
Indoor Air Quality

Introduction

The quality of indoor air and its potential effect on human health is important due to the amount of time humans spend inside buildings. Indoor air can be defined as "**air within a building occupied for at least one hour by people of varying states of health**". This definition includes air within :

- dwellings
- hotels
- hospitals
- schools
- offices
- restaurants
- shops
- other public buildings

Note : it does not cover workplaces which are covered by other occupational health standards.

Indoor air can be contaminated by the same pollutants as outdoor air, particularly :

- nitrogen oxides (NO_x)
- carbon monoxide (CO)
- particulate matter (PM₁₀)
- volatile organic compounds (VOC)

Concentrations of particulates and nitrogen oxides can reach higher levels indoors than outdoors and in some situations they can persist for longer periods indoors. In addition, indoor air quality can be affected by pollutants that are associated with the indoor environment such as:

- formaldehyde from upholstery foams
- dust mites
- tobacco smoke
- microbial contaminants such as legionella
- radon

Indoor air quality is affected by a range of factors including:

- the use of pollutant emitting materials
- temperature and humidity
- ventilation rates

Factors affecting indoor air quality

- **building and furnishing materials**

Modern building and furnishing materials contribute to indoor air pollution. Adhesives contained in chipboard, plywood, carpets and furniture may emit significant amounts of volatile organic compounds and formaldehyde. Other pollutants are found in insulation materials, paints and varnishes.

Note : The increasing use of water based paints and low solvent varnishes has reduced indoor air pollution.

- **temperature, humidity and ventilation rates**

Modern building construction design and technology result in dwellings with more bathrooms and with more air tight construction. This can result in higher levels of humidity.

In addition, more adults work away from home nowadays. This means that dwellings are left closed up resulting in long periods without adequate ventilation.

Where sources of pollution are present within the dwelling, poor ventilation results in a build up of the contaminant. These conditions are ideal for the breeding of moulds and dust mites.

Affect on human health of indoor pollutants

- **nitrogen oxides (NO_x)**

Combustion appliances such as unflued gas heaters and cooking appliances are the main source of nitrogen dioxide (NO₂). Tobacco smoke and infiltration of outdoor air contaminated by NO₂ from motor vehicles adds to indoor pollution.

Nitrogen oxides cause irritation of the lungs and impair lung function. Asthma sufferers are particularly affected. They can also lead to a reduced resistance to infections.

- **carbon monoxide (CO)**

Carbon monoxide (CO) is a result of incomplete combustion of fuels. Combustion appliances such as unflued gas heaters and cooking appliances are the main source of CO. As for nitrogen oxides, infiltration of outdoor air contaminated by CO from motor vehicles adds to indoor pollution.

CO combines with the haemoglobin in the blood and reduces its capacity to carry oxygen around the human body. This can adversely affect the functioning of the heart and the brain. This can cause headaches, dizziness and affect concentration. It can cause serious problems for people who suffer from angina, a heart condition.

Affect on human health of indoor pollutants

- **particulate matter (PM₁₀)**

Source of indoor particulates include combustion appliances (heaters and cookers), tobacco smoke, deterioration of building materials, dust mite faeces and human skin. In addition, there will be some infiltration of outdoor dust.

Health problems associated with particulates are related to the size of the particles. Smaller particles, less than 10mm are of most concern.

Particulates can cause impaired lung function and respiratory problems.

- **volatile organic compounds (VOC)**

These are emitted from a variety of building materials and furnishing products. In addition, outdoor VOCs are emitted by motor vehicle engines and other industrial activities.

VOCs can irritate the respiratory tract, eyes and nose. Some VOCs such as benzene are known to cause cancers.

- **formaldehyde from upholstery foams**

The most common sources of formaldehyde are building and furnishing materials. This includes chipboard, plywood, some insulating materials and some carpets.

Formaldehyde can cause irritation of the respiratory system, coughing and wheezing and allergic reactions such as skin rashes. It is also thought to cause some cancers.

- **dust mites**

Dust mites live in carpets, bedclothes and other furnishings. They feed on human skin that is shed continually. The faeces of dust mites are found in house dust. It is these faeces that cause allergic reactions in some humans.

Dust mite faeces can cause impairment of respiratory function. This causes problems particularly for those with asthma.

- **tobacco smoke**

Tobacco smoke is a serious indoor pollutant. It is composed of a variety of pollutants such as particulates, carbon monoxide, nitrogen dioxide, nicotine, tars, formaldehyde and hydrogen cyanide.

Health effects of tobacco smoke include eye, nose and throat irritation, headaches and lung cancer.

Affect on human health of indoor pollutants

- **other indoor pollutants**

Other indoor pollutants include:

- **lead**

Lead levels in indoor air are usually low. The main source being flaking of old lead paints. Until the 1960s lead containing pigments such as white lead were widely used in oil based paints for windows, doors and interior woodwork, and in paints for iron and galvanised metalwork.

Lead can also be introduced into indoor air by infiltration of air contaminated by lead from motor vehicle emissions.

Lead can cause a decrease in brain function in infants resulting in learning and behavioural difficulties. Lead is also associated with raised blood pressure in adults.

- **ozone**

Sources of indoor ozone include laser printers and photocopying machines.

Ozone is an irritant and affects the mucous membranes and lung tissues.

- **asbestos**

While asbestos products are now banned, there can be asbestos contained in older buildings. There are strict regulations covering the removal of asbestos from buildings.

Asbestos fibres, when breathed into the lungs, can cause asbestosis (a lung disease) and mesothelioma (tumours in the lungs, heart and abdomen).

- **moulds**

Moulds are common in damp humid conditions, particularly in bathrooms, laundry rooms and kitchens. The conversion of old unheated buildings, like warehouses, into dwellings causes problems when the introduction of heating draws moisture out of the building fabric.

The warm humid conditions allow toxic moulds to grow. At least 12 types of mould are recognised as being harmful to human health. The moulds feed on organic materials such as carpets and wallpaper and can eat into plaster and even brickwork.

Moulds are known to cause inflammation, allergic reactions and can lead to serious respiratory problems.

- **polycyclic aromatic hydrocarbons (PAHs)**

PAHs is a collective term covering a range of organic compounds which are known to cause cancer. Sources of PAHs include gas heaters / cookers and tobacco smoke.

Affect on human health of indoor pollutants

- **microbial contaminants such as legionella**

Bacteria thrive in damp humid conditions. Outbreaks of Legionnaires disease, for example, have been associated with water spray from air conditioning systems.

Legionnaires disease is a life threatening pneumonia caused by inhaling airborne *Legionella pneumophila* bacterium. This is found naturally in environmental water sources. Within a building, they can colonise water systems such as cooling towers, hot and cold water supplies and spa pools.

Infection occurs by breathing in moist air contaminated by legionella bacteria. Typical symptoms include fever, headache, muscle pains, diarrhoea, coughing and vomiting.

- **radon**

Radon is an inert, colourless, odourless radioactive gas. It is emitted from the radioactive decay of radium, which in turn comes from the radioactive decay of uranium. This is found in small quantities in some soils and rocks often found in granite and limestone areas.

The main areas in the UK where radon is a problem include granite areas in Devon / Cornwall and the limestone areas of Oxfordshire, Northamptonshire, Lincolnshire, Derbyshire and Somerset.

Concentrations of radon in the open air are very low. When radon enters an enclosed space such as a building the concentration increases rapidly. When radon is breathed into the lungs they can cause lung cancer.

- **sick building syndrome (SBS)**

The term '**sick building syndrome**' is used to describe situations where the occupants of a building experience health problems that appear to be linked to the time spent within the building.

The symptoms associated with sick building syndrome are non specific, i.e. not related to any particular illness. They include allergies, eye, nose or throat irritation, headaches, poor concentration, dizziness and nausea.

These symptoms are generally thought to result from indoor emissions of VOCs and lack of ventilation. Most of the sufferers of SBS get relief from their symptoms soon after leaving the building.

SBS is usually found where the air conditioning / ventilation systems are poorly designed or maintained; in new buildings fitted with modern materials; in buildings where temperatures are consistently above 21 degrees C and where lighting is poor.

Assessment

Indoor Air Quality

Questions 1 to 5 - Select the correct response for the following questions :

1. Which of the following stages is **not** included when considering the definition of indoor air quality?
 - A dwellings
 - B workplaces
 - C schools
 - D hospitals

2. Which of the following is **not** a source of both indoor and outdoor air pollution ?
 - A nitrogen oxides
 - B radon
 - C carbon monoxide
 - D volatile organic compounds

3. What is the source of formaldehyde as an indoor pollutant ?
 - A combustion product of gas heaters
 - B flaking of paints and varnishes
 - C chipboard, plywood and carpets
 - D dust mite faeces

4. In what conditions do legionella bacteria thrive ?
 - A hot dry conditions
 - B cold dry conditions
 - C damp humid conditions
 - D all the above

5. Which of the following is **not** a health hazard caused by sick building syndrome ?
 - A cancer
 - B eye, nose and throat irritation
 - C dizziness and nausea
 - D headaches and lack of concentration

Questions 6 to 10 - Decide whether each of these statements is True (T) or False (F).

6. i) Indoor air can be defined as "**air within a building occupied for at least one hour by people of varying states of health**".
ii) Concentrations of particulates/nitrogen oxides can reach higher levels indoors than outdoors and in some situations they can persist for longer periods indoors.

Which option best describes the two statements?

- A i) T ii) T
B i) T ii) F
C ii) F ii) T
D ii) F ii) F

7. i) Indoor air quality is not affected by temperature or humidity.
ii) Modern building and furnishing materials do not contribute to indoor air pollution.

Which option best describes the two statements?

- A i) T ii) T
B i) T ii) F
C i) F ii) T
D i) F ii) F

8. i) Although volatile organic compounds can cause irritation of the respiratory system they do not cause serious health problems.
ii) Nowadays, asbestos is never found in buildings.

Which option best describes the two statements?

- A i) T ii) T
B i) T ii) F
C i) F ii) T
D i) F ii) F

9. i) Radon gas is easily detected due to its strong smell.
ii) The faeces of dust mites are found in house dust. It is these faeces than cause allergic reactions in some humans.

Which option best describes the two statements?

- A i) T ii) T
B i) T ii) F
C i) F ii) T
D i) F ii) F

10. i) Within a building, legionella bacteria can colonise water systems such as cooling towers, hot and cold water supplies and spa pools.
ii) Strangely, sick Building Syndrome is usually found where the air conditioning / ventilation systems are well designed or maintained

Which option best describes the two statements?

- A i) T ii) T
B i) T ii) F
C i) F ii) T
D i) F ii) F