

Indoor Air Quality (IAQ)

Indoor Air Quality (IAQ) refers to the physical, chemical, and biological characteristics of air in the indoor environment within a building. A more technical definition of IAQ is related to how well indoor air satisfies the three basic requirements for human occupancy: thermal acceptability, maintenance of normal concentrations of respiratory gases, dilution and removal of contaminants to levels below health or odour discomfort thresholds.

I – Indoor Air Quality Generally

1. Parameters determining IAQ

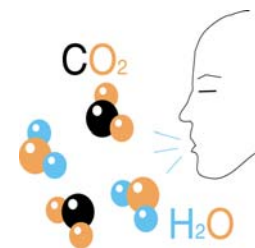
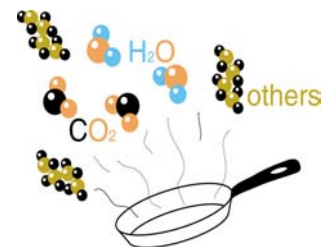
IAQ is a constantly changing interaction of complex factors that affect the types, levels, and importance of pollutants in indoor environments. Problems are usually reflected from the dissatisfaction of the building's occupants with the indoor environment, and the associated complaints encountered.

Poor or inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the home, but inadequate supplies of fresh air or oxygen are only part of the problems.

2. What causes indoor air problems

There are many sources of indoor air pollution in any home:

- Pollutants
 - Inorganic gases e.g. CO, NO₂, CO₂
 - Organic compounds e.g. benzene, toluene, limonene, TVOC
 - Non-biological particles and fibres e.g. PM₁₀, PM_{2.5}
 - Biological particles e.g. fungi, bacteria, virus
 - Radon
 - Mixture of pollutants e.g. landfill gas, ETS
- Temperature
- Humidity



3. Study of school following refurbishment

TVOC annual mean concentration in the staff room of 380µg m³ and this was highest of all locations. Peak concentration in October 2003 associated with decorating of the room. Subsequently smaller peak in February 2004 associated with decorating activities in other rooms nearby (4 months exceeded 300µg m³)

4 week mean toluene concentration in the staff room $\sim 800\mu\text{g m}^3$ in October. Peak concentration was associated with decorating activities and was concurrent with the peak TVOC value. WHO guideline value is $260\mu\text{g m}^3$ for 7 day period. The 4 week mean concentration did not exceed the guideline value in any other month.

Monthly mean concentrations in the nursery exceeded the 7 day WHO guideline for toluene during October and April. Monthly mean very close to guideline in May and monthly mean very close to guideline value in May. Peak concentrations were concurrent with building and decorating activities in the nursery or nearby area.

Conclusion: While some peaks occurred during school holidays the guideline was exceeded during periods the school was in use, potentially harming the health of occupants.

II – Problems due to Indoor Air Quality

1. Why be concerned about IAQ

Poor indoor environmental quality has been related to increases in sick building symptoms, respiratory illnesses, sick leave and losses in productivity in offices and schools – Seppanen and Fisk, Indoor Air 2005.

A growing body of scientific evidence has indicated that the air within homes and other buildings can be more seriously polluted than the outdoor air in even the largest and most industrialized cities. Other research indicates that people spend approximately 90 percent of their time indoors. Therefore most people's exposure to air pollutants is determined primarily by exposure indoors, particularly in their home.

2. Immediate effects

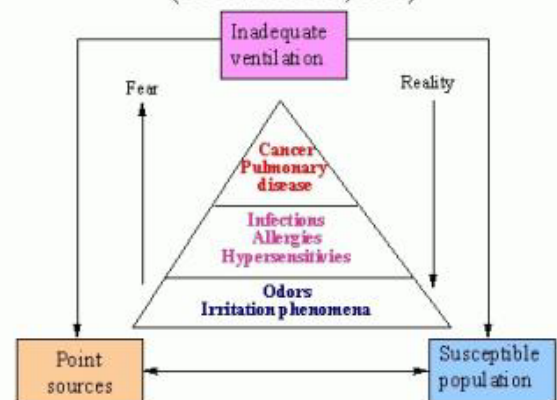
May show up after a single exposure or repeated exposures. These include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Such immediate effects are usually short-term and treatable. Sometimes the treatment is simply eliminating the person's exposure to the source of pollution, if it can be identified. Some effects may be made worse by an inadequate supply of outdoor air or from the heating, cooling, or humidity conditions prevailing in the home.

3. Other health effects

May show up either years after exposure has occurred or only after long or repeated periods of exposure. These effects, which include some respiratory diseases, heart disease, and cancer, can be severely debilitating or fatal.

It is prudent to try to improve the indoor air quality even if symptoms are not noticeable so an effort should be made to identify indoor air sources that may be possible cause.

Understanding Indoor Air Quality Problems
(Brooks & Davis, 1992)



III – Preventing indoor environmental problems

1. IAQ measurements

Methods used in an indoor air quality investigation may include: identification of pollutant sources; evaluation of the heating, ventilating, and air conditioning (HVAC) system performance; observation of practices; measurement of contamination levels and exposure; medical testing or physical examinations.

2. Efficient ventilation system

Ventilation accounts for between 25-30% of the total building energy use. There are large disparities in the energy consumption of similar buildings in similar locations and this is due to various levels of thermal insulation, services system efficiencies, differences in building construction, occupancy behaviour and building management.

IV – Legislation on Indoor Air Quality

1. Guidelines and Standards

UK DH (COMEAP) - Recommended Indoor Air Quality guidelines for homes
WHO guidelines for individual compounds relates to indoor and outdoor air
National guidelines/standards in some countries

DH guidelines:

Benzene; annual mean $5\mu\text{g m}^3$

CO; 15mn, 30mn, 1h, 8h means

NO₂; 1h and annual averages

Formaldehyde; $100\mu\text{g m}^3$ (30mn)

Benzo(a)pyrene; 0.25ng m^3 provisional annual means

2. European labelling schemes

i) National labelling

Finnish classification of finishing materials

The indoor climate label (Denmark and Norway)

Swedish floor covering standard

Nordic swan ecolabelling scheme

AgBB scheme for building materials in Germany

EMICODE for flooring adhesives (Germany based)

GUT for carpets (Germany based)

German Blue Angel e.g. furniture

ii) ECA

European collaborative action on indoor air quality and its impact on people

Harmonisation of indoor material emission labelling systems in the EU

Prepared draft report on inventory of existing schemes made available to CEN in June 2005

Expert group will explore possibility of further convergence of schemes

iii) Construction Products Directive

European Council Directive 89/106/EEC

Essential requirement no.3; hygiene, health and the environment

A healthy indoor environment can be achieved by the controlling of sources and by eliminating or limiting the release of pollutants into the air.

3. How the new Part F deals with IAQ

<u>Parameter</u>	<u>Performance criteria</u>
Nitrogen dioxide	$\leq 288\mu\text{g m}^3$ - 1 hour average $\leq 40\mu\text{g m}^3$ - long term average
Carbon monoxide	$\leq 100\mu\text{g m}^3$ - 15 minute averaging time $\leq 60\mu\text{g m}^3$ -30 minute averaging time $\leq 30\mu\text{g m}^3$ - 1 hour averaging time $\leq 10\mu\text{g m}^3$ - 8 hours averaging time
VOCs	$\leq 300\mu\text{g m}^3$ - 8 hours averaging time
Ozone	$\leq 100\mu\text{g m}^3$ (not applicable to dwellings)
Mould growth	No visible mould on external walls in a properly heated building

Conclusion

Indoor Air Quality is a vital factor for the health of occupants in buildings.

There is considerable value in demonstrating to clients the value of spending more capital on high quality buildings which promote good airflow characteristics, by using natural or mechanical systems.

The process of achieving indoor air quality is a continual one throughout the design, construction, commissioning, facilities management and refurbishment stages of a building's life.

ADF performance criteria propose several IAQ guidelines.

To check compliance with criteria the strategy and methods of measurement must be defined appropriate for the building.

Source control will have a growing impact through voluntary labels and legislation such as the CPD (and it is hoped an integrated policy involving REACH, biocides directive etc.)

References: Seppanen and Fisk, Indoor Air - 2005.
Brooks and Davies, Understanding Indoor Air Quality Problems - 1992
BRE Report 477 - 2005
BRE IP9/04
BRE Digest 464

Thanks: D. Crump - BRE