Best practice for handling high pressure cylinders R-744

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Specific features of carbon dioxide for refrigeration

❶ Pressure

- Very high pressure = 57.3 bar at 20°C.
- Critical temperature = +31°C (73.8 bar at 31.1°C).
- Triple point = 5.2 bar -56.6°C.

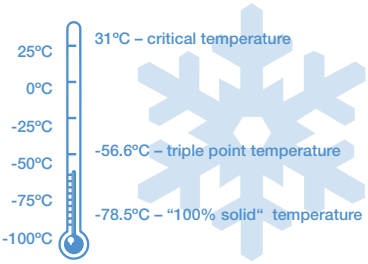
At the triple point, it can change directly from:

- solid state ⟷ (fusion / solidification) liquid state
- solid state ⟷ (sublimation / condensation) gaseous state
- gaseous state ⟷ (condensation / vaporisation) liquid state

The danger of CO_2 is that of ending up with dry ice in the pipes (problem during the loading operation, for example).

i As a comparison:
R-134a = 5.7 bar at 20°C,
R-404A = 11 bar at 20°C.

i The triple point is a point where the 3 states of CO_2 coexist: solid/liquid/vapour.



❷ Physical and chemical data

- A1 safety group fluid and practical limit of 0.1kg/m^3 according to EN378.
- L1 for ERP.
- Low toxicity.
- Chemical reaction with water – very high oxidation and therefore internal destruction of pipes and irreversible corrosion.
- Carbon dioxide has low water solubility: dehydration of circuits is necessary before introducing fluid.

i In the presence of a large quantity of water:
- formation of CO_2, hydrate particles
- similar to small ice crystals
- causes obstruction of filters and blocking of automatic valves.

❸ Labelling

- H280: Contains gas under pressure, may explode if heated.
- P410+P403: Protect from sunlight. Store in a well ventilated place.

Presentation of risks - Handling

❶ Risk of freeze burn

Dry ice (-78°C) can cause burns to the skin or eyes in the event of contact.

The correct treatment ➔ In the event of freeze burn, hold under cold water for 15 min.

Preventing/Anticipating the risk ➔ Safety goggles, clothing, overalls and cryo gloves.

❷ Risk in the event of ingestion

Ingestion must always be avoided due to the danger represented by the cold and the pressure resulting from evaporation.

The correct treatment ➔ Call for a doctor.

The correct treatment ➔ Move the victim into a non-contaminated area, using individual breathing apparatus. Keep the victim warm and resting. Call for a doctor. Practice artificial respiration if the victim is not breathing.

❸ Risk of asphyxiation

• **High concentrations** may lead to asphyxiation.

Potential symptoms: loss of consciousness or mobility.

The person may not be immediately aware of asphyxiation.

• **Low concentrations** (in the case of vaporisation) cause rapid respiratory failure.

Potential symptoms: headache, nausea and vomiting that may lead to loss of consciousness.

❹ Risk of poisoning

Carbon dioxide is naturally present in air at a level of approximately 380 ppm (0.038%). If the concentration increases, pulmonary gas exchange is compromised.

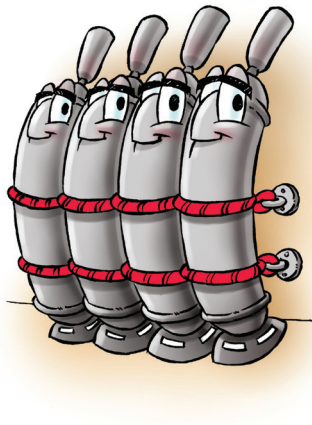
In simple terms, as its concentration in the ambient air increases, smaller quantities of carbon dioxide leave the blood and/or the alveoli have less space for oxygen.

Source: IS 08-11-EIGA

A carbon dioxide concentration of more than 9.5% in the air runs the risk of a very dangerous situation (see scale).

Risk prevention and management – Measures to be taken

Precautions for the handling of high pressure cylinders:



- Never remove the protection from the valve (cover).
- Never change the gauges on the frames.
- Secure the cylinders in all circumstances or stow the frames especially during transport.
- Wear suitable personal protective equipment (e.g. cryo gloves, CO_2 detector, etc.).

- Specific high pressure training is recommended as well as specific CO_2 training.
- Ensure that the room is well ventilated especially near floor level.
- Ensure correct operation of the CO_2 detector.

Equipment used

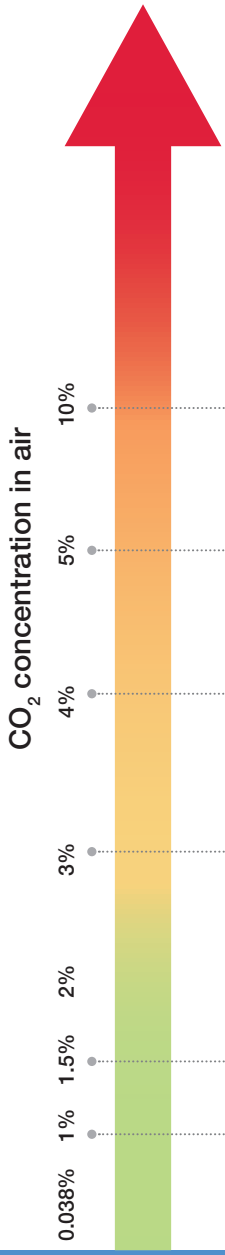
Use specific equipment:

- High pressure hoses with anti-whip cable.
- Portable and permanent leak detector.
- CO_2 detector.

Compliance with the regulations that apply

- DESPT (Directive for high pressure equipment)
- ADR
- Health and Safety at work laws

Physiological effects of carbon dioxide



Carbon dioxide concentration higher than 10%: loss of consciousness in less than one minute and unless there is rapid intervention, if exposure continues at these high levels, it could lead to death.

serious problems leading to coma and death

Breathing becomes more laboured with headache and confusion.

problems with vision

Stimulation of respiratory function leading to deeper and faster breathing. The signs of poisoning become more obvious after 30 minutes' exposure.

dizziness

At 3%, breathing is deeper, reduction in hearing capacity and headache, increase in blood pressure and accelerated heart rate.

breathing problems

Slight effect on chemical metabolism after several hours' exposure.

Source: Safety Advisory Council, translated from the EIGA (European Industrial Gases Association).

Other precautions to be taken in the workplace

Carbon dioxide can be used without risk if common sense precautions are taken.

The SAC* therefore recommends that companies using carbon dioxide in the workplace or in applications should take into consideration the risk of poisoning by this product:

- By training, raising awareness among employees concerning information about the risks of carbon dioxide poisoning and the preventive measures and by providing them with the **Material Safety Data Sheet** (MSDS).
- By performing a detailed analysis of the risks in workstations where carbon dioxide is used.

When, after analysis of the risks in the workstation, the risk of poisoning is considered possible, one or more of the following measures should be implemented:

- Provide **efficient ventilation**, particularly around the lowest levels of the premises.
- Install **a carbon dioxide analyser and an alarm**; the positioning of the analysers should be determined based on the workplace risk analysis.
- Ensure that **people have received training** and are aware of how to act in the event of an alarm.
- **Perform regular maintenance and calibration** of the carbon dioxide system and the **alarms**, as well as all mechanical ventilation systems.
- Ensure that the carbon dioxide analysis equipment and the alarms operate at temperatures of less than 0°C, and that they are designed to operate in these conditions and for the application or process planned.

Carbon dioxide «is not simply an asphyxiating agent!»

*SAC: Safety Advisery Council

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