SLOVENSKI STANDARD
SIST EN 12245:2002

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Premiļ ne plinske jeklenke - Popolnoma obvite jeklenke iz kompozitnih mas

Transportable gas cylinders - Fully wrapped composite cylinders

Ortsbewegliche Gasflaschen - Vollumwickelte Flaschen aus Verbundwerkstoffen

Bouteilles a gaz transportables - Bouteilles entierement 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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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

This document EN 12245:2002 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of an identical text or by endorsement, at the latest by August 2002, and conflicting national standards shall be withdrawn at the latest by August 2002.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports the objectives of the framework Directives on Transport of Dangerous Goods.

This European Standard has been submitted for reference into the RID and/or the technical annexes of the ADR. Therefore in this context the standards listed in the normative references and covering basic requirements of the RID/ADR not addressed within the present standard are normative only when the standards themselves are referred to in the RID and/or the technical annexes of the ADR.

Annex A is normative, annex B is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The purpose of this 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 with a water capacity up to and including 450 l for compressed, liquefied and dissolved gases.

NOTE For the purposes of this standard, the word “cylinder” includes tubes up to 450 l water capacity

This 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 standard is also applicable to composite cylinders without liners.

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

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

EN 1089-1, *Transportable gas cylinders — Gas cylinder identification (excluding LPG) — Part 1: Stampmarking.*

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 litres up to and including 150 litres — Part 1: Cylinders made of seamless steel with an* R_m *value of less than 1100 MPa.*

prEN 1964-2, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless steel gas cylinders from 0,5 litres up to and including 150 litres — Part 2: Tensile strength (*R_m *max)* $\geq$ *1100 MPa.*

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 litres up to and including 150 litres — Part 3: Stainless steel cylinders.*

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 l up to 150 l.*

EN 12862, *Transportable gas cylinders — Refillable transportable welded aluminium alloy gas cylinders.*

prEN 13322-1, *Transportable gas cylinders — Refillable transportable welded steel gas cylinders — Part 1: Welded steel.*

prEN 13322-2, *Transportable gas cylinders — Refillable transportable welded stainless steel gas cylinders — Part 2: Welded stainless steel.*

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 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, *Fitting of valves to gas cylinders (ISO 13341:1997).*

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 — Determination of the effects of liquid chemicals, including water.*

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 melt volume-flow rate (MVR) of thermoplastics.*

ISO 1183, *Plastics — Methods of determining the density and relative density of non-cellular plastics.*

ISO 1628-3, *Plastics — Determination of viscosity number and limiting viscosity number — 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.*

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

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 2343-95, *Test method for tensile properties of glass fibre 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 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 or components of the resin 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. The batch 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

4 Design and manufacture

4.1 General

4.1.1 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 such as rings, bases, etc.

4.1.2 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 the following European Standards:

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

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

c) seamless aluminium alloy liners: EN 1975;

d) welded steel liners: prEN 13322-1;

e) welded stainless steel liners: prEN 13322-2;

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, 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.

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

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

4.2.2 Non-metallic liners

4.2.2.1 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.

4.2.2.2 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. The following material properties important for design shall be specified in the design as follows:

— minimum yield stress;

— minimum tensile strength;

— minimum elongation of the boss material;

— 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 No 16 (see 5.2.16) and Test No 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. The following material properties shall be specified:

a) for metallic liners:

— minimum yield stress;

— minimum tensile strength;

— minimum elongation;

— minimum burst pressure;

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

b) for non-metallic liners:

— density;

— melting point, as determined by:
— ISO 3146 for thermoplastics; or
— ISO 75-1 and ISO 75-3 for thermoset materials;

— auto-ignition temperature in oxygen as determined by EN ISO 11114-3 (for cylinders for oxidising gases only);

— glass transition temperature as determined by differential scanning calorimetry;

— composition;

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

— end boss design in accordance with 4.2.2.2.

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 No 16 (see 5.2.16) and Test No 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 linerless cylinders) or boss material.

4.3 Composite overwrap

4.3.1 Materials

Material requirements for the fibre and the matrix 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.

The following parameters shall be defined and monitored:

— percentages of the components of the matrix system and their batch numbers;

— the batch numbers of the fibres used;

— the number of strands used;

— the winding tension per strand, (if applicable);

— the winding speed(s);

— the winding angle and/or pitch for each layer;

— resin bath temperature range, (if applicable);

— the number and order of layers;

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

— the polymerisation cycle;

— the 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 two parts joined with adhesive, additional procedures and parameters shall be defined, monitored and recorded as follows:

— percentages of the components of the adhesive system and their batch numbers;

— polymerisation cycle;

— polymerisation process (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 also 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. The minimum burst pressure shall be at least 2 × test pressure (p_h).

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

4.4.2 Cylinders without liner

The composition of the composite materials and also their properties shall be specified, as follows:

— tensile strength;

— tensile modulus;

— elongation;

— heat distortion temperature;

— viscosity.

The composite materials shall be compatible with the contained gas as determined by EN ISO 11114-2. The auto-ignition temperature in oxygen gas shall be determined in accordance with EN ISO 11114-3.

Where a metal end boss is used in a cylinder without liner the drawing of the cylinder shall include the specification of the material and material properties of the boss in accordance with 4.2.2.2.

4.4.3 Autofrettage

Internal pressurisation 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.

During the autofrettage operation, the following parameters shall be recorded:

— autofrettage pressure;

— length of application of this pressure;

— expansion at autofrettage pressure;

— permanent expansion after autofrettage.

If autofrettage is performed, a check shall be made that the procedure has been effectively performed on all cylinders.

4.4.4 Manufacturing requirements for the finished cylinder

The internal and external surfaces of the finished cylinder shall be free of defects which can adversely affect the safe working of the cylinder. In addition there shall be no visible foreign matter present inside the cylinder (e.g. resin, swarf or other debris).

4.5 Liquefied gases

Cylinders intended to contain non-toxic, non-flammable liquefied gases shall be fitted with a bursting disc designed to operate below 1,15 p_h.

5 Cylinder and material tests

5.1 General

This clause describes tests to be conducted on fully wrapped composite cylinders, cylinder liners and the materials used in manufacture of cylinders for prototype testing of new cylinder designs, design variant testing and production testing. The tests listed can be required or optional, as identified in the schedule of testing and inspections in annex A.

No tests shall be performed with a removable protective sleeve fitted to the cylinder.

5.2 Test procedures and test requirements

5.2.1 Test No 1 - Composite material tests, including adhesives (where applicable)

Tests shall be carried out on composite materials as follows:

a) On all cylinders: