

## Health Impacts of Indoor Air Pollution

There is a lot of confusing and conflicting information about indoor air pollution and its impact on our health available from a myriad of sources. With an unique almost 50-year history in the field of indoor air quality (IAQ) and air cleaning, IQAir makes sense of it and provides an overview of common air pollutants and related health effects. Not every little piece of technical IAQ information contained in this section should be presented to every customer, but it's important to obtain the knowledge and be able to offer informed answers to questions from your customers.

### 1. Indoor Air Quality

#### Why is it so important?

It only takes a small increase in indoor airborne pollution levels to result in a huge increase in health risk. This is because:

- Every day we breathe in and out about 30,000 times.
- Our lungs make up the largest surface of our body. (The surface of a lung is the size of a tennis court.)
- Oxygen reaches every cell in the body through the lungs.
- Air pollutants also can reach every cell in the body through the lungs: brain, heart, liver, kidneys, etc.

Approximately 80% of our lives are spent indoors and 60% are spent at home. This is why the *Environmental Protection Agency* states that bad indoor air quality is one of the most serious health risks today. The facts speak for themselves:

- 20 - 25% of the population suffer from allergies or asthma
- 50% of households have children or elderly
- 50% of the world's population live in areas with unhealthy outdoor air
- 9 out of 10 homes have unhealthy air

#### Everyone needs cleaner air

Better air quality is of benefit to everyone who is interested in a healthy and long life, because the less allergens, microorganisms and chemical pollutants we breathe, the smaller the chance of becoming ill.

### 2. Indoor Air Pollution

Air pollution, both indoor and outdoor, is a major environmental health problem affecting developed and developing countries alike. It comes from sources of dust, gases and smoke, and is generated mainly by human activities but also naturally. While the problem regarding outdoor air pollution has been well publicised for several decades, it is indoor air pollution that is causing the most recent concerns for obvious reasons:

#### Exposure to Indoor Air Pollution

People's exposure to indoor air pollution is determined by the concentrations of pollutants in the indoor environment and, most importantly, by the time individuals spend in polluted environments. Most people spend a large amount of their time indoors, which makes indoor spaces important micro-environments when addressing risks from air pollution. Most of a person's daily exposure to many air pollutants comes through inhalation of indoor air, both because of the amount of time spent indoors and because of the higher pollution levels indoors.

The air quality inside buildings is affected by many factors. In an effort to conserve energy, modern building design has favoured tighter structures with lower rates of ventilation. By contrast, in some areas of the world only natural ventilation is used; in other areas mechanical ventilation is common. Factors that can have a negative effect on health and comfort in buildings range from chemical and biological pollutants to occupant perceptions of specific stresses such as temperature, humidity, artificial light, noise and vibration.

#### Sources of Indoor Air Pollution

Important sources of indoor pollutants include outdoor air, the human body and human activities, emissions from building materials, furnishings and appliances and use of consumer products. Microbial contamination is mostly related to the presence of humidity. The heating, ventilating and air conditioning (HVAC) system can also act as a pollutant source, especially when it is not properly maintained. For example, improper maintenance of HVAC

equipment can lead to re-emission of particulate contaminants. Biological contamination can proliferate in moist components of the system and be distributed throughout the building.

### **Health Effects of Specific Air Pollutants**

Most indoor air pollutants directly affect the respiratory and cardiovascular systems. Sometimes the brain and general nervous system are also affected. The direct human health effects of indoor air pollution on the respiratory system vary according to both the intensity and the duration of exposure, and also with the health status of the population exposed. Certain parts of the population may be at greater risk, for example, the very young and elderly, those already suffering from respiratory disease, hyper-responders and people exercising. Over recent decades the list of airborne pollutants which can have an impact on our health has become longer and longer. Here is just a small selection of the most common and important air pollutants and their effects on health:

#### **Allergens**

Allergens such as pollen, house dust mites' faeces and moulds in indoor environments of high humidity can cause allergic asthma (reversible narrowing of lower airways), allergic rhinoconjunctivitis in children and young adults, and recurrent bouts of pneumonia or milder attacks of breathlessness.

#### **Asbestos**

Asbestos and other mineral fibres may be a cause of an increased incidence of lung cancer. Acute exposure to asbestos and glass fibres can cause severe skin irritation.

#### **Carbon Monoxide (CO)**

Carbon Monoxide results from burning of gasoline, natural gas, coal, oil etc. Breathing CO reduces the ability of blood to transport oxygen to body cells and tissues; cells and tissues need oxygen to work. It may be particularly hazardous to people who have heart or circulatory (blood vessel) problems and people who have a damaged lung or respiratory tract.

#### **Formaldehyde (CH<sub>2</sub>O)**

The main acute effects of formaldehyde include odour perception and irritation of eyes, nose and throat. Discomfort, lacrimation, sneezing, coughing, nausea and dyspnea have also been observed, depending on the concentration. Formaldehyde is also a well known carcinogenic.

#### **Infectious Microorganisms**

Inhalation of infectious microorganisms discharged by people and animals is a primary mechanism of contagion for most acute respiratory infections. In indoor environments characterised by reduced ventilation and increased use of untreated recirculated air, concentrations of microorganisms may increase.

#### **Nitrogen Oxides (NO<sub>x</sub>)**

Nitrogen oxides are smog-forming chemicals, created by the burning of gasoline, natural gas, coal, oil etc. Cars are a major source of NO<sub>2</sub>. Health effects include lung damage and illnesses of the respiratory organs.

#### **Ozone (O<sub>3</sub>)**

This pollutant is not emitted directly by cars or industrial operations, but formed by the chemical reaction of sunlight on air containing various air pollutants, such as VOCs and NO<sub>x</sub>. Ozone is the principle component of smog. Indoor sources of ozone include outdoor ozone, office equipment (e.g. printers, photocopiers), as well as ozone generators. Some ionising and UV air cleaners also produce ozone. Health effects include: breathing problems, reduced lung function, asthma, irritation of eyes, stuffy nose, reduced resistance to colds and other infections. Long-term exposure to ozone has been shown to increase risk of death from respiratory illness. A recent study\* of 450,000 people living in urban areas of the USA showed a significant correlation between ozone levels and respiratory illness over the 18-year follow-up period. The study revealed that people living in cities with high ozone levels such as Houston or Los Angeles had an over 30% increased risk of dying from lung disease.

\* Jerrett, Michael; Burnett, Richard T. and Pope, C. Arden, III and Ito, Kazuhiko and Thurston, George and Krewski, Daniel and Shi, Yuanli and Calle, Eugenia and Thun, Michael (March 12, 2009). "Long-Term Ozone Exposure and Mortality". N. Engl. J. Med.360 (11): 1085–1095.

**Particulate Matter (PM)**

In addition to smoke and soot generated by burning of fossil fuels, tobacco smoke, by industrial processes, agriculture, wild fires etc., particulate matter consists of tiny aerosol particles formed from gaseous emissions of sulfur dioxide and VOCs. Particulate pollution is classified by size, with finer particles (PM<sub>2.5</sub>, i.e. particles of 2.5 microns size and less) considered to be more dangerous than coarser material (PM<sub>10</sub>), because they are small enough to evade the body's respiratory defence mechanisms and lodge deep in lung tissue. For that reason, these tiny particles appear to have the greatest health-damaging potential. Many scientific studies have linked breathing PM to a series of significant health problems, including:

- nose and throat irritation
- increases in respiratory symptoms (like coughing and difficult or painful breathing)
- aggravated asthma
- decreased lung function
- lung damage
- bronchitis
- heart disease and other cardiac problems
- premature death

**Sulfur Dioxide (SO<sub>2</sub>)**

This chemical is generated by the burning of coal and oil, and other industrial processes and can cause breathing problems and permanent damage to the lungs.

**Tobacco and Biomass Smoke**

Smoke contains a variety of health-damaging pollutants, including particles, carbon monoxide, nitrous oxides, sulphur oxides (mainly from coal), formaldehyde and many carcinogens (chemical substances known to increase the risk of cancer) such as benzene. The active and passive inhalation of smoke can lead to a reduction of pulmonary function, to an increased incidence of respiratory symptoms and infections, to an increased incidence of lung cancer and early death. There is consistent evidence that exposure to smoke increases the risk of acute lower respiratory infections in childhood, particularly pneumonia. Globally, acute lower respiratory infections represent the single most important cause of death in children under 5 years and account for at least 2 million deaths annually in this age group.

**Volatile organic compounds (VOCs)**

VOCs are released from burning fuel (gasoline, oil, coal, natural gas, etc.), solvents, paints, glues and other products used at work or at home. Cars are also an important source of VOCs. VOCs include chemicals such as benzene, toluene, methylene chloride and methyl chloroform. Health effects reported for VOCs range from sensory irritation to behavioural, neurotoxic, hepatotoxic and genotoxic effects. Long-term exposure is suspected to cause damage to the liver and other parts of the body. Exposure to mixtures of VOCs may be an important cause of Sick Building Syndrome.

### 3. Health Issues Related to Particulate Air Pollution

There are millions of particles floating in the air of the typical home. This can be shown with a simple ParticleScan reading. A home with 200 square metres and a 2.70 m ceiling has 540 m<sup>3</sup> of air. If you measured 50'000 particles per litre of air in that home, then you would have approximately 27 billion total particles in that home. And not a single one of these particles is a „healthy“ particle. In fact, particles in the air can cause all sorts of health problems:

**Allergies**

The immune system overreacts to normally harmless particles or substances, such as pollen. It acts as if the substance or particulate is harmful. About 20 - 25% of the population has some sort of allergy with rising tendency. There are 3 basic types of allergies: inhalation, food and contact allergies. Out of those, inhalation is the one we are addressing. There are two types of inhalation allergies:

- outdoor allergies (seasonal) – caused by pollen from trees, plants and grass
- perennial allergies (permanent) – caused by indoor allergens such as house dust mites, mould spores and pet dander

Typical symptoms for both include sneezing, congestion, itchy watery eyes, coughing.

### **Asthma**

This is a chronic inflammation of the airways that make a person sensitive to airborne allergens and irritants. In the USA alone 20 million citizens have been diagnosed with asthma, and nearly 9 million are children. Asthma can be genetic and can be caused and aggravated by environmental conditions such as exposure to tobacco smoke, infections and allergens early in life. Asthma symptoms are caused or can be aggravated by:

- allergens
- airborne irritants like cigarette smoke, air pollution, strong odours, scented products
- cold air
- medicine
- sulfites in food
- infections

Symptoms of asthma include wheezing, coughing, chest tightness and trouble breathing.

### **Air Pollution and Heart Disease**

Long-term exposure to fine particulates promotes heart disease and stroke. A study by Dr. Joel Kaufman, et. al., published in January 2007 in the *New England Journal of Medicine*, stated that 66,000 women over 50 years of age finds that each time the concentration of fine particulates increased by 10 micrograms per cubic metre of air, a woman's risk of dying of heart disease rose by 76%. To put that in layman's terms, we typically breathe air that has 20 – 40 micrograms per cubic metre of particles. So increasing that by 10 micrograms is a fairly small increase. We may typically see that much change in particle concentrations just based on weather changes.

### **Decreased Life Expectancy**

High particulate pollution levels are intrinsically linked to premature death and thus a reduced life expectancy. Consequently, reducing one's exposure to ambient fine-particulate air pollution can lead to significant and measurable improvements in life expectancy. A study published in the January 2009 issue of the *New England Journal of Medicine* by Dr. C. Arden Pope III et. al., examined the correlation between the reduction in average PM<sub>2.5</sub> air pollution in the United States with the increase in average life expectancy. Although multiple factors affect life expectancy, they were able to attribute up to 15% of that increase to improvements in air quality. They found that a decrease of 10 micrograms per cubic metre in the concentration of fine particulate matter was associated with an estimated increase in average life expectancy of 0.61 years. In conclusion, cleaner air yields longer life.

## **4. Other Illnesses Associated with Indoor Air Pollution**

### **Multiple Chemical Sensitivity (MCS)**

MCS is a chronic condition affecting different parts of the body in response to a chemical exposure. MCS can be genetic and can be caused by environmental factors such as exposure to chemicals, especially formaldehyde, pesticides, disinfectants such as gluteraldehyde, glues, solvents and paints.

MCS is activated or aggravated by airborne chemicals, cleaning substances and toxic chemicals produced by mould. Other factors include stress, certain foods and food additives, medicine and infections.

Symptoms can be extreme, such as breathing problems, nausea, sickness, lethargy, joint and muscle pains, burning in mouth and throat, severe headaches and disorientation.

### **Sick Building Syndrome (SBS)**

SBS is the occurrence of specific symptoms with unspecified aetiology. SBS is experienced by people while working or living in a particular building, but which disappear after they leave it. Symptoms include mucous membrane, skin and eye irritation, chest tightness, fatigue, headache, malaise, lethargy, lack of concentration, odour annoyance and influenza symptoms. It is assumed that the interaction of several factors, involving different reaction mechanisms, cause the syndrome, but there is yet no clear evidence of any exposure-effect relationship.

### **Building Related Illness (BRI)**

BRI is an illness related to indoor exposures to biological and chemical substances (e.g. fungi, bacteria, endotoxins, mycotoxins, radon, CO, CH<sub>2</sub>O). It is experienced by some people working or living in a particular building and it does not disappear after leaving it. Illnesses include respiratory tract infections and diseases, legionnaires' disease, cardiovascular diseases and lung cancer.

IQAir systems are at least 99.5% effective at removing particles down to 0.003 microns in size and can therefore effectively reduce exposure to pollutants. Thus IQAir can contribute to reducing allergy and asthma symptoms, risk of heart disease and increasing life expectancy.