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Seamless aluminium-alloy gas cylinders — Periodic inspection and testing

Bouteilles à gaz sans soudure en alliage d'aluminium — Contrôles et essais périodiques

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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.

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.

International Standard ISO 10461 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Sub-Committee SC 4, *Operational requirements for gas cylinders*.

Annexes A, B, C, D, E, F, G, H and J of this International Standard are for information only.

Introduction

The primary object of periodic inspection and testing of gas cylinders is to ensure that at the completion of the test the cylinders may be re-introduced into service for a further period of time.

Experience in the inspection and testing of cylinders which are specified in this International Standard is an important factor when determining whether a cylinder should be returned into service.

The inspection and testing should be carried out only by persons who are competent in the subject, to assure all concerned that the cylinders are fit within the permissible limits for continued safe use.

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Seamless aluminium-alloy gas cylinders — Periodic inspection and testing

1 Scope

This International Standard specifies the minimum requirements for periodic inspection and testing to verify the integrity of gas cylinders for further service. It does not exclude the application of additional national requirements.

This International Standard deals with seamless aluminium-alloy transportable gas cylinders intended for compressed, liquefied or dissolved gases under pressure, excluding acetylene, of water capacity from 0,5 litre up to 150 litres; it also applies, as far as practicable, to cylinders of less than 0,5 litre water capacity.

This International Standard does not apply to periodic testing and inspection of fibre overwrap aluminium-alloy cylinders.

Additional International Standards cover similar requirements for seamless steel, welded-steel and acetylene cylinders and the inspection and tests to be carried out during normal filling procedures.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 32:1977, *Gas cylinders for medical use — Marking for identification of content.*

ISO 448:1981, *Gas cylinders for industrial use — Marking for identification of content.*

ISO 6506:1981, *Metallic materials — Hardness test — Brinell test.*

ISO 10297:—[1], *Gas cylinder valves — Specifications and testing.*

3 List of procedures for periodic inspection and tests

Each cylinder shall be submitted to periodic inspection and testing. The following procedures form the basic requirements for such inspection and testing:

a) identification of cylinder and preparation for the inspection and test;

b) external visual inspection;

c) internal visual inspection;

d) hardness test where required;

e) verification of the cylinder mass or tare, as appropriate;

f) inspection of cylinder neck/shoulder;

g) hydraulic test;

h) inspection of the valve;

i) final operations.

When the condition of the cylinder remains in doubt after these inspections and tests have been carried out, additional tests shall be implemented.

The maximum temperature for any of the above procedures shall be limited (see 13.1).

1) To be published.

4 Intervals between periodic inspection and tests

The interval between periodic inspection and tests is usually specified by national or international authorities. Should no such regulations apply, some recommended intervals are proposed in annex A.

5 Identification of the cylinder and preparation for inspection and tests

Before any work is carried out, the cylinder and its contents shall be identified. The cylinder shall be emptied using a safe procedure and the release of pressure shall be controlled.

If it is suspected that a cylinder valve is obstructed, a check or checks shall be made to establish whether there is free passage through the valve or not. Typical test procedures are given in annex B.

Special attention shall be given to cylinders containing toxic, irritating or flammable gases. Cylinders shall be emptied at a properly equipped testing station by an operator trained to handle such gases.

Cylinders with unknown gas contents, or those which cannot be safely emptied of gas, shall be set aside for special handling.

Care shall be taken if a coating of fused nylon, polyethylene or similar material, has been applied to the cylinder by a system requiring excessive heat.

Provided the above requirements have been complied with, the valve shall be removed.

6 External visual inspection

6.1 The cylinder shall have all loose coatings, corrosion products, tar, oil or other foreign matter, as well as any labels or transfers, removed from its external surface by a suitable method, e.g. by stainless steel wire brushing, shot blasting (under closely controlled conditions), water-jet abrasive cleaning, chemical cleaning (see annex D or consult the cylinder manufacturer), or other suitable methods. Alkaline solutions and paint strippers which are harmful to aluminium and its alloys shall not be used. Care shall be taken to avoid damaging the cylinder.

If a fused nylon, polyethylene or similar coating has been applied and is seen to be damaged, then the coating shall be stripped. If the coating has been removed by the application of heat (maximum 150 °C for heat-treated alloys and 60 °C to 80 °C for other alloys), the cylinder shall be hardness-tested (see 13.1).

6.2 The external surface of the cylinder shall then be inspected for:

a) dents, cuts, gouges, bulges, cracks or laminations;

b) heat damage, torch or electric arc burns (see table C.1);

c) corrosion;

d) other defects, such as illegible or unauthorized stamp markings, unauthorized additions or modifications;

e) integrity of all permanent attachments.

6.3 Typical rejection limits are given for guidance in annex C.

7 Internal visual inspection

The cylinder shall be inspected internally over its whole surface using an appropriate device (e.g. a lamp) to identify any of the defects similar to those listed in 6.2. Any internal lining or coating which may obstruct a thorough internal visual inspection shall be removed. Any cylinder showing presence of foreign matter or signs of more than minor surface corrosion shall be cleaned internally by using shot blasting (under closely controlled conditions), water-jet abrasive cleaning, flailing, steam-jet cleaning, hot-water-jet cleaning, rumbling, chemical cleaning (see annex D or consult cylinder manufacturer) or other suitable methods. Care shall be taken to avoid damage to the cylinder. After cleaning, the cylinder shall be inspected again.

Typical rejection limits are given for guidance in annex C.

8 Supplementary tests

Where there is doubt concerning the type and/or severity of a defect found on visual inspection, additional tests or methods of examination, e.g. ultrasonic techniques or other non-destructive tests, may be applied.

9 Verification of the cylinder mass or tare

The cylinder stamp marking shall be scrutinized to determine whether this marking indicates a mass or a tare. The cylinder must be weighed on a calibrated weighing device to determine the difference between the actual mass and the original mass stamped on the cylinder. A cylinder showing a loss of mass of more than 3 % shall be subjected to an additional examination to determine its suitability for further service. A cylinder having a difference in mass greater than 5 % of the original mass shall be

rejected. If a mass/tare is not marked on the cylinder, the tester shall obtain the original mass/tare information from the manufacturer.

NOTE 1 The mass of a cylinder, expressed in kilograms, is defined as the combined mass of the empty cylinder with the permanently attached parts (e.g. foot ring, neck ring, etc.) but without valve and without valve protection device. The tare of a cylinder, expressed in kilograms, is defined as the mass of a cylinder with permanently attached parts (e.g. foot ring, neck ring, tulip guard, etc.) and valve but without removable valve protection cap.

10 Inspection of the cylinder neck/shoulder

10.1 Internal/external neck threads

The internal neck threads of the cylinder shall be examined to ensure that they are:

— clean and of full form;

— free of damage;

— free of burrs;

— free of cracks;

— free of other imperfections.

In particular, neck threads shall be examined thoroughly for evidence of cracks (see annex C). Cracks manifest themselves as lines which run vertically down the thread and across all the thread faces (see figure C.5). They should not be confused with tap marks (thread machining marks) (see figure C.6). Special attention should be paid to the area at the bottom of the thread.

10.2 Other neck surfaces

Other surfaces of the neck shall also be examined to ensure they are free of cracks or other defects (see annex C).

10.3 Damaged internal neck thread

Where necessary, and where the cylinder manufacturer confirms that the design of the neck permits, threads may be re-tapped to provide the appropriate number of effective threads. Re-tapping shall be carried out with special equipment and tools, and by qualified persons only. After re-tapping, the threads shall be checked with the appropriate thread gauge.

10.4 Neck ring and collar attachment

When a neck ring/collar is attached, examination for security and for thread damage shall be carried out. If any significant damage to the cylinder material has occurred by replacement of the neck ring/collar, the cylinder shall be rejected. If the neck ring has been re-attached by welding or brazing, the cylinder shall be rejected.

11 Hydraulic test

Each cylinder shall be submitted to a hydraulic pressure test, using a suitable fluid, normally water, as the test medium. This may be a proof pressure test, or a volumetric expansion test. The use of one particular type of test being decided, its result shall be final. No attempt shall be made to transfer from one type of test to another.

NOTE 2 Aluminium can be sensitive to highly salted or chlorinated water.

11.1 Proof pressure test

The test pressure shall be established from the marking on the cylinder, directly or indirectly from the filling pressure.

This test requires that the water pressure in the cylinder increase gradually until the test pressure is reached.

The cylinder test pressure shall be held for a sufficiently long period to ascertain that there is no tendency for the pressure to decrease and that tightness is guaranteed.

A typical test method is given in annex E. Any cylinder failing to comply with the requirements of this test shall be rejected.

11.2 Volumetric expansion test

The permanent volumetric expansion of the cylinder, expressed as a percentage of the total expansion at test pressure, shall not exceed the percentage given in the design specification, but shall not exceed 10 % of the total expansion. If this figure is exceeded, the cylinder shall be rejected.

Annex F proposes a typical test method and gives details for determining the volumetric expansion of aluminium gas cylinders.

12 Inspection of the valve

If the cylinder is to be re-introduced into service, each valve shall be inspected and maintained so that it will perform satisfactorily and close without leakage, according to ISO 10297.

A typical test procedure is given in annex G.

13 Final operations

13.1 Drying, painting and paint stoving

The interior of each cylinder shall be thoroughly dried by a suitable method, immediately after hydraulic pressure testing.

Cylinders are frequently repainted, sometimes using paints which require stoving (heating).

Aluminium-alloy cylinders are normally manufactured using heat treatment to obtain the final mechanical properties of the cylinders. Therefore the maximum temperature for any operation such as paint stoving shall be limited, and in no case shall the temperature of the cylinder treatment exceed that recommended by the manufacturer since overheating could change the mechanical properties of the cylinder.

For cylinders manufactured from heat-treated alloys with tempering, the maximum stoving temperature should not exceed 150 °C. For temperatures between 100 °C and 150 °C the exposure time should be limited to 30 min. If the stoving time exceeds 30 min at temperatures between 100 °C and 150 °C or exceeds 150 °C, then a hardness test shall be conducted (see ISO 6506). For cylinders manufactured from non-heat-treated alloys, the maximum temperature should not exceed 80 °C. For temperatures between 60 °C and 80 °C the exposure time should be limited to 15 min. If the stoving time exceeds 15 min at temperatures of 60 °C and 80 °C, or exceeds 80 °C, then a hardness test shall be conducted. The hardness test results shall meet or exceed the minimum required design hardness values. When the hardness value is not known, the cylinder shall be hardness-tested both before and after the stoving operation, and there shall be no appreciable decrease in the hardness value. All hardness tests shall be performed on parallel sections of the cylinder, taking adequate care to ensure that no deep impressions are formed.

The interior of the cylinder shall be inspected to ensure that it is dry and free from other contaminants.

Plastic coatings may be re-applied only in consultation with the cylinder manufacturer.

13.2 Revalving of the cylinder

The valve shall be fitted to the cylinder using a suitable jointing medium and the optimum torque (see manufacturer's recommendations) necessary both to ensure a seal between the valve and the cylinder and to prevent overstressing the neck.

The torque applied shall take into consideration the neck design of the cylinder, the size and form of the threads, the material of the valve, and the type of jointing material used according to the manufacturer's recommendation. Where the use of lubricants/sealing material is permitted, only those materials approved for the intended gas service shall be used. This is particularly important for materials intended for use with oxygen gas.

13.3 Reference to next test date

The next test date may be indicated using an appropriate method.

A code, using a disc fitted between the valve and the cylinder, which indicates the date (year) of the next periodic inspection and tests is proposed in annex H.

13.4 Marking

After satisfactory completion of the periodic inspection and test and the revalving of the cylinder, each cylinder shall undergo the following:

a) For liquefiable gas cylinders, the tare shall be established, taking into account the possible loss in mass of the cylinder with the attached parts and the possible difference in mass of the valve. If it differs from the marked tare significantly, the latter shall be lined out, but so that it is still readable, and the correct tare shall be marked in a permanent and legible fashion.

NOTE 3 This practice can be applied to any gas cylinder.

b) The cylinder shall be stamped, adjacent to the previous inspection/test mark, according to national requirements or with

— the symbol of the inspection body or test station;

— the date of the test (this date may be indicated by the month and year or by the year followed by a number within a circle to denote the quarter of the year).

The markings should preferably be not less than 6 mm in height but in any case shall be not less than 3 mm in height.

When a marking collar is fitted it shall be used. When there is no space available, markings may be stamped on the shoulder if its thickness is greater than the cylinder wall thickness. Under no circumstances shall the stamping be on the cylindrical part of the cylinder.

13.5 Identification of contents

The cylinder contents shall be identified in accordance with national requirements and/or in accord-

ance with ISO 32 and ISO 448. If painting is required, care shall be exercised in accordance with 13.1.

13.6 Records

An inspection/test record shall be retained by the testing station for not less than the period between tests. It shall record sufficient information to identify positively the cylinder and the results of the test/inspection. Where national regulations require certain information to be recorded, this shall be complied with. The test record may include the following information:

a) the owner;

b) serial number;

c) the date of the previous test;

d) the manufacturer;

e) the manufacturing specifications;

f) the water capacity;

g) the cylinder mass/tare as tested, if applicable;

h) the test pressure;

i) the inspection/test date;

j) the results of the inspection/test;

k) the inspection performed;

l) details of any modification or repair made to the cylinder.

14 Rejection and destruction of unserviceable cylinders

The decision to reject a cylinder may be taken at any stage during the inspection and test procedure. A rejected cylinder shall not under any circumstances be re-issued into service. It shall be destroyed either by the testing station, after agreement with the owner, or by the owner. In case of any disagreement, ensure that the legal implications of any contemplated action are fully understood.

The markings on the cylinder shall be obliterated.

Prior to taking any of the following actions, ensure the cylinder is empty (see clause 5).

The following destruction methods may be employed:

a) crushing the cylinder by mechanical means;

b) burning an irregular hole in the shoulder equivalent in area to approximately 10 % of the area of the shoulder or, in the case of thin-walled cylinders, by piercing in at least three places;

c) irregular cutting of the neck;

d) irregular cutting of the cylinder into two or more pieces;

e) bursting.

Annex A
(informative)

Recommended intervals between periodic inspection and tests

Table A.1 gives recommended time intervals between periodic testing of aluminium alloy gas cylinders.

Table A.1 — Periodicity of inspection and tests

Contents of the cylinder		Periodicity of inspections and hydraulic tests (years)
Permanent gases	Air, argon, carbon monoxide, helium, hydrogen, neon, nitrogen, oxygen, xenon and their mixtures	10[1)]
	Methane, natural gas and other gases compatible with aluminium	5
Non-corrosive low-pressure-liquefiable gases ($T_c > +70$ °C)	Cyclopropane, propane, fluorocarbons	10
	Ammonia, butadiene	5
Non-corrosive high-pressure-liquefiable gases (-10 °C $< T_c < +70$ °C)	Ethylene	10
	Carbon dioxide, nitrous oxide	10

1) For cylinders used for underwater operations and self-contained breathing apparatus, the retest period shall not exceed 5 years.