Guidelines for the use of cylinders for compressed, dissolved or liquefied gas

Department of Materials Science and Chemical Engineering

Document for internal use

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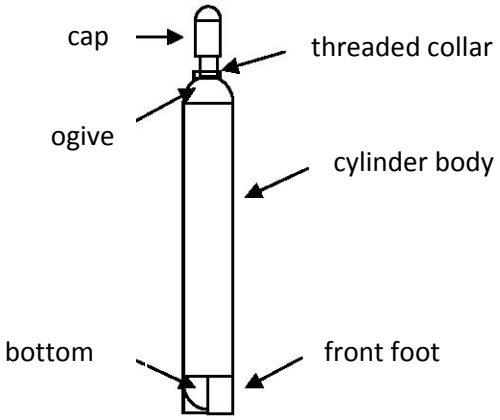
Cylinders

The term cylinder indicates a transportable container destined to contain fluids under pressure (compressed, dissolved or liquefied gas), constructed in steel (or in a light alloy), in one single piece without any longitudinal soldering that has a capacity of between 5 and 150 litres and which can contain fluids whose loading pressure, referring to 15°C, exceeds 20 kg/cm^2 (characteristics of the cylinders).

The fluids in the cylinders are classified as *compressed gas* if their critical temperature is below -10° C, in *liquefied gas* if the critical temperature is above – 10°C and in *dissolved gas* if they are soluble in a solvent. Liquefied gases should not be confused with liquid gases at cryogenic temperatures, such as liquid nitrogen, which should be stored in different kinds of containers from cylinders.

A cylinder is generally made up of:

1. A cylindrical main part (the body).
2. An ogive (the upper part tapered).
3. A bottom part.
4. A front foot or base (which surrounds the bottom of the cylinder).
5. A threaded collar.
6. A valve.
7. A cap screwed onto the threaded collar of the ogive.



The **cap** protects the valve (the weakest point of the cylinder) from possible breakages due to capsizing or accidental bumps. If the cap is of a fixed type, it should never be removed, while **if it is removable, it should always be screwed to the threaded collar,** except when the cylinder is in use. A cap has openings to allow gas to escape, in the case of leaks from the valve, and it is important that the escape holes that are on the caps are never closed.

The **base,** apart from allowing the cylinder to remain stable in a vertical position, raises the bottom off the ground and protects it from bumps, abrasion and corrosion when there is dampness.

Inspection

The cylinders should be **inspected and subjected to periodical services by the owner** (the suppliers): this should be done each 5 years for flammable substances (e.g. hydrogen and carbon monoxide) and each 10 years for all the other gases; both the last verification and the expiry date should be reported, through punching, on the ogive of the cylinder. The cylinder certificate should be kept by the owner, and the user is not obliged to even have a copy. It is forbidden to use expired cylinders. This means that empty cylinders should be returned to the suppliers. Furthermore, the suppliers should be contacted whenever the validity period of the inspection has expired. The lack

of **restitution of the empty cylinders or the use of expired cylinders, renders the purchaser liable to the consequences that could derive from their use.**
Each person should therefore look after the acquired containers until they are returned.

Risks
The general risks connected to the use of the cylinders refer to:
- their lack of stability;
- the pressure
- exposition to either high or low temperatures.

Given their shape, cylinders are unstable containers and can cause damage to the people or objects they come into contact with, but they can also suffer from damage to the valve during falls: the pressure caused by the uncontrolled escape of the contained gas causes a sudden strong rotary movement of the cylinder, and in this latter case, the environment could be saturated by the exiting gas with the consequent danger of intoxication, asphyxia, etc. The importance of **always anchoring the cylinders to a stable support** and **of always protecting the valve with the cap** is therefore evident.
Temperatures can provoke breakage of the containers: exposition to temperatures above 50° C can make them explode because of an excessive increase in the internal pressure while very low temperatures can instead make the steel they are made of fragile. Cylinders in light alloys can sustain temperatures even below -20° C. **It is necessary to pay attention to both irradiation from the sun and to the proximity of sources of heat.** In general, if the contents are inflammable, it is necessary to ascertain that there are no priming sources in the vicinity.

Pressure reducers
Pressure reducers are devices that are connected to the cylinder valve or to the wall socket of the gas distribution network and they have the purpose of diminishing and regulating the pressure. A pressure reducer for cylinders is usually made up of an input flange, which depends on the type of gas and by a flange on the mouth of the valve of the cylinder, an output flange, which is usually connected to a needle valve joined to the gas-line and a central main part (body) onto which the manometer that is used to measure the pressure in the cylinder is mounted, a supply regulation crank and a second manometer which measures the pressure after the pressure reducer.
The pressure reducer should be treated as a precision instrument; it is therefore necessary to protect it from accidental bumps and contact with dust, oil and other impurities. The reducer should never be used if it is malfunctioning.

Identification of the contents
A gas cylinder can only be used if the contents are known. The contents of a cylinder can be identified in the following ways.

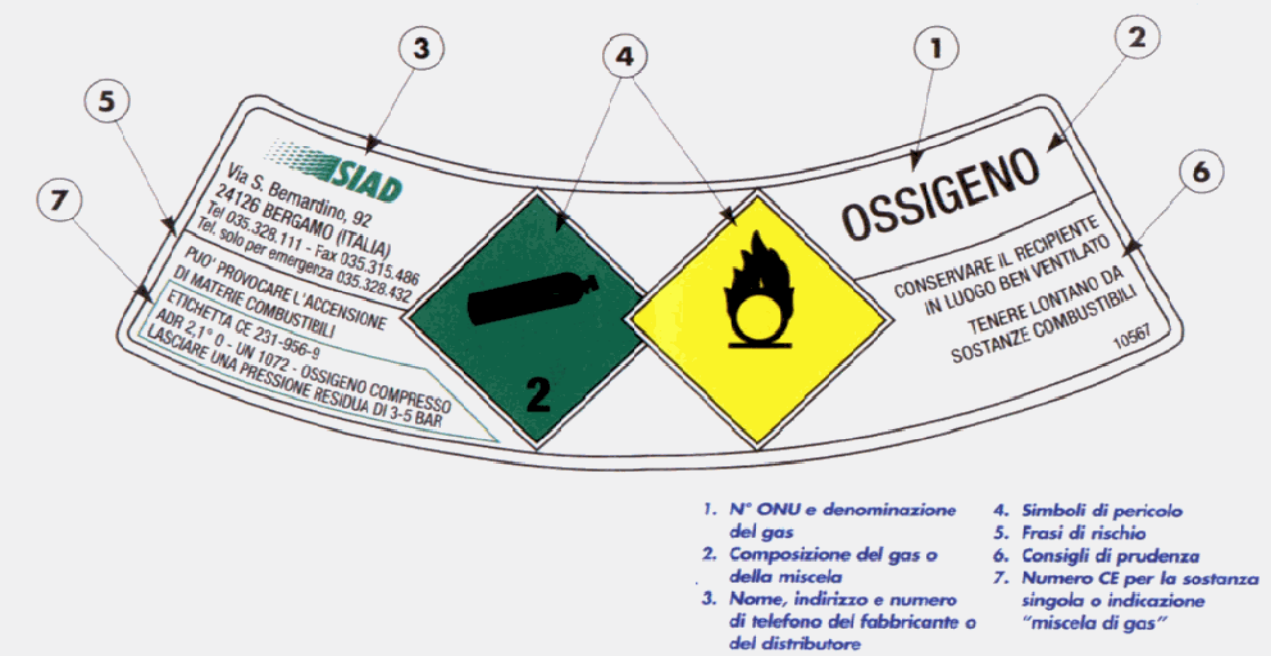
a) commercial name of the gas, indelibly written, self-adhesive label, decalcomania placed on the main part of the container, or identification tags attached to the valve or the protection cap.

b) **colouration of the ogive,** according to the colour codified by the standards in force.
c) release valve flange, according to the standards in force.
d) types and characteristics of the containers.

Labelling of the cylinders

Each cylinder has a label that gives important information on the kind of gas it contains and on its dangers. An example of a label is shown in the following figure:

1) ONU number and name of the gas;
2) Composition of the gas or of the mixture;
3) Name, address and telephone number of the manufacturer and of the supplier;
4) Symbols of danger;
5) Sentences pertaining to the risks;
6) Precautionary advice;
7) EC number for the individual substances and indication of the “gas mixture”.



Colour code of the ogives

The main risk pertaining to compressed gas contained in cylinders is identified by the colour of their ogives. The colour only identifies a particular substance for the most common gases. The present colour code has been in force since 10 August 1999 and has the purpose of unifying the identification system of all counties in the European Union. The previous colour code, which was only valid in Italy, has been kept valid for the cylinders that were already in circulation before 30 June 2006.

The codification of the colours according to the new standard is identified with the capital letter “N”, which is reported in two diametrically opposite positions on the ogive. The codification of the colours only concerns the cylinder ogive; the main part of the cylinder can in general be painted in any colour whatsoever that does not lead to the risk of erroneous interpretations (table).

Handling of the cylinders

The following precautions should be adopted during the movement of the cylinders.

- Always tighten the protective cap. The cap has the purpose of protecting the supply valve of the cylinder from mechanical bumps and it is therefore a good idea to ensure that the cylinders have caps before moving them.

- **Use a trolley.** The movement of the cylinders, even for short distances, should be carried out using an appropriate trolley which should allow the cylinder to be arranged vertically; the cylinder should be securely fastened in order to prevent it from being dropped and from capsizing.

- **Use gloves.** The operator should wear gloves during the handling operations. The cylinders **should not be handled without gloves or with gloves covered in oil or grease**: this regulation is particularly important when moving containers with **oxidizing gases** (e.g. oxygen or nitrogen protoxide).

- It is advisable to protect the feet by wearing **safety shoes.**

- **Avoid bumps and dropping the cylinders.** The cylinders should be handled with caution and violent bumps, falls or mechanical stresses that could compromise the integrity and strength of the cylinders should be avoided.

- **Do not lift the cylinders by the cap.** The cylinders should not be lifted by the cap, nor should they be dragged, rolled or slid along the floor.

- **Do not leave the cylinders** close to hydraulic lifts or in places where heavy objects in movement could come into contact with them and cause them to topple over.

Arrangement of the cylinders in the laboratories

- The compressed gas cylinders should be **secured with chains** or attached to another solid support. **Only after having secured it, is it possible to remove the protection cap.**

- The cylinder must be placed in an **upright position (ogive at the top).** It is forbidden to use the cylinders in a horizontal position or turned upside down. In the case of liquefied gases or adsorbent materials (e.g. acetylene), the liquid part could in fact come into contact with the internal part of the valve and cause the leakage of large quantities.

- The ideal location of a cylinder is outside the laboratory in a **dry, cool and well aired place, protected from the rays of the sun or other sources of heat.**

- Cylinders should never be exposed to **excessive dampness or to corrosive chemical materials.** Rust damages the cover of the container and provokes blockage of the cap.

- The cylinders should be **protected from sharp objects that could cause piercing or other abrasions** on the metal surface.

- Do not place cylinders containing **incompatible gases** in the same place (e.g. oxygen-hydrogen, oxygen-ammonia, chlorine-hydrogen) in order to avoid dangerous reactions, such as explosions or fires. Inflammable gases (hydrogen, acetylene, methane, etc.) should therefore be kept separate from combustive gases (oxygen, protoxide, etc.) and ammonia should also be kept separate from acidic gases (hydrogen chloride, etc.).

- The cylinders should never be placed in an area where they could become **part of an electric circuit.**

- Avoid accumulating unused cylinders in the laboratories.

Use precautions

- The use of a gas requires knowledge of its characteristics and the measures that should be undertaken in the case of an emergency, and it is therefore necessary to **read its safety card carefully** before using it.

- During the handling of toxic gases, it is necessary to be equipped with adequate Individual Protection Devices (gas mask with filters,….).

- The use of inflammable or toxic gases (H_2,CO, acetylene, etc.) is only permitted in laboratories equipped with specific sensors.

-Never **use cylinders whose service period has expired.**

- Cylinders **should be used exclusively to** contain the gas for which they have been constructed and inspected. They must not be used in any way as rollers, anvils, supports or in any other improper way.

- Never pour the contents of one cylinder into another.

- It is not necessary to lubricate the cylinder valves. **It is absolutely forbidden to use oil, grease or other combustible lubricants** on the valves of the cylinders containing oxygen or other oxidizing gases.

Temperature of the cylinders

- The cylinders cannot be heated to temperatures above 50° C.

- The cylinders must not be cooled to very low temperatures. Many types of steel loose ductility and become fragile at low temperatures. The limit temperature for cylinders in steel is -20°C.

- In the case of **elevated gas flows,** it should be considered that an **abrupt drop in temperature** of the cylinder could occur and this could compromise the strength of the material**.**

Verification of the contents

- Before opening the supply valve, ascertain the gas contents. It should be recalled that the type of gas can be identified from the following parameters: the colouring of the cylinder ogive, the commercial name of the gas punched into the ogive, writings or self adhesive labels placed onto the main part of the cylinder and type of output flange of the supply valve. The user **should not rub out or make the writing illegible**, nor should he/she remove the labels, the decalcomania, or the tags attached to the container by the supplier in order to identify the gas contents.

Connection to the pressure reducer

- Pressure reducers should always be used for compressed gas. Never check to see if there is pressure by directly opening the cylinder: if it is empty this would cause pollution and if it is full it could cause damage.

- As certain that the reducers are of a type that is valid according to the laws in force and calibrated to bear a pressure that is 20% higher than the maximum pressure of the cylinder (this information can be found on the ogive).

- Before attaching them, ensure that the connections are in a good condition and that there is no dirt or oil etc. on them.

- Pressure reducers, manometers, hoses or other apparatus foreseen for a particular gas or group of gases **should not be mounted onto gas containers that have different and incompatible chemical properties.**

- Before and after use, verify that the **reducer has been regulated for the minimum flow.**

- If it is possible that the **gases or liquids could flow back** inside the cylinder (e.g. for low pressure flows), it is necessary to mount a **one-way valve on the line.**

- Any mechanical or modification action of the reducers is forbidden.

- The user **must not change, modify, tamper with or block any safety devices that might be present,** nor carry out repairs of full containers or on the valves in the case of a gas leak.

- No parts of the reducer or cylinder valve should be lubricated. Lubricants in contact with combustible gases, such as oxygen or nitrogen protoxide, can lead to combustion or explosions.

Opening of the valves and checking the supply

- It is only allowed to open a cylinder valve **after the cylinder has been secured** and in general there is a pressure reducer.

- The cylinder valve should be opened gradually and slowly and the user, if possible, should remain at a safe distance. If the valve is opened too quickly, it can cause an increase in temperature inside the reducer with consequent **damage of the internal parts** and the **possibility of triggering burning of the non metallic parts.**

- Never use wrenches or other equipment to open or close valves equipped with hand-wheels. It is necessary to contact the supplier for instructions whenever the valves are stiff or for those that are blocked because of corrosion or whenever the valve or the connection appears damaged. Forcing the valve open could cause damage to the valve and dangerous gas leaks.

- After having opened the cylinder valve, verify that there **are no leaks** in correspondence to the input connection, to the manometer connections and to the reducer safety valve. The sealing of the circuit should be **checked with soapy water** and never with a flame.

- If there are no leaks, open the needle valve after the gas supply regulator by turning the reducer hand-wheel.

- At the end of use, **close the cylinder valve and discharge the gas contained in the reducer (**the cylinder valve should only remain **open when the gas is being used),** close the pressure reducer valve and the needle valve.

The used-up cylinders

Always leave a slightly positive pressure inside the container in order to prevent changes in the environmental temperature from causing air to enter through the cylinder opening once the reducer has been removed (e.g. recharging).

When the **cylinder has been used-up,** it is necessary to ensure, before it is returned, that **the cylinder valve is closed tightly,** therefore it is necessary to tighten any plugs that might be present **and replace the protection cap.**

The used-up cylinders should be marked with the word **"VUOTA"** written in chalk on the main part of the cylinder.

Empty cylinders should always be clearly placed separately from the full ones to facilitate their return.

A synthesis is reported in the section Behaviour regulations for the management of the cylinders.

Behaviour Regulations for the management of the cylinders

Handling of the cylinders

- Always tighten the protection cap.
- Use a trolley
- Use gloves and safety shoes.
- Avoid bumps and dropping the cylinders.
- Do not lift the cylinders by their caps.
- Do not leave the cylinders unattended.

Arrangement of the cylinders in the laboratories

- Secure the cylinder using chains or another solid support.
- Arrange the cylinders in an upright vertical manner (ogive at the top).
- Place the cylinders in a dry, cool and well ventilated place, protected from sunrays and other sources of heat; do not expose them to excessive dampness or to corrosive chemicals and protect them from any object that could damage them.
- Only connect cylinders with inflammable or toxic gases in laboratories equipped with specific sensors.
- Do not place cylinders containing incompatible gases in the same place.
- Do not place cylinders in places where they could become part of an electric circuit.
- Avoid accumulating unused cylinders in the laboratories.

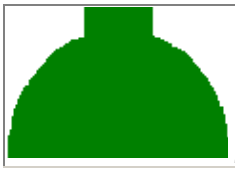
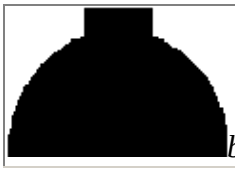
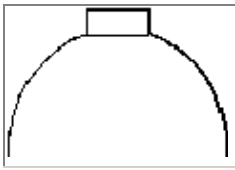
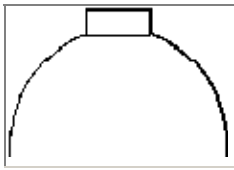
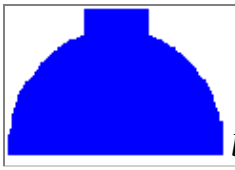
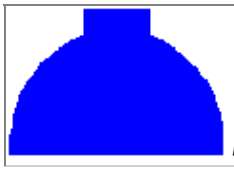
Use precautions

- Never use cylinders that have service periods that have run out.
- Always ascertain the gas contents in the cylinder before using it. Read the gas safety label and be equipped with the necessary Individual Protection Devices.
- Connect a pressure reducer that is of a type that is valid according to the laws in force to a clean connection that is in a good condition. If necessary, mount a one-way valve onto the line.
- No part of the reducer or the cylinder valve should be lubricated.
- The cylinder valve should be opened gradually and slowly. Do not use wrenches or other equipment to open or close the valves equipped with hand-wheels.
- After having opened the cylinder valve, ensure that there are no leaks using soapy water.
- Regulate the gas supply by turning the reducer hand-wheel.
- At the end of use, close the cylinder valve, discharge the gas remaining in the reducer and then close the pressure reducer valve.

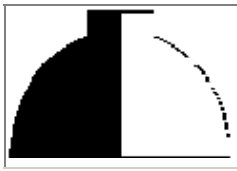
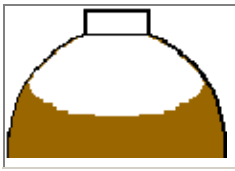
Colour code of the cylinder ogive – The main risks associated to the gas

Type of danger	Old colouring	New colouring
inert	 *alluminium*	 *bright green*
flammable	 *alluminium*	 *red*
oxidant	 *alluminium*	 *light blue*
toxic and/or corrosive	 *yellow*	 *yellow*
toxic and flammable	 *yellow*	 *yellow+red*
toxic and oxidant	 *yellow*	 *yellow+light blue*

Colour code for the cylinder ogive – Specific colours for the most common gases

Type of gas	Old colouring	New colouring
acetylene C_2H_2	 *orange*	 *reddish brown*
ammonia NH_3	 *green*	 *yellow*
argon Ar	 *reddish purple*	 *dark green*
nitrogen N_2	 *black*	 *black*
carbon dioxide CO_2	 *light grey*	 *grey*
chlorine Cl_2	 *yellow*	 *yellow*
helium He	 *brown*	 *brown*
hydrogen H_2	 *red*	 *red*
oxygen O_2	 *white*	 *white*
nitrogen protoxide N_2O	 *blue*	 *blue*

Colour code for the cylinder ogive – Mixtures of the most common gases

Type of gas	Old colouring	New colouring
Air for industrial use	 *black and white*	 *bright green*
Breathable air	 *black and white*	 *black and white*
Helium-oxygen mixture for breathing purposes	 *alluminium*	 *brown and white*