INDOOR AIR QUALITY IN BUILDINGS

Building owners and operators are concerned about the health, safety, and working environment of their buildings. Unfortunately, most buildings today do not provide acceptable levels of indoor air quality for their employees, customers, or tenants. There have been many studies in the past few years which address the problems caused by inadequate ventilation, filtering, and air cleaning in building environments. Worker productivity has shown significant increases when the air quality in a building environment was adequate (clean and healthy). Research has also shown that symptoms for workers related to poor air quality in buildings is substantially reduced with adequate air quality.

Indoor air quality ("IAQ") is defined by the concentrations of various pollutants including:

Volatile Organic Compounds (VOC's)	Carbon dioxide and Carbon monoxide	Airborne fungi, bacteria, and viruses
Mold and mildew	Dust and dust mites	Smoke and odors

Specific concentration of these pollutants, as well as ventilation rates, have been linked to sick building syndrome ("SBS"). Sick building syndrome can be characterized by several symptoms, including:

Lethargy, lack of attention, drowsiness	Headaches	Dryness and pain in the eye
Nasal stuffiness and sinus infections	Dry and itchy skin	Sore throat

Indoor Air Quality Affects Occupants Health and Comfort

1. Health consequences from bad indoor air quality can lead to health issues immediately or years after the exposure to the pollutants.
2. Mold and mildew in rooms can lead to wheezing, exhaustion, headaches, and other breathing illnesses in people with compromised immune systems.
3. High levels of humidity in a building can promote mold and mildew growth.
4. Symptoms may include irritation of the eyes, nose, and throat; headaches; dizziness; rashes; and muscle pain and fatigue.
5. Lower ventilation rates in offices, below about 25 l/s per person, are associated with increased prevalence of sick building syndrome (SBS) symptoms.
6. Inflammation, respiratory infections, asthma symptoms and short-term sick leave increase with lower ventilation rates.
7. Employees regularly miss work because of respiratory infections, allergies, or an adverse reaction to chemicals used in building cleaning.
8. Long-term effects due to indoor air pollutants may include respiratory diseases, heart disease, and cancer, all of which can be severely debilitating or fatal.
9. Customers and visitors may refrain from visiting buildings with bad indoor air quality or noxious odors.

Indoor Air Quality Affects Employees' Performance

1. Ventilation has a significant impact on several important human outcomes including communicable respiratory illnesses, task performance and productivity, and respiratory allergies and asthma.
2. Higher CO2 levels cause many employees to easily lose focus during work hours, hurting their performance.
3. Other environmental factors such as abnormally high room temperature or particulate matter levels also contribute to inattention on the part of employees.
4. Loaded particle filters provide a significant source of air pollution. To counteract this, filters should be changed frequently or an alternative method of removing particles from the air should be applied.
5. Poor indoor air quality can eventually lead to an overall loss of employees; no one wants to work for a business that does not care about their health.
6. Improvements in overall air quality nationwide have been estimated to have saved manufacturers $20 billion annually in productivity lost from 2000 to 2008. That is only the manufacturing industry!

Causes of Poor Indoor Air Quality

The following building factors or pollution in buildings most frequently associated with respiratory health effects include:

Low ventilation rates	Outdoor pollutants or vehicle exhaust	Presence of mold and bacteria
Formaldehyde	VOCs used in paints and lacquers or glues	Nitrogen or carbon monoxide
Chemicals in cleaning products	Moisture or dirt in an HVAC system	Animal and other biological allergens

"A 30 per cent saving in HVAC energy translates into something on the order of $0.25–$0.35 per square foot. However, the 3 per cent loss in productivity associated with poor environmental quality would correspond to approximately $4.50–$6.00 per square foot, with unmeasured additional impacts of discomfort and poor health."

The following list includes many of the reasons for bad indoor air quality in buildings:

1. Poor ventilation results in high levels of pollutants, pathogens, and CO_2 in offices, conference rooms and break areas.
2. Modern HVAC equipment is made so efficiently that air handling units and split systems do not provide an adequate amount of outside air to enter buildings using the most energy efficient systems.
3. Buildings located near sources of pollution or busy highways are inundated daily with noxious gases like carbon monoxide and industrial waste products. Opening windows or dampers to bring in outside air exacerbates the problem.
4. The construction of tightly sealed buildings, the reduction of ventilation rates to save energy, the use of synthetic building materials and furnishings, and the use of chemical products have led to an increase in indoor air pollution in buildings.
5. Clutter and debris that partially covers vents and makes proper cleaning difficult contribute to bad indoor air quality.
6. Ozone, radon, and other odors from outside sources are often overlooked.
7. Filtration systems are not properly maintained by periodic replacement.
8. Cleaning supplies, paint, and lacquers used in maintaining buildings can be a source of air pollution.

Suggestions to Improve Indoor Air Quality in Buildings.

1. ***Improve Ventilation*** - Keep the air in the building moving by checking the number of times per hour that the air is circulated throughout a building. Air in offices, conference rooms, and break areas needs to be exchanged four to six times per hour. If a particular room is occupied with more people than normal, additional ventilation for that room will be required.
2. ***Install an iAIRE <u>Active</u> Air Cleaner - iAIRE*** BiPolar Ionization ("BPI") technology uses electric voltage to convert oxygen molecules to charged atoms that inactivate airborne contaminants. These negatively and positively charged atoms, called ions, are effective against viruses, bacteria, and mold. They also neutralize volatile organic compounds, odors, and allergy-causing dander. BPIs inactivate airborne pathogens in two main ways. First, the charged particles surround the microbe and break it down. In the case of viruses, the ions induce a chemical reaction on the cell membrane surface. They **envelop the SARS-2 virus and puncture the protein spikes on its membrane, neutralizing them.** Second, the ions attach to contaminants and **enlarge them enough to be trapped by the HVAC system filters**.
3. ***Install iAIRE CO_2 Sensors in the Building Management System*** - CO_2 sensors should be installed in offices and other rooms in the building in order to continually monitor the space for adequate ventilation. If there is an unexpected ventilation malfunction, the CO_2 sensor will then alert building operators about the problem.
4. ***Install iAIRE VOC Sensors in the Building Management System*** - VOC sensors can inform the building operators about the level of volatile organic compounds in a building system. Again, VOC sensors are dynamic measurements of indoor air quality allowing the building operator to recognize the level of potential pollutants in the indoor air of buildings.
5. ***Upgrade the Filters in the HVAC System to MERV 13 Filters*** – MERV 13 filters are 99% effective in trapping particles as low as 0.3 microns in size. Unfortunately, the SARS-2 virus is only 0.1 microns in size. If putting in a MERV 13 filter is not feasible due to space constraints or existing fan size, an ***iAIRE*** Bi-Polar Ionization unit installed in the HVAC system will increase a MERV filter rating by 4 - 5 points.
    a. MERV 8 + BPI => MERV 13 (Blue Heaven labs)
    b. MERV 12 + BPI => MERV 16 (NRC Canada)
    c. Saves cost of higher MERV filter + fan energy.
6. ***Install an iAIRE Economizer Package*** - Install ionization devices in the rooftop unit (RTU). Install a VOC sensor in the building space to monitor the cleanliness of the air. Install a CO_2 sensor in the space to monitor occupancy. The economizer controller does not bring in any outside air unless the sensors detect the building space needs additional air to be cleaned (VOC & CO_2 sensors determine the amount of outside air, if any, required). The air inside the building space is constantly monitored to maintain a consistent level of indoor air quality using an algorithm to maximize clean indoor air quality and minimize the influx of outside air. The need of outdoor air to maintain clean indoor air is minimized. The reduction leads to a 6% - 12% on-going utility savings by reducing energy consumption used to heat or cool outside air to indoor air temperature settings.
7. ***Replace Existing HVAC Equipment with iAIRE Dedicated Outside Air Systems*** – Since current HVAC equipment is so efficient, they do not bring in much, if any, outside air into a building. Outside air is needed to keep buildings safe but only when air quality sensors indicate that outside air is needed. Outside air is minimized and brought into the building **<u>only</u>** when the sensor(s) show a demand in the space that justifies the need for additional outside air. When used in conjunction with an economizer, the building operator will normally see about a 2/3 reduction of the outside air being brought into the building while maintaining a healthy Indoor Air Quality that is constantly monitored by the sensors.