INTERNATIONAL STANDARD

ISO 11622

First edition
2005-07-15

Gas cylinders — Conditions for filling gas cylinders

Bouteilles à gaz — Conditions de remplissage des bouteilles à gaz

Reference number
ISO 11622:2005(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11622 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 4, *Operational requirements for gas cylinders*.

Gas cylinders — Conditions for filling gas cylinders

1 Scope

This International Standard specifies the general requirements (charging pressure, filling ratio, etc.) for filling single gas cylinders and manifolded gas cylinders (bundles) with single component gases.

This International Standard excludes the specific requirements for filling cryogenic gas and liquefied petroleum gas (LPG) commercial-grade cylinders.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6406, *Gas cylinders — Seamless steel gas cylinders — Periodic inspection and testing*

ISO 10460, *Gas cylinders — Welded carbon-steel gas cylinders — Periodic inspection and testing*

ISO 10461, *Gas cylinders — Seamless aluminium-alloy gas cylinders — Periodic inspection and testing*

ISO 10462, *Gas cylinders — Transportable cylinders for dissolved acetylene — Periodic inspection and maintenance*

ISO 10691, *Gas cylinders — Refillable welded steel cylinders for liquified petroleum gas (LPG) — Procedures for checking before, during and after filling*

ISO 11755, *Gas cylinders — Cylinder bundles for compressed and liquefied gases (excluding acetylene) — Inspection at time of filling*

ISO 24431, *Gas cylinders — Cylinders for compressed and liquefied gases (excluding acetylene) — Inspection at time of filling* [1)]

1) To be published.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
gas
any substance that is completely gaseous at 1,013 bar [2] and 20 °C or has a vapour pressure exceeding 3 bar at 50 °C

NOTE 1 Hydrogen fluoride and hydrogen cyanide are handled as low-pressure liquefied gases in this International Standard and listed in Table 5 together with other liquids that may be used to fill gas cylinders.

NOTE 2 All pressures are given in bar gauge unless otherwise stated (1 bar = 105 N/m^2 = 100 kPa).

3.2
single component gas
gas (3.1) that is technically pure in the gas cylinder

NOTE A single component gas dissolved under pressure falls within this category.

3.3
gas cylinder
transportable pressure receptacle of a water capacity not exceeding 150 l

3.4
bundle
assembly of cylinders that are fastened together and are interconnected by a manifold and transported as a unit with a total water capacity not exceeding 3 000 l, except for bundles intended for the transport of Division 2.3 (as defined in the *United Nations Recommendations on the Transport of Dangerous Goods — Model Regulations*), which are limited to 1 000 l water capacity

3.5
compressed gas
gas which when packaged under pressure for transport is entirely gaseous at −50 °C

NOTE This category includes all gases with a critical temperature less than or equal to −50 °C.

3.6
high-pressure liquefied gas
gas which when packaged under pressure for transport is partially liquid at temperatures above −50 °C and has a critical temperature between −50 °C and +65 °C

3.7
low-pressure liquefied gas
gas which when packaged under pressure for transport is partially liquid at temperatures above −50 °C and has a critical temperature above +65 °C

3.8
dissolved gas
gas which when packaged under pressure for transport is dissolved in a liquid-phase solvent

3.9
critical temperature
temperature above which a substance cannot exist in the liquid state

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2) 1 bar = 10^5 Pa = 100 kPa = 0,1 MPa = 10^5 N/m^2.

3.10
filling ratio
ratio of the mass of gas to the mass of water at 15 °C that would fill completely a pressure receptacle fitted ready for use

NOTE Related terms are filling factor and filling degree, often expressed in kg/l or similar.

3.11
filling-ratio reference temperature
temperature at which the liquid density is to be evaluated for calculating the filling ratio

NOTE See 4.3 and 4.4.

3.12
developed pressure
pressure achieved by the contents of a gas cylinder filled according to this International Standard when raised to a specified reference temperature

3.13
developed pressure at T_{max}
pressure developed by the gas contents in a cylinder at a uniform temperature of T_{max}

NOTE T_{max} is the expected maximum uniform temperature in normal service as specified in international or national cylinder filling regulations.

3.14
settled pressure
pressure of the contents of the cylinder at 15 °C (p_{15})

3.15
test pressure
required pressure applied during a pressure test

3.16
pressure relief device
device that is fitted to the cylinder or cylinder valve and designed to relieve gas pressure in the event of abnormal conditions resulting in the development of excessive pressure inside the cylinder or when the cylinder is subjected to high temperatures

3.17
compatibility
interaction of gas and cylinder/cylinder equipment that comes in contact with gas under the conditions of use, implying a satisfactory gas/cylinder/cylinder equipment combination

3.18
tare weight
mass of the cylinder and other fittings not removed during the cylinder filling operation, such as valve, dip tube and any permanently or semi permanently fixed valve protection device

4 Principles and requirements for filling gas cylinders

4.1 General requirements (all gases and gas cylinders)

4.1.1 The gas to be used for filling shall be compatible with the cylinder, the cylinder valve and any other fittings that may be in contact with the gas (see ISO 11114-1 and ISO 11114-2).

4.1.2 When presented for filling, the cylinder shall be within the specified period for periodic inspection and test in accordance with ISO 6406, ISO 10460, ISO 10461 and ISO 10462.

4.1.3 The cylinder and cylinder valve shall be in serviceable condition in accordance with ISO 10691, ISO 11755 and ISO 24431.

4.1.4 The cylinder shall be equipped with a suitable valve with the appropriate valve outlet.

4.1.5 The cylinder shall be correctly identified for the intended gas.

4.1.6 Filling ratios specified in this International Standard are maximum values. Hence, the filling mass charged into the cylinder shall take account of the accuracy of the filling procedure and weighing equipment.

4.1.7 The pressure relief device shall be suitably designed to a setting relative to the cylinder's test pressure. It shall operate between −10 % and +0 % of the cylinder test pressure.

4.1.8 If required before filling, the identity of the cylinder's owner shall be established, and his authorization shall be obtained to fill the cylinder.

4.2 Compressed gases

The maximum settled pressure shall be the lower of the following values:

a) two-thirds of the test pressure;

b) a pressure that does not exceed the cylinder test pressure when the cylinder content is raised to the reference temperature of 65 °C;

c) the pressure given in Table 1.

4.3 Low-pressure liquefied gases

The developed pressure at 65 °C shall not exceed the cylinder test pressure.

At a filling ratio reference temperature of 50 °C, there shall be a vapour space of at least 5 % of the total cylinder water capacity, and the cylinder shall not be hydraulically full at any temperature up to 60 °C.

Data for low-pressure liquefied gases are given in Table 2. The tare weight of the cylinder shall be identified in accordance with ISO 13769. For pure gases where the filling data are not provided in Table 2, the following determination is required:

$$k_f = (0{,}0032 \times T_b - 0{,}24) \times \rho_l$$

where

k_f is the maximum filling ratio

T_b is the boiling point (in Kelvin)

ρ_l is the density of liquid at boiling point (in kg/l)

4.4 High-pressure liquefied gases

4.4.1 The chosen filling ratio shall be such that the developed pressure at a reference temperature of 65 °C does not exceed the corresponding cylinder test pressure.

4.4.2 Data for high-pressure liquefied gases are given in Table 3. For high-pressure liquefied gases where filling data are not provided in Table 3, the maximum filling ratio shall be determined as follows:

$$k_f = 8{,}5 \times 10^{-4} \times \rho_g \times p_h$$

where

k_f is the maximum filling ratio

ρ_g is the gas density in g/l (at 15 °C and 1 bar)

p_h is the minimum test pressure (in bar)

If the density of the gas is unknown, the following formula can be used:

$$k_f = \frac{p_h \times M \times 10^{-3}}{R \times 338}$$

where

k_f is the maximum filling ratio

p_h is the minimum test pressure (in bar)

M is the molecular mass (in g/mol)

$R = 8{,}31451 \times 10^{-2}$ bar · l/mol · K (gas constant)

NOTE For several gases from Table 3 (chlorotrifluoromethane, ethane, ethylene, hydrogen chloride, nitrous oxide, phosphine, silane, sulfur hexafluoride and trifluoromethane) the minimum test pressure can be below the value shown in Table 3, according to the filling ratio.

4.5 Dissolved gases

If cylinders are filled with gases dissolved under pressure, the minimum test pressure shall be 60 bar in the case of acetylene for cylinders without pressure relief devices or 52 bar for cylinders with fusible plugs. In the case of other dissolved gases, the test pressure shall correspond to that pressure resulting from a reference temperature of 65 °C and prescribed concentration of the gas in the solvent.

4.6 Cases where the reference temperatures are to be deliberately exceeded

4.6.1 The maximum anticipated temperature shall be established. The choice of pressure relief device, if used, shall ensure that the pressure of a full cylinder does not exceed the cylinder rated test pressure. The suitability of the cylinder and valve materials shall be checked for operation at the maximum anticipated temperature.

4.6.2 The filling ratios for high-pressure and low-pressure liquefied gases given in this International Standard shall not be exceeded.

4.6.3 For compressed gases, a filling pressure shall be chosen to ensure the developed pressure at the maximum anticipated temperature does not exceed the cylinder test pressure.

4.6.4 For liquefied gases where the critical temperature is equal to or greater than the maximum anticipated temperature, the cylinder test pressure shall exceed the vapour pressure of the gas at the maximum anticipated temperature. A filling ratio shall be chosen to ensure the cylinder is not hydraulically full at the anticipated maximum temperature.

4.6.5 For liquefied gases where the critical temperature is less than the maximum anticipated temperature, a filling ratio shall be chosen to ensure the cylinder test pressure is not exceeded at the maximum anticipated temperature.

4.7 Gases not listed in Tables 1 to 5

4.7.1 The following data shall be sought or determined experimentally:

— gas group (i.e. compressed, low-pressure liquefied, high-pressure liquefied or dissolved gas);

— for compressed gases, the value of developed pressure at the reference temperature;

— for low-pressure liquefied gases, the vapour pressure at 65 °C and liquid density at the filling ratio reference temperature;

— for high-pressure liquefied gases, the developed pressure at the reference temperature for the proposed filling ratio(s);

— flammability, oxipotential, toxicity and corrosivity data for labelling, cylinder colour coding and valve outlet determination;

— material compatibility data for selection of suitable cylinder and cylinder valve materials and determination of periodic cylinder inspection and test requirements.

4.7.2 Appropriate calculations shall be made to determine safe filling conditions to comply with the requirements of this International Standard.

4.7.3 A review of the gas service shall be undertaken by competent persons to establish

— that the materials of construction of the cylinder and cylinder valve are compatible with the gas contents,

— the colour coding and labelling requirements for gas cylinders,

— the valve outlet to be used, and

— the periodic inspection and test requirements of gas cylinders.

5 Fitting of pressure relief devices

The filling conditions defined in this International Standard are designed to give safe operation in normal use without a pressure relief device; if fitted, the selection of pressure relief device is at the discretion of the gas supplier/cylinder owner or in accordance with regulatory requirements.

Pressure relief devices shall not be fitted to cylinders intended for the conveyance of toxic gases (or mixtures) with an $LC_{50} < 200$ ppm or pyrophoric gases.

Cylinders used for the conveyance of non-toxic or non-pyrophoric gases may be fitted with appropriate pressure relief devices at the discretion of the gas supplier/cylinder owner or in accordance with regulatory requirements. The pressure relief device shall be suitably designed to a setting relative to the cylinder's test pressure. It shall operate between −10 % and +0 % of the cylinder test pressure.

6 Tables for gases and other substances

Gases are listed in groups by description in Tables 1 to 5 as follows:

— Table 1, Compressed gases

— Table 2, Low-pressure liquefied gases

— Table 3, High-pressure liquefied gases

— Table 4, Gases dissolved under pressure

— Table 5, Liquids that may be used to fill gas cylinders

NOTE Gases and other substances are in alphabetical order based on the English language.

The minimum test pressure in the tables is a function of the settled pressure p_{15} or the filling ratio, except for fluorine, nitric oxide and oxygen difluoride, but shall be at least 10 bar.

Other filling factors may be used provided that the requirements of Clause 4 are met.

For high-pressure liquefied gases, the use of a test pressure other than those indicated is permitted, provided that the filling ratio is such that the internal pressure does not exceed the test pressure of the cylinder at 65 °C.

Annex A provides translations for the gases.

Table 1 — Compressed gases

UN number	Gas name	Chemical formula	Critical temperature T_{cr} °C	Minimum test pressure bar	Settled pressure p_{15} bar or kg/l	Pressure relief device	Remarks
3374	Acetylene (solvent free)	C_2H_2		52 for cylinders with fuse plugs 60 for cylinders without fuse plugs	[a]	See ISO 3807-1 and ISO 3807-2	with porous mass See ISO 3807-1 and ISO 3807-2
1006	Argon	Ar	−122,2	$1,5 \times p_{15}$	300		
1016	Carbon monoxide	CO	−140,2	$1,5 \times p_{15}$	200		
1957	Deuterium	D_2	−234,8	$1,5 \times p_{15}$	300		
1045	Fluorine	F_2	−129,0	200	30	forbidden	Max. 5 kg per cylinder
1046	Helium	He	−267,9	$1,5 \times p_{15}$	300		
1049	Hydrogen	H_2	−239,9	$1,5 \times p_{15}$	300		
1056	Krypton	Kr	−63,8	$1,5 \times p_{15}$	200		
1971	Methane	CH_4	−82,6	$1,5 \times p_{15}$	200		
1065	Neon	Ne	−228,7	$1,5 \times p_{15}$	300		
1660	Nitric oxide	NO	−92,9	200	50	forbidden	
1066	Nitrogen	N_2	−146,9	$1,5 \times p_{15}$	300		
1072	Oxygen	O_2	−118,3	$1,5 \times p_{15}$			
2190	Oxygen difluoride	OF_2	−58,0	200	30	forbidden	

[a] According to type approval.