dizziness, fatigue, and even lung cancer or other malignancies. Recent study reveals that bacteria, molds and house dust mites bred inside carpets and air conditioners can be airborne by dust particles. Paints, varnishes, harmful chemical fibers and pressed wood products, which are most commonly used in household decoration, may emit formaldehyde, benzene and other hazardous and carcinogenic organic chemicals -- all these as well as unwholesome matters produced in the metabolism of human bodies and ammonia inside toilets have made the air within homes and other buildings more seriously polluted than the outdoor air.

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People may experience one or more of the following reactions when exposed to indoor air pollution:

Allergic Reactions

Some common signs and symptoms are:

- Watery eyes
- Runny nose and sneezing
- Nasal congestion
- Itching
- Coughing
- Wheezing and difficulty breathing
- Headaches
- Fatigue

Infectious Reactions

Caused by bacteria and viruses, such as influenza, measles, chicken pox, and tuberculosis. Most infectious diseases pass from person to person through physical contact. Crowded conditions with poor air circulation can promote this spread. Some bacteria and viruses thrive in buildings and circulate through indoor ventilation systems.

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Toxic Reactions

Some fungi are known to produce toxic substances as a by-product of their metabolism, which can cause a variety of adverse health effects. Short-term symptoms can include dermatitis, respiratory irritation, headaches and fatigue. Long-term health effects can include cancer, damage to the central nervous system, and suppression of the immune system.

The U.S. Environmental Protection Agency ranks poor indoor air quality among the top five environmental risks to public health. Poor indoor air quality can cause or contribute to the development of chronic respiratory diseases such as asthma and hypersensitivity pneumonitis. In addition, it can cause headaches, dry eyes, nasal congestion, nausea and fatigue. People who already have respiratory diseases are at greater risk.

What is Sick Building Syndrome?

The term " sick building syndrome " (SBS) is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified.

The following have been cited causes of or contributing factors to sick building syndrome:

1. Inadequate ventilation

   In an effort to achieve acceptable Indoor Air Quality or IAQ while minimizing energy consumption, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recently revised its ventilation standard to provide a minimum of 15 cfm of outdoor air per person (20 cfm/person in office spaces). Up to 60 cfm/person may be required in some spaces (such as smoking lounges) depending on the activities that normally occur in that space.

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2. Chemical contaminants from indoors sources

Most indoor air pollution comes from sources inside the building. For example, adhesives, carpeting, upholstery, manufactured wood products, copy machines, pesticides, and cleaning agents may emit volatile organic compounds (VOCs), including formaldehyde. Environmental tobacco smoke contributes high levels of VOCs, other toxic compounds, and repairable particulate matter. Research shows that some VOCs can cause chronic and acute health effects at high concentrations, and some are known carcinogens. Low to moderate levels of multiple VOCs may also produce acute reactions. Combustion products such as carbon monoxide, nitrogen Dioxide, as well as respirable particles, can come from unvented kerosene and gas space heaters, wood stoves, fireplaces and gas stoves.

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3. Chemical contaminants from outdoor sources

The outdoor air that enters a building can be a source of indoor air pollution. For example, pollutants from motor vehicle exhausts; plumbing vents, and building exhausts (e.g., bathrooms and kitchens) can enter the building through poorly located air intake vents, windows, and other openings. In addition, combustion products can enter a building from a nearby garage.

4. Biological contaminants

Bacteria, molds, pollen, and viruses are types of biological contaminants. These contaminants may breed in stagnant water that has accumulated in ducts, humidifiers and drain pans, or where water has collected on ceiling tiles, carpeting, or insulation. Physical symptoms related to biological contamination include cough, chest tightness, fever, chills, muscle aches, and allergic responses such as mucous membrane irritation and upper respiratory congestion.