

Out of sight, – out of mind?

Oxygen, Carbon Monoxide and Carbon Dioxide

Impact of oxygen deficiency on human health

- Normal level in air: 20.9%
- If level falls below 19%: concentration is affected
- Below 15%: poor judgement and co-ordination very apparent
- Below 12%: respiration badly affected, permanent damage to heart likely. Nausea, vomiting and fainting without warning can all occur within minutes
- Below 10%: consciousness lost and death will follow unless treatment – mainly in the form of pure oxygen – is provided very quickly
- Even a small drop in oxygen levels can have serious implications on site where workers are using tools and equipment

Oxygen, carbon monoxide and carbon dioxide are all colourless, odourless and tasteless gases. Dangers arise to human health when their levels in the air depart from the norm. This paper looks at the resulting hazards, and measures that should be taken to ensure safe, respirable air is maintained on site.



Oxygen

Oxygen is the most fundamental requirement of human life. While we can survive without water for a few days, and food for a few weeks, just a few minutes without oxygen is fatal. It is vital that good air quality is maintained wherever people are working.

Oxygen makes up 20.9% of the air in the atmosphere around us but is often lower in confined spaces – including those below ground such as tunnels and basements – and other poorly ventilated areas. In such locations, even if the oxygen levels are fine when work starts, they will diminish simply through the workers own breathing. Processes such as welding will also consume oxygen, and even more is used up if diesel plant is operating.

While too little oxygen is dangerous, too much oxygen can also cause damage to the body's respiratory system. Although pure oxygen is regularly administered in hospitals to alleviate various conditions, this is typically diluted by the ambient air, and a patient would never be allowed so much oxygen as to move out of a state of hypoxia – too little oxygen – to one of hyperoxia – too much.

The main hazard arising from a surfeit of oxygen in the air, however, is that of fire or explosion. The richer the air, the greater the danger, which is why enriching a workspace with oxygen to make it more breathable is not a practical option.

- Carbon dioxide is a 'substance hazardous to health' under the Control of Substances Hazardous to Health Regulations 2002 (COSHH).
- Workplace Exposure Limits (WELs) are set at a long-term (8 hour) exposure limit of 5000 ppm and a short-term (15 minute reference period) exposure limit of 15,000 ppm
- CO2 is the most commonly used gas in fire extinguishers; in the USA, there were 72 reported deaths from 1975 to 2000 attributed to discharge from extinguishers, usually during their maintenance



Carbon Dioxide

Like oxygen, carbon dioxide is a component of the air we breathe, but a much smaller one: just 0.037%. And, like oxygen, it is essential – if less immediately – to life. We need carbon dioxide to maintain cellular function, and without it plant life – and therefore the basis of all our food – would cease to exist. The dangers posed by carbon dioxide arise when there is an excess in the air.

If too much carbon dioxide is in the air, the symptoms are similar to there being too little oxygen: headaches, dizziness, confusion and loss of consciousness, leading potentially to death. Note that carbon dioxide poisoning can occur even when oxygen levels remain healthy.

Carbon dioxide is heavier than air, which means that as well as being a problem in confined spaces it can settle in trenches, pits or other depressions outside. It can accumulate naturally, such as in proximity to volcanoes, as well as through human activity. Any process involving the burning of fossil fuels will as a by-product release carbon dioxide, which includes running diesel or petrol equipment. This is one reason why powered site equipment should either be sited in the open or, where this is impossible, in a space supplemented by a constant supply of fresh air.



Being heavier than air, carbon dioxide can accumulate in below surface sites, so it is important to provide a continuous supply of fresh air.

- Like carbon dioxide, carbon monoxide is a 'substance hazardous to health' under the Control of Substances Hazardous to Health Regulations 2002 (COSHH).
- Workplace Exposure Limits (WELs) are set at a long-term (8 hour) exposure limit of 30 ppm and a short-term (15 minute reference period) exposure limit of 200 ppm
- It is not a normal component of air, but is the most abundant air pollutant found in the atmosphere.
- More than 90% of the total carbon monoxide emitted from fossil fuels is derived from petrol-driven motor vehicles.



Carbon Monoxide

Unlike oxygen and carbon dioxide, carbon monoxide is not permanently present in the atmosphere. It is a poisonous gas produced by burning of carbon-based fuels like gas, petrol, wood and coal. When inhaled, it prevents blood from supplying oxygen to cells, tissues, and organs.

Symptoms of carbon monoxide poisoning include drowsiness, headaches, breathlessness and nausea. In poorly ventilated conditions where there is a source of carbon monoxide, such as a faulty heater or an engine running, the levels can quickly rise to become fatal.

Although diesel engines – such as typically power construction site equipment – are known to produce less carbon monoxide than petrol engines, they will still be dangerous if used in enclosed areas with inadequate ventilation (and not just because of the risks from carbon monoxide: diesel fumes also contain several other noxious gases).



Ensuring safe levels

A shortage of oxygen, or excess of either carbon monoxide or dioxide, can lead rapidly to serious health problems and death. But, each of the three gases is odourless, tasteless and invisible, making it practically impossible for any of the body's senses to detect when the levels are dangerous. In the open air, excesses will usually disperse quickly and there will be a steady supply of oxygenated air (although, as noted above, carbon dioxide can collect in trenches and pits because it is heavier than air). This is not the case, though, in enclosed environments, such as basements, tunnels and indoor worksites.

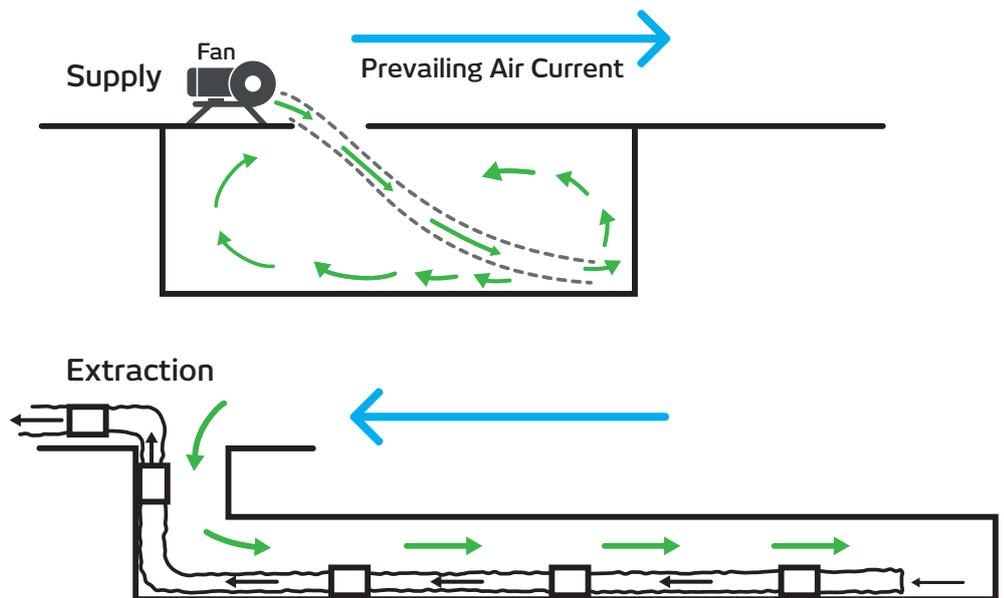
- The COSHH Regulations require employers and site managers to follow the 'Assess, Control and Review' model.
- In confined spaces, a minimum fresh air supply of 0.3 m³/min per person should normally maintain adequate oxygen levels.
- Additional ventilation should be provided when construction equipment is in use to reduce the effects of exhaust emissions and heat generated.

Ensuring safe levels (continued)

In these confined spaces, pushing fresh air to the remotest point is vital to ensure that fresh air is circulated throughout and concentrations of dangerous gases are effectively diluted. While this can be combined with extraction of the gases, relying on extraction alone is very risky as undirected air flow will always follow the easiest route and it is likely that 'dead spots' will arise where the build-up of dangerous gases takes place. To keep levels within safe limits, powerful fans combined with ducting can be used to drive fresh air to where it is needed and create positive pressure that ensures the stale air is driven out. Where necessary, these can be supplemented by additional fans set up to extract the polluted air.

Air quality control - Air flow patterns

Ventilation - Confined space



The amount of fresh air required through the system should be calculated to determine the number and power of fans required for its delivery. The fans themselves should be sited downwind of any generators used, so that no exhaust fumes contaminate the air being supplied.