# indoor air quality monitoring

## A PRACTICAL GUIDE

ENVISYS

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# 01
# Definition of Indoor Air Quality

Indoor Air Quality (IAQ) refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. Understanding and controlling common pollutants indoors can help reduce your risk of indoor health concerns.

Health effects from indoor air pollutants may be experienced soon after exposure or, possibly, years later.

# IAQ statistics

**90%**

Australians spend 90% or more of their time indoors

**x5**

Indoor air pollution is 2 to 5 times higher than outdoors

**$12b**

CSIRO estimates that the cost of poor IAQ in Australia is $12 billion per year

# Health Effects

Some health effects may show up shortly after a single exposure or repeated exposures to a pollutant. These include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue.

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.

**Whether a source of air pollutants causes an indoor air quality problem or not depends on:**

- type of air pollution
- the amount and rate at which it is released from its source
- control measures such as ventilation or eliminating the source

- Building operations
- Construction materials
- household products
- Human indoor activities
- External factors

**are Common sources of indoor air pollutants**

"Working environments, which are inadequately designed from the building physical point of view (acoustics, indoor climate, lighting, air quality), have an impact on health, comfort and performance."

- THE FRAUNHOFER INSTITUTE

# Particulate matter


Particulate matter, also known as particle pollution or PM, is a term that describes extremely small solid particles and liquid droplets suspended in air.

Particulate matter can be made up of a variety of components including nitrates, sulphates, organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mould spores).

Particle pollution mainly comes from motor vehicles, wood burning heaters and industry. During bushfires or dust storms, particle pollution can reach extremely high concentrations.

# Particulate Matter (PM)

The size of particles affects their potential to cause health problems:

PM10 (particles with a diameter of 10 micrometres or less): these particles are small enough to pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

PM2.5 (particles with a diameter of 2.5 micrometres or less): these particles are so small they can get deep into the lungs and into the bloodstream. There is sufficient evidence that exposure to PM2.5 over long periods (years) can cause adverse health effects. Note that PM10 includes PM2.5.

# Carbon Dioxide


Carbon Dioxide is a relatively easy to measure surrogate for indoor pollutants emitted by humans, and correlates with human metabolic activity.

Carbon dioxide at levels that are unusually high indoors may cause occupants to grow drowsy, to get headaches, or to function at lower activity levels.

Indoor CO2 levels are an indicator of the adequacy of outdoor air ventilation relative to indoor occupant density.

# Carbon Dioxide (CO2)

To eliminate most complaints, the total indoor CO2 level should be reduced to a difference of less than 600 ppm above outdoor levels.

The National Institute for Occupational Safety and Health (NIOSH) considers that indoor air concentrations of carbon dioxide that exceed 1,000 ppm are a marker suggesting inadequate ventilation.

The UK standards for schools say that carbon dioxide in all teaching and learning spaces, when measured at seated head height and averaged over the whole day should not exceed 1,500 ppm

# Carbon Monixide


Carbon monoxide (CO) is an odourless, colourless gas which forms when the carbon in fuels doesn't completely burn.

It is usually generated by motor vehicles and industry but can also be formed during bushfires. Indoors, carbon monoxide is formed by unflued gas heaters, wood-burning heaters, and contained in cigarette smoke.

Carbon monoxide can cause harmful health effects by reducing the amount of oxygen reaching the body's organs (like the heart and brain) and tissues. At extremely high levels, carbon monoxide can cause death.

# Carbon Monoxide (CO)

Potential health effects from exposure to carbon monoxide:

> Flu-like symptoms such as headaches, dizziness, disorientation, nausea and fatigue

> Chest pain in people with coronary heart disease

> At higher concentration: impaired vision and coordination, dizziness and confusion

> Potentially serious health effects on unborn babies when exposed to high levels

# Volatile Organic Compunds


Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects.

Organic chemicals are widely used as ingredients in household products. Paints, varnishes;and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing and hobby products. Fuels are made up of organic chemicals. All of these products can release organic compounds while you are using them, and, to some degree, when they are stored.

# Volatile Organic Compounds (VOC)

Health effects of exposure to VOCs include eye, nose and throat irritation, headaches, loss of coordination and nausea, damage to liver, kidney and nervous system, and cancer.

Examples of volatile organic compounds are gasoline, benzene, formaldehyde, solvents such as toluene and xylene, styrene, and perchloroethylene.

Formaldehyde is an important chemical used widely by industry to manufacture building materials and numerous household products. Formaldehyde can cause irritation of the skin, eyes, nose and throat. High levels of exposure may cause some types of cancers.

# 02
# Improving Indoor Air Quality

Despite the various causes of poor IAQ, there are several concrete, often low cost steps that you can take to improve that air that you and your workforce breathe.

We've outlined a guide for getting started below. These steps are divided into easy, medium, and hard categories. While several tips are provided, they are all versions of two basic approaches: "reducing and removing sources" of indoor pollution, and "reducing the concentration" of indoor pollutants through ventilation and cleaning.

# EASY STEPS - 1

- **Smoking should never be permitted indoors or within several feet of a building entrance. Second hand smoke will not dissipate indoors, and will build up over time.**

- **Place large doormats outside and inside at entrances. Dust, pesticides, trace amounts of lead, and a host of other contaminants are carried inside on people's shoes. While you can request that people take off their shoes at the front door of your home, you're unlikely to want to do this at your place of business. Large doormats, however, trap a surprising amount of these particles, and can later be cleaned.**

- **Clean regularly. Use vacuum cleaners with HEPA filters, which emit fewer particles back into the air. Damp dust and mop where you are able. This is a great way to trap particulate that vacuum cleaners and regular dusting miss.**

- **Forgo air fresheners altogether. This includes plug-ins, sprays, and other scented products that are designed to perfume rather than clean your air. Air fresheners mask bad smells that indicate that you need to remediate a problem, such as find and remove mold and mildew. They also add problem compounds to the air. VOCs and phthalates are commonly found in the catch-all ingredient "fragrance" in air fresheners. Six phthalate compounds have recently been banned in children's toys because of the harm they pose.**

# EASY STEPS - 2

- **Ensure that your cleaning products aren't adding to the problem. Avoid cleaners that include any kind of "fragrance," as well as cleaners that use chlorine or ammonia.**

- **Clean up moisture and other spills immediately to reduce the chances of mold and mildew growth. Mold and mildew spores are naturally occurring, but you can control the conditions that encourage growth.**

- **Skip the tabletop air purifier, but maybe not the indoor plants. Research is mixed on whether or not indoor plants remove VOCs from the air, though they do increase oxygen levels, which can help improve alertness. Air purifiers, of the stand-alone variety, do very little, and are unlikely to impact the air quality in your building overall.**

- **Install an Indoor Air Quality Monitor. These are usually required in new construction, but are a good safety investment for all structures. Especially consider installing these if you have fuel-burning devices in the building, such as gas stoves, water heaters, and space heaters.**

# MEDIUM STEPS

- **Regularly maintain your HVAC and other building systems. This includes changing air filters.**
- **Keep moisture levels somewhere in the range of 30 to 50% humidity. This will inhibit the growth of mold and other allergens, and also make occupants more comfortable. Your approach to managing humidity will depend on your climate.**
- **Determine the air exchange rate in your building. In a small building, you can always open windows to allow in new air and flush out the old. In larger buildings, this is a more complicated issue. Work with a professional to ensure that the building system replaces the air in your building at an adequate rate.**
- **Apply AFM Safecoat sealants or similar sealants to pressed wood products. This water-based sealant is effective at preventing the off-gassing of formaldehyde and other VOCs present in most pressed wood products.**
- **Manage pests without pesticides. Pesticides should be a last resort, and there are several resources and methods of pest control, also known as Integrated Pest Management (IPM) that do not require the widespread application of pesticides.**
- **Invest in testing to identify specific hazards. With so many potential contaminants, your best course of action is to identify the worst offender or offenders and deal with those. There are a variety of tests that you can purchase and then send to a lab that test for VOCs, formaldehyde, radon, lead, and mold. For larger buildings, more accurate testing and evaluations can be performed by professionals.**

# HARD STEPS - 1

If at any point you are in a position to remodel or replace furnishings in your building, research the materials that you'll be replacing. Choose options that have little to no chance of releasing any kind of noxious gas or chemicals and that do not contain problem substances. Fortunately, industry standards are changing due to consumer demand, and there are new laws in place limiting the presence of certain key problem chemicals. Older materials may or may not meet new standards.

Additionally, an updated or new air system may be in order. Any new air system should efficiently replace the air in your building and include a system for collecting contaminants.

# HARD STEPS - 2

- **Carpet and carpet padding: Carpets trap dust and other particulate, and are very difficult to fully clean. Furthermore, they often off-gas flame-retardants and other hazardous chemicals. Some options are better than others, and may emit fewer VOCs. Some carpet companies manufacture low-emission lines of carpets with better overall environmental impact.**

- **Particleboard, pressed wood, and plywood: The resins and glues in these are often filled with formaldehyde. Industry standards are changing, and formaldehyde levels have been reduced in many products and eliminated in a few. Medium density fiberboard (MDF), commonly used in furniture, has the highest levels of formaldehyde.**

- **Textiles and fabrics: This includes upholstery and drapes, and very possibly your wrinkle-resistant shirt. These often have been treated with VOCs to reduce wrinkling and to act as a flame retardant. Formaldehyde is a common problem here as well.**

- **Paints, sealants, and finishes: Look for low VOC paints and finishes, and finishes that are water based. Your local green building supply company should have good resources on what products are safest. Regardless of what you use, use these products outdoors whenever possible. Let your space air out thoroughly before moving people back into a newly painted or refinished space.**

- **Fuel-burning appliances: This may not be an issue in your space, but if you have a gas stove, water heater, or other appliance that could be releasing gases through combustion, ensure that these appliances have local ventilation that vent to the outside of the building.**

**Technology should be used to create unforgettable experiences that enhance our natural and built environments, transforming them in newly meaningful ways.**

DAVID ROCKWELL

# 03
# Indoor Air Quality Monitoring

**STANDARDS**

Ambient (outdoor) air quality follows well-known standards across the world. Parameters to be monitored, acceptable technologies, monitoring criteria and limit values are documented and accepted in each country.

However, there is no integrated guideline for Indoor Air Quality monitoring. Some of the famous guidelines which are available on the web are set by:

> WHO
> Australian Building Codes Board (ABCB)
> ASHRAE

# Methods of IAQ monitoring

**1- Direct Reading Instruments**
Real-time and continuous measurement or IAQ parameters let you to manage and control the air quality.

**2- Sampling and lab test**
Since various parameters cannot be measured at same time, this method is used for special parameters where direct reading instruments are too expensive.

# Types of Air Quality Monitoring Devices

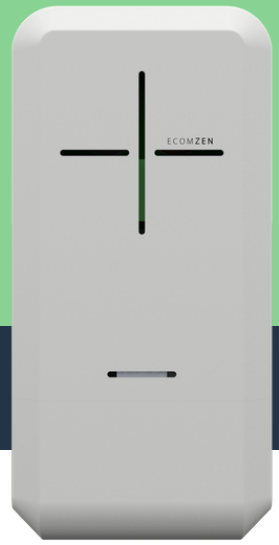
| | |
|---|---|
| **Reference** | Expensive and complex equipment developed for ambient air monitoring purpose |
| **Near-Reference (Indicative)** | Economical instruments, yet with very accurate measurements and easy to maintain **(preferred)** |
| **Low-cost sensors** | Gadgets and small sensors to estimate air quality picture, but not accurate for taking action |

# ECOMZEN

Ecomesure, French air quality specialist, designed ECOMZEN to monitor the key parameters for indoor air quality including concentration of particles (PM), CO2, CO, VOCs, temperature, humidity and pressure.

Easy to install, ECOMZEN connects automatically to the web platform using WiFi or 3G/4G, where a lot of services mapping of stations, air quality index, instant data, air quality profiles, downloads, warnings and reports are available.

# ECOMZEN




## SPECIFICATIONS ECOMZEN

| | |
|---|---|
| Communication between ECOMZEN | Radio Mesh Network 2.4 GHz (IEEE 802.15.4) - Line of sight range: 500 m<br>LoRa/SigFox ready |
| Communication with the web server | Ethernet (optional 3G backup connection) or WiFi<br>Encrypted and secured data exchanges using SSL protocol |
| Digital I/O | 1 Digital Input / 1 Digital Output |
| Localization | Accelerometer, GPS |
| Access to services | https://www.i-comesure.com<br>Secured by password and SSL authentification |
| Services | On-line data access and FTP download<br>Automatic reports<br>Customized graphics<br>Alerts by SMS and e-mail<br>Synchronization with other instruments connected to the ECOMBOX system (e.g. weather station, indoor air analyzers, ...) |
| Power supply | 5 VDC USB, 2 A max<br>Mains adapter included: 90-264 VAC 50/60 Hz |
| Dimensions | H7 x L3.5 x P3″ (H175 x L85 x D73 mm) / 1.8 lbs. (0.8 kg) |
| Temperature / Relative Humidity | From 10 to 110 °F (-10 to 45 °C) / from 10 to 85 % RH without condensation<br>From 0 to 120 °F (-20 to 50 °C) / from 0 to 95 % RH without condensation with degraded per-formances |
| Certifications | CE class B, FCC class A |

# ECOMZEN

## INTEGRATED SENSOR CARTRIDGE

| | Range | Accuracy |
|---|---|---|
| $PM_{total}$ sensor (optical) | 0 – $10^7$ part/cm³ | 9% |
| $CO_2$ sensor (infrared) | 0 to 5000 ppm | 50 ppm at full scale |
| COV sensor (PID) | 0 to 50 ppm eq. isobutylene | up to 1 ppb |
| CO sensor (electrochemical) | 0 to 400 ppm | 20 ppb |
| Temperature | 0 to 120 °F (-20 to +50 °C) | 0.02 °F (0.01°C) |
| Humidity | 0 to 100 % | 0.04 % |
| Pressure | 950 to 1050 hPa | 1 hPa |
| Supplementary measurements | Other gas sensors (including $SO_2$, $NO_2$, $O_3$) available as options | |
| Corrections | Drift corrected as a function of temperature, relative humidity and ageing | |
| Dimensions | H5 x L3.5 x D1.5″ (H128 x L85 x D38 mm) | |

**Designed & Made in France**

ECOMESURE

# References


- Department of the Environment and Energy, website
- NSW Health, website
- United States Environmental Protection Agency, website
- Breath of Fresh Air, by S.Harvey, GREEN PLUS website
- World Health Organization publications


# We Care about The Environment and People

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