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Premične plinske jeklenke - Popolnoma obvite jeklenke iz kompozitnih mas (vključno z dopolnilom A1)

Transportable gas cylinders - Fully wrapped composite cylinders

Ortsbewegliche Gasflaschen - Vollumwickelte Flaschen aus Verbundwerkstoffen

Bouteilles à gaz transportables - Bouteilles entièrement bobinées en matériaux composites

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Transportable gas cylinders - Fully wrapped composite cylinders

Bouteilles à gaz transportables - Bouteilles entièrement bobinées en matériaux composites

Ortsbewegliche Gasflaschen - Vollumwickelte Flaschen aus Verbundwerkstoffen

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Contents

Page

Foreword

This document (EN 12245:2009+A1:2011) 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of an identical text or by endorsement, at the latest by May 2012, and conflicting national standards shall be withdrawn at the latest by May 2012.

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This document supersedes [A1] EN 12245:2009 [A1].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] [A1].

The modifications of the related CEN Corrigendum have been implemented at the appropriate places in the text and are indicated by the tags [AC] [AC].

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of [A1] EU Directive 2008/68/EC [A1].

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Introduction

The purpose of this European Standard is to provide a specification for the design, manufacture, inspection and testing of refillable, transportable fully wrapped composite cylinders.

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

1 Scope

This European Standard specifies minimum requirements for the materials, design, construction, prototype testing and routine manufacturing inspections of composite gas cylinders for compressed, liquefied and dissolved gases.

NOTE 1 For the purposes of this European Standard, the word “cylinder” includes tubes (seamless transportable pressure receptacles of a water capacity exceeding 150 litres and of not more than 3 000 litres).

This European Standard is applicable to cylinders that comprise a liner of metallic material (welded or seamless) or non-metallic material (or a mixture thereof), reinforced by a wound composite consisting of fibres of glass, carbon or aramid (or a mixture thereof) embedded in a matrix.

This European Standard is also applicable to composite cylinders without liners.

This European Standard is not applicable to gas cylinders which are partially covered with fibres and commonly called "hoop wrapped" cylinders. For hoop wrapped composite cylinders, see EN 12257.

NOTE 2 This European Standard does not address the design, fitting and performance of removable protective sleeves. Where these are fitted, they should be considered separately.

This European Standard is primarily for industrial gases other than LPG but may also be applied to LPG.

NOTE 3 For dedicated LPG cylinders, see EN 14427.

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.

EN 720-2, *Transportable gas cylinders — Gases and gas mixtures — Part 2: Determination of flammability and oxidizing potential of gases and gas mixtures*

EN 1964-1, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0,5 litre up to and including 150 litres — Part 1: Cylinders made of seamless steel with an R_m value of less than 1100 MPa*

EN 1964-2, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0,5 litre up to and including 150 litres — Part 2: Cylinders made of seamless steel with an R_m value of 1100 MPa and above*

EN 1964-3, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0,5 litre up to and including 150 litres — Part 3:. Cylinders made of seamless stainless steel with an Rm value of less than 1100 MPa*

EN 1975, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless aluminium and aluminium alloy gas cylinders of capacity from 0,5 litre up to 150 litres*

EN 12862, *Transportable gas cylinders — Specification for the design and construction of refillable transportable welded aluminium alloy gas cylinders*

EN 13322-1, *Transportable gas cylinders — Refillable welded steel gas cylinders — Design and construction — Part 1: Carbon steel*

EN 13322-2, *Transportable gas cylinders — Refillable welded steel gas cylinders — Design and construction — Part 2: Stainless steel*

EN 14638-1, *Transportable gas cylinders — Refillable welded receptacles of a capacity not exceeding 150 litres — Part 1: Welded austenitic stainless steel cylinders made to a design justified by experimental methods*

EN ISO 11114-1, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 1: Metallic materials (ISO 11114-1:1997)*

EN ISO 11114-2, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials (ISO 11114-2:2000)*

EN ISO 11114-3, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 3: Autogenous ignition test in oxygen atmosphere (ISO 11114-3:1997)*

EN ISO 11114-4, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement (ISO 11114-4:2005)*

EN ISO 11120, *Gas cylinders — Refillable seamless steel tubes for compressed gas transport, of water capacity between 150 l and 3000 l — Design, construction and testing (ISO 11120:1999)*

EN ISO 13341, *Transportable gas cylinders — Fitting of valves to gas cylinders (ISO 13341:1997)*

EN ISO 13769, *Gas cylinders — Stamp marking (ISO 13769:2002)*

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

ISO 75-3, *Plastics — Determination of temperature of deflection under load — Part 3: High-strength thermosetting laminates and long-fibre-reinforced plastics*

ISO 175, *Plastics — Methods of test for the determination of the effects of liquid chemicals*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

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

ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

ISO 1183 (all parts), *Plastics — Methods of determining the density and relative density of non-cellular plastics*

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

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

ISO 3341, *Textile glass — Yarns — Determination of breaking force and breaking elongation*

ISO 8521, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the apparent initial circumferential tensile strength*

ISO 10156, *Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets*

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

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

ISO 15512, *Plastics — Determination of water content*

ASTM D 2196-86, *Test methods for rheological properties of non-newtonian materials by rotational (Brookfield) viscometer*

ASTM D 2290-92, *Test method for apparent tensile strength of ring or tubular plastics and reinforced plastics by split disk method*

ASTM D 2291-83, *Fabrication of ring test specimens for glass-resin composites*

ASTM D 2343-03, *Test Method for Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics*

ASTM D 2344-84, *Test method for apparent interlaminar shear strength of parallel fiber composites by short beam method*

ASTM D 3418-99, *Standard test method for transition temperature of polymers by differential scanning calorimetry*

ASTM D 4018-93, *Test methods for tensile properties of continuous filament carbon and graphite fibre tows*

3 Terms, definitions and symbols

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

3.1 Terms and definitions

3.1.1
ambient temperature
temperature of surroundings varying between 10 °C and 35 °C (for test purposes only)

3.1.2
autofrettage
pressure application procedure which strains the metal liner past its yield point sufficiently 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

3.1.3
batch (of fibres, pre-impregnated fibres or components of the matrix system)
homogeneous quantity of material, identified and certified as such by the supplier

3.1.4
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

3.1.5
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

3.1.6
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

3.1.7
batch (of finished cylinders with no liners)
production quantity of up to 200 finished cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design

3.1.8
burst pressure
highest pressure reached in a cylinder or liner during the relevant burst test

3.1.9
composite overwrap
fibres and matrix taken together as a combined unit

3.1.10
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

3.1.11
exterior coating
layer of clear or pigmented material applied to the cylinder as protection or for cosmetic purposes

3.1.12
fibre or strand
load-carrying part of the composite overwrap e.g. glass, aramid or carbon

3.1.13
fully wrapped cylinder
cylinder reinforced by wrapping to take both circumferential and longitudinal stress

3.1.14
liner
metallic or non-metallic vessel that contains the gas but may also contribute to the mechanical behaviour of the cylinder

3.1.15
non-load sharing liner
liner that contributes less than 5 % of the load bearing of the overall cylinder design at test pressure, and is intended only to prevent diffusion of the contained gas

3.1.16
non-metallic liner
liner made from thermoplastic, thermosetting or elastomer material

3.1.17
cylinder without liner
cylinder having no liner and consisting wholly of the composite winding

3.1.18
matrix
material which is used to bind and hold the fibres in place

3.1.19
rejected cylinder
cylinder which in its present condition has not passed the test requirements

3.1.20
thermoplastic
plastics capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature

3.1.21
thermoset
plastics which, when cured by the application of heat or chemical means, change into a substantially infusible and insoluble product

3.2 Symbols

p_b actual burst pressure of composite cylinder, in bar [1] above atmospheric pressure

p_{bL} burst pressure of liner, in bar [1] above atmospheric pressure

p_{bmin} minimum burst pressure of composite cylinder obtained during design variant approval testing, in bar [1] above atmospheric pressure

p_h hydraulic test pressure of composite cylinder, in bar [1] above atmospheric pressure

p_{max} maximum developed pressure at 65 °C, in bar [1] above atmospheric pressure

4 Design and manufacture

4.1 General

A fully wrapped composite gas cylinder may be manufactured with a metallic or non-metallic liner or without a liner. Cylinders without a liner may be manufactured from two parts joined together with adhesive. An optional exterior coating may be used to provide external protection and when this is an integral part of the design shall be permanent.

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

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

4.2 Liner

4.2.1 Metallic liners

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

a) seamless steel liners: EN 1964-1 or EN 1964-2, as appropriate;

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1) 1 bar = 10^5 Pa = 0,1 MPa.

b) seamless stainless steel liners: EN 1964-3;

c) seamless aluminium alloy liners: EN 1975;

d) welded steel liners: EN 13322-1 or prEN 14638-3, as appropriate;

e) welded stainless steel liners: EN 13322-2 or EN 14638-1, as appropriate;

f) welded aluminium liners: EN 12862;

g) steel tubes (i.e. > 150 l): EN ISO 11120.

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

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, aluminium or welded steel, the relevant sections of the appropriate standard also apply.

The liner material shall be compatible with the gases intended to be used as determined by EN ISO 11114-1 and EN ISO 11114-4.

4.2.2 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 the gases intended to be used as determined by EN ISO 11114-2.

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 4.2.1.

The drawing of the liner shall include the specification of the material and material properties of the boss. Important material properties shall be specified in the design and are those such as:

a) minimum yield stress;

b) minimum tensile strength;

c) minimum elongation of the boss material;

d) compatibility with the contained gas 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 16 (see 5.2.16) and Test 17 (see 5.2.17).

4.2.3 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:

   1) minimum yield stress;

   2) minimum tensile strength;

   3) minimum elongation;

   4) minimum burst pressure;

5) compatibility with the contained gas as determined by EN ISO 11114-1.

b) for non-metallic liners:

1) density;

2) melting point, as determined by:

i) ISO 3146 for thermoplastics; or

ii) ISO 75-1 and ISO 75-3 for thermoset materials;

3) auto-ignition temperature in oxygen as determined by EN ISO 11114-3 (for cylinders intended for air and oxidising gases (see ISO 10156 for definition of oxidising gases));

4) glass transition temperature as determined by differential scanning calorimetry;

5) composition;

6) compatibility with the contained gas as determined by EN ISO 11114-2;

7) end boss design in accordance with 4.2.2.

4.2.4 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 16 (see 5.2.16) and Test 17 (see 5.2.17).

4.2.5 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 a method appropriate to the liner (or cylinder for cylinders without liner) or boss material.

4.3 Composite overwrap

4.3.1 Materials

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

4.3.2 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 3.1.3;

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.

4.3.3 Cylinders without liners comprising two or more parts

For cylinders without liners which comprise of two parts joined with adhesive, additional procedures and parameters shall be defined, monitored and recorded and are:

a) adhesive system component percentages and batch numbers;

b) polymerisation cycle;

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

4.4 Finished cylinder

4.4.1 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 an 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, underwater suitability, vacuum suitability and/or maximum fitting torque restrictions) shall be stated.

4.4.2 Cylinders without liner

The requirements for the composite materials and their properties to be specified are:

a) tensile strength;