IAQ – Indoor Air Quality
The importance for our health

INDOOR AIR QUALITY

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Air pollution in general

Clean air is a mixture of gases; it consists of 21% oxygen and 78% nitrogen by volume, and traces of other gases such as argon, carbon dioxide (CO_2) and water vapour. These gases form the atmosphere that allows life to flourish. Every day, the average adult breathes about 15,000 to 20,000 litres of air. Both indoor and outdoor air contain chemical and biological volatiles, droplets and particles, some of which are harmful to people and animals and damaging to plants.

Air pollution is the term that describes any harmful gases or particles in the air. The air quality is affected by pollutants, which include ground-level ozone (O_3, especially in summer time), particles (e.g. dust from industrial processes, burning of wood or oil and car traffic), sulphur dioxide (SO_2 from burning processes), carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOC), hydrogen sulphide (H_2S), sulphates and nitrates. Additional air pollutants include toxic metals (lead, mercury, manganese, arsenic and nickel), benzene, formaldehyde, polychlorinated biphenyl (PCB), dioxins, and other chemical compounds.

Air pollution can affect both urban and rural areas. Although natural emissions from forest fires and wind-blown dust from soil and volcanoes contribute to air pollution, human activities release far more pollutants into the environment. The largest sources of air pollution are power plants, industries and vehicle emissions. While emission controls have improved the air in several industrialized countries over the last 20 years, a growing demand for power and the use of cars have increased the consumption of fossil fuels (gasoline, oil, natural gas, coal). Some other causes of air pollution are burning of wood, pesticides and toxic household products. Where smoking is still permitted indoors, tobacco smoke is the most important single source of indoor air pollution.

Smog in particular

Smog is another type of pollution, which occurs mostly in urban settings. It refers to the mix of nitrogen oxides (NOX) and volatile organic compounds (VOC) just above the Earth's surface, which form ground-level ozone in the presence of sunlight. Human activity is responsible for the increase in ground-level ozone in recent years.

About 95 per cent of NOX from human activity comes from the burning of gasoline, coal, gas and oil in motor vehicles, homes, industries and power plants. Levels of nitrogen dioxides vary widely. Natural background levels are ranging from 0.2 to 0.5 ppb. Annual ambient urban mean levels of NO_2, showing levels from 10 to 50 ppb, and an hourly mean ranging from 130 to 450 ppb. Unventilated gas combustion appliances in house holds may show values of 100ppb over periods of several days.

Indoor air pollution

The initial interest into indoor air pollution was triggered by the idea that high outdoor air pollution would have an influence into indoor air quality. Most people are aware that outdoor air pollution can damage their health, but fewer realize that indoor air pollution can also contribute to ill health. Asthma is the single most common chronic childhood disease in developed nations, and its prevalence and severity have been reported as increasing in many parts of the world, especially developed and fast growing countries. Exposure to nitrogen dioxide can cause inflammatory and permeability responses, lung function reduction and increases in airway resistance.

Studies by several heath care organisations have shown that levels of indoor pollutants may be even higher than outdoor levels. Since most people spend as much as 90% of their time indoors, indoor air pollution is a real concern.

Problems with indoor air quality are caused by a range of factors including:

- Emissions from building materials, and technical equipment
- Permeability of the wall structures
- Ventilation practices and ventilation rate
- Building practices and cleaning habits
- Emissions of products which are used indoors
- Smoking
- Open combustion
- Body effluents
- Ambient air quality

Reduced natural ventilation, too much humidity and the use of chemicals can lead to unhealthy air and affect health and well-being.

The health effects of air pollution

There is no known, safe level of air pollution. Even low levels of air pollution can have a negative effect on the health of vulnerable people, such as the elderly, children, and people with cardio respiratory problems. NO_2 is usually considered to be the most important of the indoor nitrogen oxides. High concentrations (e.g., 0.5 ppm) of NO_2 can cause respiratory distress in individuals with asthma and concentrations of approximately 1 ppm cause increased airway resistance in healthy individuals. Long term exposure to much lower concentrations of NO_2 may be associated with increased respiratory illness among children (Lee et al; Pediatrics 2003;112).

Air pollution can affect health in many ways:

- irritation of eyes, nose and throat;
- wheezing, coughing and breathing difficulties;
- worsening of existing lung and heart problems;
- increased risk of heart attack; and
- especially sensitive people may even result in premature death.

The target must be, to identify the level, and finally to reduce the level of indoor pollutants to increase in IAQ. Additional measures have to be taken for new constructed public and office buildings with central air conditioning. In contrast to particle filters, gaseous air cleaners, such as beds of activated carbon, are used up to now, in only a small minority of buildings because of their higher costs and uncertain performance; however, considerable efforts are needed to develop new technologies for gaseous air cleaning.

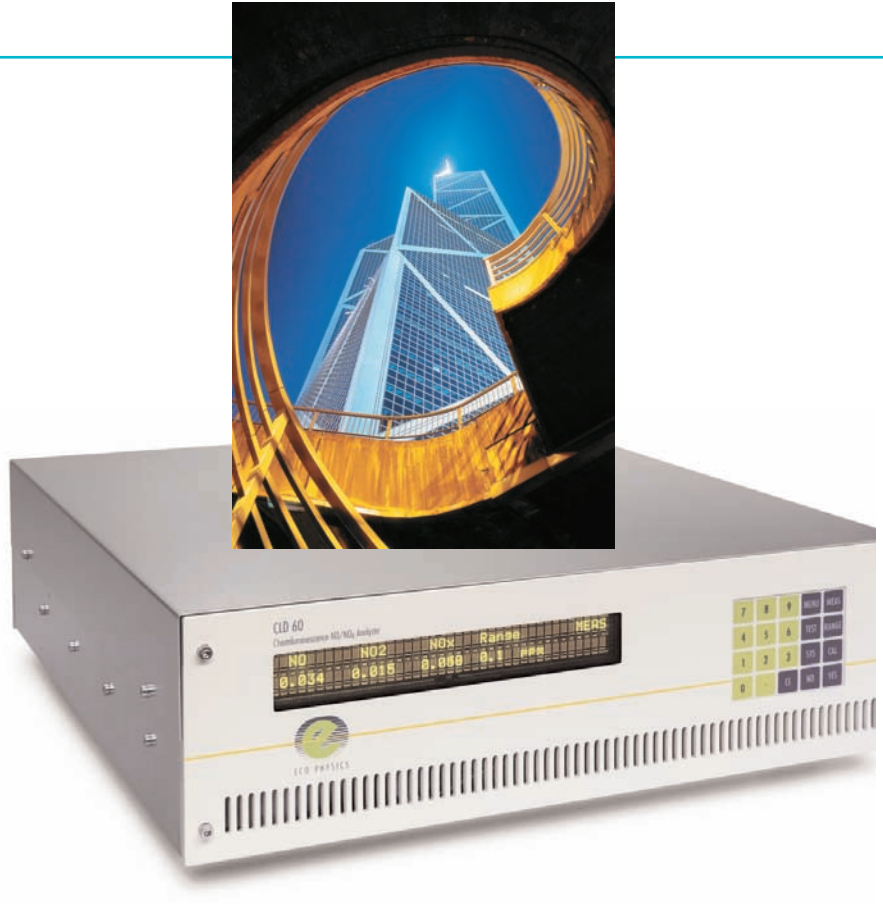
Air cleaning systems require regular maintenance and monitoring of the filter efficiency. For example, air filters must be periodically replaced to prevent reductions in air flow and to limit odor emissions and microbiological growth from soiled filters.

Standards and guidelines
The following table summarises the air quality standards and guidelines for NO_2. Most of theses standards and guidelines have been developed for outdoor air pollution levels. Adaptation for the indoor levels should be the next task. Few countries, like Japan, Korea, USA and the EU have started to define these new levels. NO_2 levels 5 to 10 times less than the maximum ambient concentration may be the right target to prevent long term health care problems.

Air quality standards and guidelines for NO_2:

Country or organisation	Averaging time	Concentration [ppb]
WHO	1 hour	200
	24 hours	80
CEC	1 year	100
Denmark	1 hour	100
Germany	1 year	150
	30 minutes	100
	24 hours	50
Switzerland	1 year	15
	24 hours	40
Netherlands	1 year	70
USA	1 year	50
Japan	24 hours	40 – 60
South Korea	1 year	50
	24 hours	80
	1 hour	150

Source: COST Project 613, commission of the European Communities



Monitoring and instrumentation

Precise monitoring is the basis of further preventive actions. A detection limit of less than 1 ppb is requested for indoor NOX analysis. The measurement should be performed over a time of up to 60 minutes at various points within buildings.

Long-term continuous measurements are often affordable and useful for tracking selected IEQ parameters including indoor temperatures and humidity, carbon dioxide and monoxide concentrations, nitrogen oxide concentrations, and rates of outside air intake into air handlers. For most other IEQ parameters, long-term continuous measurements are prohibitively costly or unavailable. The costs of sensors, and sensor maintenance and calibration may be lower in continuous monitoring systems that use single sensors to analyze samples drawn sequentially from multiple locations.

The principle of chemiluminescence detection is an extremely selective method for measuring nitrogen oxides precisely, with high linearity over a wide concentration range and with very high reproducibility.

These qualities are the basis for the acknowledged high performance of ECO PHYSICS CLD NOX-analyzers in tracking nitrogen oxides even down to the ppt-level.

The latest development, the economical CLD 66 analyzer series fulfils the requirements of indoor NO_2 monitoring, it detects even smallest variations of NO/NOX concentrations. The small size enables mobile or stationary use. Mains or battery operation guarantees flexible use, even in buildings which are still under construction.