SLOVENSKI STANDARD
SIST EN 17339:2020

01-september-2020

Premične plinske jeklenke - Popolnoma obvite jeklenke in velike jeklenke za vodik iz kompozitnih materialov z ogljikovimi vlakni

Transportable gas cylinders - Fully wrapped carbon composite cylinders and tubes for hydrogen

Ortsbewegliche Gasflaschen - Vollumwickelte Flaschen und Großflaschen aus Kohlenstoff-Verbundwerkstoffen für Wasserstoff

Bouteilles à gaz transportables - Bouteilles et tubes entièrement bobinées en matériaux composites carbones pour l'hydrogène

Ta slovenski standard je istoveten z: **EN 17339:2020**

ICS:

23.020.35	Plinske jeklenke	Gas cylinders

SIST EN 17339:2020 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 17339

June 2020

ICS 23.020.35

English Version

Transportable gas cylinders - Fully wrapped carbon composite cylinders and tubes for hydrogen

Bouteilles à gaz transportables - Bouteilles et tubes entièrement bobinées en matériaux composites carbones pour l'hydrogène

Ortsbewegliche Gasflaschen - Vollumwickelte Flaschen und Großflaschen aus Kohlenstoff-Verbundwerkstoffen für Wasserstoff

This European Standard was approved by CEN on 10 May 2020.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 17339:2020 E

Contents

Page

European foreword

This document (EN 17339:2020) has been prepared by Technical Committee CEN/TC 23 “Transportable gas cylinders”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2020, and conflicting national standards shall be withdrawn at the latest by December 2020.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been submitted for reference in:

— the RID; and

— the technical annexes of the ADR.

NOTE These regulations take precedence over any clause of this document. It is emphasised that RID/ADR are being revised regularly at intervals of two years which may lead to temporary non-compliances with the clauses of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The purpose of this document is to provide a specification for the design, manufacture, inspection and testing of refillable, transportable carbon fully wrapped composite cylinders and tubes filled with hydrogen and protected in a frame such as a bundle or a trailer.

The specifications given are based on knowledge of, and experience with, materials, design requirements, manufacturing processes and control during manufacture of cylinders and tubes in common use in the countries of the CEN members.

For gas cylinders covered by RID/ADR, the maximum service pressure (maximum developed pressure at 65 °C) should not exceed the test pressure. Consequently the safety factor applies to the test pressure since, whatever the gas, the maximum developed pressure (p_{max}) is, in any case, lower than or equal to the test pressure.

This document only covers compressed hydrogen (dedicated service), therefore, the safety factor is applied to the maximum developed pressure at 65 °C (p_{max}), which is the maximum accepted temperature by transport regulations.

1 Scope

This document specifies minimum requirements for the materials, design, construction, prototype testing and routine manufacturing inspections of composite gas cylinders and tubes for compressed hydrogen.

NOTE 1 Unless specified in the text, for the purposes of this document, the word “cylinder” includes tubes.

This document applies only to fully wrapped composite cylinders with carbon fibres intended to be permanently mounted in a frame (e.g. bundle or trailer) with a test pressure of not less than 300 bar, with:

— non-metallic liners or seamless metallic liners;

— a maximum water capacity of 3 000 l;

— a maximum working pressure of 1 000 bar;

— the product of working pressure times water capacity (p × V) not exceeding 1 000 000 bar.l.

NOTE 2 A glass fibre protective layer is sometimes applied to the external surface of the cylinder.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 13807, *Transportable gas cylinders - Battery vehicles and multiple-element gas containers (MEGCs) - Design, manufacture, identification and testing*

EN ISO 75-1, *Plastics - Determination of temperature of deflection under load - Part 1: General test method (ISO 75-1)*

EN ISO 75-3, *Plastics - Determination of temperature of deflection under load - Part 3: High-strength thermosetting laminates (ISO 75-3)*

EN ISO 527-1, *Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1)*

EN ISO 527-2, *Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2)*

EN ISO 1133-1, *Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 1: Standard method (ISO 1133-1)*

EN ISO 1183 (all parts), *Plastics - Methods for determining the density of non-cellular plastics*

EN ISO 1628-3, *Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscometers - Part 3: Polyethylenes and polypropylenes (ISO 1628-3)*

EN ISO 2884-1, *Paints and varnishes - Determination of viscosity using rotary viscometers - Part 1: Cone-and-plate viscometer operated at a high rate of shear (ISO 2884-1)*

EN ISO 3146, *Plastics - Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods (ISO 3146)*

EN ISO 7866, *Gas cylinders - Refillable seamless aluminium alloy gas cylinders - Design, construction and testing (ISO 7866)*

EN ISO 9809-1, *Gas cylinders - Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 1: Quenched and tempered steel cylinders and tubes with tensile strength less than 1 100 MPa (ISO 9809-1)*

EN ISO 9809-2, *Gas cylinders - Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 2: Quenched and tempered steel cylinders and tubes with tensile strength greater than or equal to 1 100 MPa (ISO 9809-2)*

ISO 9809-4, *Gas cylinders - Refillable seamless steel gas cylinders - Design, construction and testing - Part 4: Stainless steel cylinders with an Rm value of less than 1 100 MPa*

EN ISO 10961, *Gas cylinders - Cylinder bundles - Design, manufacture, testing and inspection (ISO 10961)*

EN ISO 11114-1, *Gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 1: Metallic materials (ISO 11114-1)*

EN ISO 11114-2, *Gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 2: Non-metallic materials (ISO 11114-2)*

EN ISO 11114-4, *Transportable gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 4: Test methods for selecting steels resistant to hydrogen embrittlement (ISO 11114-4)*

EN ISO 11120, *Gas cylinders - Refillable seamless steel tubes of water capacity between 150 l and 3000 l - Design, construction and testing (ISO 11120)*

EN ISO 13341, *Gas cylinders - Fitting of valves to gas cylinders (ISO 13341)*

EN ISO 13769, *Gas cylinders - Stamp marking (ISO 13769)*

EN ISO 14130, *Fibre-reinforced plastic composites - Determination of apparent interlaminar shear strength by short-beam method (ISO 14130)*

ISO 6721-11, *Plastics - Determination of dynamic mechanical properties - Part 11: Glass transition temperature*

ISO 10618, *Carbon fibre - Determination of tensile properties of resin-impregnated yarn*

ASTM D 2196-10, *Test methods for rheological properties of non-newtonian materials by rotational (Brookfield) viscometer*

ASTM D 2344/D 2344M-13, *Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates*

ASTM D 4018-11, *Test methods for properties of continuous filament carbon and graphite fibre tows*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp/ui

3.1
ambient temperature
temperature of surroundings varying between 0 °C and 35 °C (for test purposes only)

3.2
autofrettage
pressure application procedure which strains the metal liner past its yield strength sufficient to cause permanent plastic deformation, and results in the liner having compressive stresses and the fibres having tensile stresses when at zero internal gauge pressure

[SOURCE: EN ISO 10286:2015, definition 557]

3.3
batch (of fibres, pre-impregnated fibres or components of the matrix system)
homogeneous quantity of material, identified and certified as such by the supplier

3.4
batch (of metallic liners)
quantity of liners of the same nominal diameter, thickness, length and design, made successively from the same material cast and subjected to the same heat treatment for the same length of time

3.5
batch (of non-metallic liners)
quantity of liners of the same nominal diameter, thickness, length and design, made successively from the same batch of materials and subjected to the same manufacturing process

3.6
batch (of finished cylinders with liners)
quantity of up to 200 finished cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design which may contain different batches of liners (providing the batches are nominally the same and have had the same treatments), fibres and matrix materials

3.7
burst pressure
highest pressure reached in a cylinder or liner during a burst test

[SOURCE: EN ISO 10286:2015, definition 732, modified — "or liner" has been added.]

3.8
composite overwrap
combination of fibres and matrix

3.9
elastomer
material which at ambient temperature can be stretched repeatedly to at least twice its original length and will return with force to approximately its original length immediately upon release of the stress

3.10
exterior coating
layer of clear or pigmented material applied to the cylinder as protection or for cosmetic purposes

3.11
guaranteed minimum burst pressure
guaranteed minimum burst pressure shall not be less than 2 times the maximum developed pressure at 65 °C and no less than 85 % of the value obtained during type approval.

3.12
liner
inner portion of a composite cylinder, whose purpose is both to contain the gas and transmit the gas pressure to the composite overwrap

Note 1 to entry: It can be metallic or non-metallic, load sharing or non-load sharing

[SOURCE: EN ISO 10286:2015, definition 246 modified — Note 1 to entry has been added.]

3.13
matrix
material that is used to bind and hold the fibres in place

[SOURCE: EN ISO 10286:2015, definition 245]

3.14
non-load sharing liner
liner that contributes less than 5% of the load bearing of the overall cylinder design at nominal burst pressure of the finished composite cylinder

Note 1 to entry: In this document, a non-load sharing liner is assumed to be a non-metallic one.

3.15
non-metallic liner
liner made from thermoplastic, thermosetting or elastomer material

Note 1 to entry: In this document, a non-metallic liner is assumed to be a non-load sharing one.

3.16
thermoplastic
plastics capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature

3.17
thermoset
plastics which, when cured by the application of heat or chemical means, change into a substantially infusible and insoluble product

3.18
test pressure
required pressure applied during a pressure test

[SOURCE: EN ISO 10286:2015, definition 729]

3.19
working pressure
settled pressure of a compressed gas at a uniform reference temperature of 15 °C in a full gas cylinder

[SOURCE: EN ISO 10286:2015, definition 736]

4 Symbols

p_b	actual burst pressure of composite cylinder, in bar above atmospheric pressure (1 bar = 10^5 Pa = 0,1 MPa.)
p_{bL}	burst pressure of liner, in bar above atmospheric pressure (1 bar = 10^5 Pa = 0,1 MPa.)
p_{bmin}	minimum burst pressure of composite cylinder obtained during design variant approval testing, in bar above atmospheric pressure
p_h	hydraulic test pressure of composite cylinder, in bar above atmospheric pressure, p_h is equal to 1,5 × p_w (1 bar = 10^5 Pa = 0,1 MPa.)
p_{max}	maximum developed pressure at 65 °C, in bar above atmospheric pressure. It is assumed in this document to be equal to 1,18 × p_w (1 bar = 10^5 Pa = 0,1 MPa.)
p_w	working pressure

5 Design and manufacture

5.1 General requirements

A fully wrapped composite gas cylinder may be manufactured with a metallic or non-metallic liner. An optional exterior coating or fibre layers may be used to provide external protection and when this is an integral part of the design, it shall be permanent.

The cylinder may also include additional parts (e.g. neck rings and foot rings).

Cylinders shall be designed with one or two openings along the central axis only.

The cylinders covered by this document shall be permanently mounted in a bundle according to EN ISO 10961 or a trailer/MEGCs according to EN 13807.

5.2 Liner

5.2.1 Metallic liners

Metallic liners shall be manufactured in accordance with the relevant sections of:

	Type of metallic liner	Related Standard
a)	seamless steel liners:	EN ISO 9809-1, EN ISO 9809-2 or EN ISO 11120, as appropriate;
b)	seamless stainless steel liners:	ISO 9809-4;
c)	seamless aluminium alloy liners:	EN ISO 7866

The relevant sections are those covering materials, thermal treatments, neck design, construction and workmanship and mechanical tests.

The liner material shall be compatible with hydrogen as determined by EN ISO 11114-1 and EN ISO 11114-4.

NOTE This excludes the design requirements, since these are specified by the manufacturer for the design of the composite cylinder. For liners with water capacity above 150 l manufactured of stainless steel or aluminium alloy, the relevant sections of the appropriate standard also apply.

5.2.2 Non-metallic liners

A cylinder with a non-metallic liner shall be designed as if the liner will be non-load sharing. The liner material shall be compatible with hydrogen as determined by EN ISO 11114-2 or demonstrated by suitable testing.

Where a metal end boss is used in a non-metallic liner, it shall be considered part of the liner material and shall fulfil the material requirements specified in the relevant standard, as listed in 5.2.1. Other materials are acceptable if hydrogen compatibility is demonstrated by testing according to EN ISO 11114-4 or if it is accepted by design standards (e.g. EN ISO 7866).

The drawing of the liner shall include the specification of the material and material properties of the boss. The following material properties of the boss shall be specified in the design:

a) minimum yield stress;

b) minimum tensile strength;

c) minimum elongation;

d) compatibility with hydrogen as determined by EN ISO 11114-1.

The metal end boss bearing the cylinder thread shall be designed to withstand the torque applied in fitting the valve to the cylinder and the tests specified in Test 13 (for taper threads only, see 6.2.13) and Test 14 (see 6.2.14).

5.2.3 Design drawing

A fully dimensioned drawing of the liner shall be supplied which includes the specification of the material and material properties. Material and liner properties to be specified on the drawing are:

a) for metallic liners:

— minimum yield stress;

- minimum tensile strength;
- minimum elongation;
- minimum burst pressure;
- compatibility with hydrogen as determined by EN ISO 11114-1.

b) for non-metallic liners:

1) density;

- melting point, as determined by:
  - EN ISO 3146 for thermoplastics; or
  - EN ISO 75-1 and EN ISO 75-3 for thermoset materials;
- glass transition temperature as determined by differential scanning calorimetry;
- composition;
- compatibility with hydrogen as specified by EN ISO 11114-2 or demonstrated by suitable testing;
- end boss design in accordance with 5.2.2.

5.2.4 Design of ends

The external diameter and thickness of the formed neck end of the liner shall be designed to withstand the torque applied in fitting the valve to the cylinder and the tests specified in Test 13 (for taper threads only, see 6.2.13) and Test 14 (see 6.2.14).

5.2.5 Neck ring

When a neck ring is provided, it shall be of a material compatible with that of the cylinder, and shall be securely attached by an appropriate method to the liner (or cylinder for cylinders without liner) or boss material.

5.3 Composite overwrap

5.3.1 Materials

Material requirements for the fibre and matrix or the pre-impregnated material shall be as specified by the cylinder manufacturer.

5.3.2 Winding

Appropriate procedures shall be defined for the winding and curing process to ensure good repeatability and traceability.

Parameters to be specified and monitored are:

a) composite overwrap component percentages;

b) batch numbers of the material used as defined in 3.3 to 3.6;

c) number of strands used;

d) winding tension per strand (if applicable);

e) winding speed(s);

f) winding angle and/or pitch for each layer;

g) resin bath temperature range (if applicable);

h) temperature of the strand before consolidation (if applicable);

i) number and order of layers;

j) procedure used to obtain correct impregnation (e.g. wet winding or pre-impregnation);

k) polymerisation cycle (if applicable);

l) polymerisation process (e.g. thermal cycling, ultrasonic, ultraviolet or radiation).

For thermal polymerisation, the temperature and the length of the polymerisation cycle of the resin system shall be such that they do not adversely affect the mechanical characteristics of the liner. In addition, tolerances for holding time and temperature at each stage shall be defined.

5.4 Finished cylinder

5.4.1 Design drawings

A fully dimensioned drawing of all parts that constitute the finished cylinder shall be supplied. The design drawing shall include tolerances on all dimensions, including out-of-roundness and straightness.

The drawing shall include the specification of the material(s), the material properties and the reinforcement pattern. The specifications and the reinforcement patterns may be given in a technical specification enclosed with the drawing.

The details of a permanently applied exterior coating, if it is an integral part of the design, shall be defined.

The test pressure, autofrettage pressure (if applicable) and minimum burst pressure for the design shall be specified.

Any special characteristics or special limitations (e.g. design life, vacuum suitability and/or maximum fitting torque restrictions) shall be stated.

5.4.2 Autofrettage

Internal pressurization to autofrettage pressure of cylinders with metallic liners can be part of the manufacturing process; if so this operation shall be executed after polymerisation of the composite for thermosetting resins or after the consolidation process for thermoplastics.

During the autofrettage operation, the parameters to be recorded are:

a) autofrettage pressure;

b) length of application of the autofrettage pressure;

c) expansion at autofrettage pressure;