THE LINDE GROUP

Safety Advice.
4 – Oxygen enrichment.

1. Introduction

This Safety Advice provide recommendations based on practical experience of conditions that can lead to an oxygen enriched atmosphere. It do not replace mandatory regulations but are meant to complement them.

Note:
Pure oxygen and oxygen mixtures should not be inhaled unless they have been prescribed by a doctor and are administered under strictly controlled conditions.

2. Composition of air

The approximate composition of air is :

Oxygen	O_2	21% by vol.
Nitrogen	N_2	78% by vol.
Argon	Ar	1% by vol.

It is unnecessary to take into account other gases which are only present in small quantities.

Atmospheric gases are non-toxic, but any alteration in their relative concentrations – especially that of oxygen – will have an effect on human life and any combustion process. In addition, any changes in the composition of air cannot be detected by the human senses. If the composition of air that is used for breathing is changed then it is imperative that this is detected. No matter what the operation if the percentage of oxygen is changed from the norm of 21% then a risk assessment shall be carried out. Any change in the levels of oxygen can have different affects on different people e.g. the young, elderly or pregnant women so any variation from 21% shall be investigated.

3. Properties of oxygen

Oxygen is non flammable but supports combustion.

Liquefied Oxygen has a very low temperature -183°C at this low temperature it can cause "cold burns" and make certain materials brittle (See also Safety Advice 1 – Handling of cryogenic liquid gases).

Oxidising substance warning

4. Hazards of oxygen enrichment

Oxygen enrichment of the atmosphere, even by a few percent, will considerably increases the risk of fire. Materials which do not burn in air (21% oxygen), may burn vigorously or even spontaneously in an atmosphere where the oxygen content is increased. This may include fireproofing materials.

In an oxygen enriched atmosphere any flame will burn much hotter and will propagate at a greater speed. The Ignition, flame speed, violence and extent of this reaction will depend on:

- The concentration, temperature and pressure of the reacting substances,
- ignition energy and type of ignition.

Persons who have been exposed to an oxygen enriched atmosphere must ventilate their clothes very thoroughly, since oxygen saturates the clothes. Lighting a cigarette may cause ignition of the clothes.

Breathing of pure oxygen or highly enriched air has, as a rule, no adverse effects on human organism.
Oils and greases are particulary hazardous in the presence of oxygen as they can ignite spontaneously and burn with explosive violence. They must never be used to lubricate oxygen or oxygen enriched air equipment. Equipment contaminated with oil or grease shall be cleaned immediately using suitable solvents.

Liquid oxygen leaking onto grounds such as asphalt or wood can cause an explosion.

5. Causes of oxygen enrichment and its prevention

Leakage of oxygen should always be avioded especially in closed or inadequately ventilated rooms, at least leakage quantity should be kept to a minimum.
Some of the most important causes of enrichment and precautions for its prevention are listed below:
Newly assembled equipment for oxygen service should be thoroughly leak checked. Periodic checking for leaks is recommended. Only equipment which is suitable for the type of gas and the pressure should be used. Any maintenance or repair work should be carried our by experienced and fully skilled personnel.

It is important for the correct operation of the process and to reduce the likelyhood of enrichment during welding, cutting, etc. to select the correct nozzles and pressures.
In addition, many processes where oxygen is used, e.g. gouging, flame cutting, flame desurfacing, oxygen lancing, etc., involve the deliberate use of excess oxygen. Therefore, adequate ventilation of the work area must be ensured to avoid oxygen enrichment.

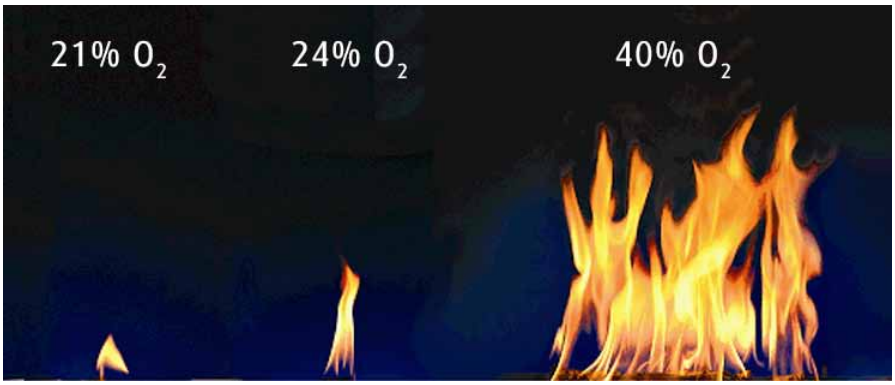
When the work is over, valves on welding or cutting torches and the cylinder valves

or oxygen supply stop valve shall be turned off in order to avoid oxygen leakage and any possible accumulation in the work area.

The following uses of oxygen are particularly dangerous and must be strictly forbidden:

- driving pneumatic tools
- inflating vehicle tyres, rubber boats, etc.
- cooling or freshening the air in confined spaces
- cooling people
- dusting benches, machinery and clothing
- starting engines
- spray-painting

Oxygen shall only be used if it cannot be replaced by another gas.
Even a small amount of liquid oxygen can lead to the formation of a large amount of gas.
One litre of liquid oxygen when vaporised produces 850 litres of oxygen gas. Consequently any liquid spillage can rapidly cause a significant oxygen enrichment.
In the gaseous state cryogenic oxygen, due to its temperature, is considerably heavier than air. Spilled liquid oxygen and cold oxygen gas may accumulate at low level e.g. in drains, cellars, pits or other low lying areas.
Vessels and equipment for storage and filling of liquid oxygen shall be designed for this purpose and thoroughly inspected and maintained.



If air is exposed to extremely cold surfaces e.g. containing liquid nitrogen then liquid air can form which contains a higher percentage of oxygen which can lead to local oxygen enrichment. To avoid this these surfaces must be lagged if not then oxygen enrichment must be expected in the vicinity of these uninsulated surfaces.

Oxygen can be released in appreciable quantities when oxygen absorbents e.g. molecular sieve is warmed. Once again adequate ventilation prevents oxygen enrichment.

6. Environment protection

Oxygen is a natural constituent of the air and makes up 21% of the atmosphere. When oxygen is released into the atmosphere there is no pollution. Inadvertent spillage of liquid oxygen does not lead to contamination of the ground, because cryogenic liquid oxygen vaporises. Temporary local soil freezing does occur.

7. Conclusion

Safe handling of oxygen is only possible if personnel are aware of its specific properties and uses. Inappropriate use of oxygen can lead to accidents. However, oxygen has neither good nor bad properties. What matters is the knowledge of how to use it in the right way.

Linde AG
Linde Gas Division, Linde Gas Germany, Seitnerstraße 70, 82049 Pullach
Phone 018 03.85 000-0*, Fax 018 03.85 000-1, www.linde-gas.com