SLOVENSKI STANDARD
SIST EN 14427:2004

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Premične, ponovno polnljive, popolnoma obvite jeklenke iz kompozitnih materialov za utekočinjeni naftni plin (LPG) - Konstruiranje in izdelava

Transportable refillable fully wrapped composite cylinders for Liquefied Petroleum Gases (LPG) - Design and Construction

Ortsbewegliche wiederbefüllbare vollumwickelte Flaschen aus Verbundwerkstoff für Flüssiggas (LPG) - Gestaltung und Konstruktion

Bouteilles entierement bobinées en matériau composite, transportables et rechargeables pour gaz de pétrole liquéfié (GPL) - Conception et fabrication

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This European Standard was approved by CEN on 18 March 2004.

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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 Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document has been prepared by Technical Committee CEN/TC 286 "Liquefied Petroleum Gas equipment and accessories", the secretariat of which is held by NSAI.

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of an identical text or by endorsement, at the latest by November 2004, and conflicting national standards shall be withdrawn at the latest by November 2004.

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 and annexes B and C are 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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This European Standard calls for the use of substances and procedures that can be injurious to health if adequate precautions are not taken.

It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

It has been assumed in the drafting of this European Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

1 Scope

This European Standard specifies minimum requirements for materials, design, construction, prototype testing and routine manufacturing inspections of fully wrapped composite cylinders with a water capacity from 0,5 litre up to and including 150 litres for liquefied petroleum gases (LPG) exposed to ambient temperatures, with a test pressure of 30 bar.

This standard is only applicable to cylinders which are fitted with a pressure relief valve (see 4.1.3).

NOTE 1 Cylinders made to this standard are suitable for the temperature range of –40 °C to 50 °C.

This standard is applicable to cylinders with a liner of metallic material (welded or seamless) or non-metallic material (or a mixture thereof), reinforced by fibres of glass, carbon or aramid (or a mixture thereof).

This standard is also applicable to composite cylinders without liners.

NOTE 2 This standard does not address the design, fitting and performance of removable protective sleeves. Where these are fitted, the choice of material and sleeve performance 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 places 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 ISO 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method (ISO 75-1:1993).*

EN ISO 75-3, *Plastics — Determination of temperature of deflection under load — Part 3: High-strength thermosetting laminates and long-fibre-reinforced plastics (ISO 75-3:1993).*

EN ISO 175, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals (ISO 175:1999).*

EN ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles (ISO 527-1:1993).*

EN ISO 960, *Plastics — Polyamides (PA) — Determination of water content (ISO 960:1988).*

EN ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics (ISO 1133:1997).*

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

EN 1442, *Transportable refillable welded steel cylinders for liquefied petroleum gas (LPG) — Design and construction.*

EN ISO 1628-3, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 3: Polyethylenes and polypropylenes (ISO 1628-3:2001).*

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.*

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 litres 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 litres up to and including 150 litres — Part 3: Cylinders made of stainless steel with an R_m value of less then 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 litre.*

ISO 2884, *Paints and varnishes — Determination of viscosity at a high rate of shear.*

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

EN ISO 3231, *Paints and varnishes — Determination of resistance to humid atmospheres containing sulphur dioxide (ISO 3231:1993).*

EN ISO 7253, *Paints and varnishes — Determination of resistance to neutral salt spray (fog) (ISO 7253:1996).*

ISO 10286, *Gas cylinders — Terminology.*

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 11507:2001 *Paints and varnishes — Exposure of coatings to artificial weathering — Exposure to fluorescent UV and water (ISO 11507:1997).*

ISO 11997-2, *Paints and varnishes — Determination of resistance to cyclic corrosion conditions — Part 2: Wet (salt fog)/dry/humidity/UV light*.

EN 12807, *Transportable refillable brazed steel cylinders for liquefied petroleum gas (LPG) — Design and construction.*

EN 13110, *Transportable refillable welded aluminium cylinders for liquefied petroleum gas (LPG) — Design and construction.*

EN 13152, *Specification and testing for LPG cylinder valves —Self closing.*

EN 13153, *Specification and testing of LPG cylinder valves — Manually operated.*

EN 14140, *Transportable refillable welded steel cylinders for Liquefied Petroleum Gas (LPG) — Alternative design and construction.*

ASTM D 2196-99, *Test methods for rheological properties of non-newtonian materials by rotational (Brookfield type) viscometer.*

ASTM D 2290-00, *Test method for apparent hoop tensile strength of plastics and reinforced plastic or by split disk method.*

ASTM D 2291-98, *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 4018-99, *Standard test methods for properties of continuous filament carbon and graphite fibre tows.*

3 Terms, definitions and symbols and abbreviations

For the purposes of this European Standard, the terms and definitions given in ISO 10286 and the following apply.

3.1 Terms and definitions

3.1.1
ambient test 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

NOTE The batch may contain different batches of liners, providing the batches are nominally the same and have had the same treatment, fibres and matrix materials.

3.1.7
batch, (of finished cylinders with no liners)
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, or fibres embedded in a 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

3.1.12
fibre/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 retains the LPG in the cylinder, 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 LPG

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

3.1.17
matrix
material which is used to bind and hold the fibres in place

3.1.18
thermoplastic
plastics capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature

3.1.19
thermoset
plastics which when cured by the application of heat or chemical means changes into a substantially infusible and insoluble product

3.1.20
removable protective sleeve
external sleeve intended to provide protection to the cylinder during operation which is not an integral part of the design, not permanently fixed to the cylinder but which can be removed during service without destroying the sleeve without the use of special tools

4 Design and manufacture

4.1 General

4.1.1 Fully wrapped composite LPG cylinders may be manufactured with a metallic or non-metallic liner or without a liner. Cylinder bodies without a liner may be manufactured from two parts joined together with adhesive.

The thicknesses of the cylinder, including any liner, shall be determined by satisfactory completion of the performance tests described in clause 5. No design calculations are required.

The cylinder may also include an external coating and/or additional parts such as valve shrouds/handles, bases and cages. Where these are an integral part of the design, they shall be permanently fixed to the cylinder such that they cannot be removed during service without destroying them, or by use of special tools.

4.1.2 The location of all openings for service connections shall be restricted to one end of the cylinder.

Where it is necessary, for production reasons, to have an opening in both ends, the non-service opening shall be permanently sealed before completion of the cylinder. The sealing arrangement shall be:

— permanent;

— inaccessible to users of the cylinder in service;

— designed so that any leakage of product past the seal can only be released local to the service valve(s) so that it will be detectable during post-fill leak checks.

4.1.3 Due to the lack of volumetric expansion, cylinders designed to this standard are intended to be used only when fitted with a pressure relief valve.

4.2 Liner

4.2.1 Metallic liners

4.2.1.1 Metallic liners shall be manufactured in accordance with the relevant clauses of the following European Standards:

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

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

c) seamless aluminium alloy liners: EN 1975;

d) welded steel liners: EN 1442 or EN 14140;

e) brazed steel liners: EN 12807;

f) welded aluminium liners: EN 13110.

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

NOTE This excludes the design requirements, since the design is determined by the manufacturer in accordance with this standard for the design of the composite cylinder.

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 LPG 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 listed in 4.2.1.

4.2.3 Design drawing

A fully dimensioned drawing of the liner shall be produced which shall include the specification of the material and material properties. The following properties shall be specified:

a) for metallic liners:

— minimum yield stress;

— minimum tensile strength;

— minimum elongation;

— minimum burst pressure;

b) for non-metallic liners:

— density;

— for thermoplastics, the melting point, as determined by EN ISO 3146;

— for thermoset materials, the temperature of deflection under load, as determined by EN ISO 527-1 and EN ISO 75-3;

— for thermoset materials, the glass transition temperature as determined by differential scanning calorimetry;

— composition;

— compatibility with LPG as determined by EN ISO 11114-2;

— end boss material specification:

  — minimum yield stress;

  — minimum tensile strength;

  — minimum elongation of the boss material.

4.3 Composite overwrap

4.3.1 Materials

Material requirements for the fibre and the matrix, if applicable, shall be as specified by the manufacturer.

4.3.2 Winding

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

For all cylinders, the following parameters shall be defined and monitored:

a) the batch numbers of the fibres used;

b) the number of strands used;

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

d) the winding speed(s);

e) the winding angle and/or pitch for each layer;

f) the number and order of layers.

If a matrix system is used, the following additional parameters shall be defined and monitored:

g) percentages of the components of the matrix system and their batch numbers;

h) resin bath temperature range, (if applicable);

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

j) the polymerisation cycle;

k) 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 parts

For cylinders without liners which comprise two parts joined with adhesive, additional procedures and parameters shall be defined, monitored and recorded for the adhesive system as follows:

a) percentages of the components and their batch numbers;

b) polymerisation cycle;

c) 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 produced. 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 referenced on the drawing.

The details of any exterior coating and additional, permanently fixed parts, which are an integral part of the design, shall be specified.

The manufacturer shall specify the minimum burst pressure for the design which shall be at least 67,5 bar (the test pressure shall be 30 bar) i.e. a burst ratio of 2,25.

The drawing shall specify any special characteristics or special limitations (e.g. maximum fitting torque restrictions, the requirements for fitting a relief valve).

4.4.2 Cylinders without liner

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

a) tensile strength;

b) tensile modulus;

c) elongation;

d) heat distortion temperature;

e) viscosity.

The composite materials shall be compatible with LPG as determined by EN ISO 11114-2.

Where a metal end boss is used in a cylinder without a liner the drawing of the cylinder shall include the specification of the material and material properties of the boss in accordance with 4.2.3.

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:

a) autofrettage pressure;

b) duration of application of this pressure;

c) expansion at autofrettage pressure;

d) 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 could 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).

4.4.5 Neck ring

When a neck ring is provided, it shall be of a material compatible with that of the cylinder. It shall be securely attached by a method appropriate to the cylinder or boss material so as to withstand the test specified in test No. 18 (see 5.2.18).

4.4.6 Cylinder stability

For cylinders designed to stand on their base, the variation from vertical shall be less than 1 % of their height. The outer diameter of the surface in contact with the ground shall be greater than 75 % of the nominal outside diameter.

5 Cylinder and material tests

5.1 General

This clause describes some of the tests to be conducted on fully wrapped composite cylinders, cylinder liners and the materials used in manufacture of cylinders, as required by annex A, for:

— prototype testing of new cylinder designs (see A.2);

— design variant testing (see A.3); and

— production testing (see A.4).

The tests listed are mandatory or optional, as identified in the schedule of testing and inspections in annex A.

Cylinders subjected to the tests shall include all permanently fixed parts, unless otherwise specified.

No tests shall be performed with a removable protective sleeve fitted to the cylinder, except where specified (see test 10, 5.2.10.1).

NOTE Attention is drawn to the risks associated with testing pressurised cylinders. Appropriate safety precautions should be taken in order to reduce the risks to testing personnel e.g. during positioning and handling of cylinders they can be depressurised between individual tests.

5.2 Test procedures and test requirements

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

5.2.1.1 Tests on all cylinders

5.2.1.1.1 Procedure

Tests on the composite materials to establish their mechanical properties shall be carried as follows for:

a) Tensile properties of fibres in accordance with the following standards:

For glass, aramid: - ASTM D 2290-00 and ASTM D 2291-98;

- ASTM D 2343-95;

For carbon: - ASTM D 4018-99.

Alternative standards are acceptable providing that they give equivalent results.

b) Shear properties in accordance with the following standard: - ASTM D 2344-84.

Alternative standards are acceptable providing that they give equivalent results.

c) Impact properties

Impact tests on the material shall be carried out at room temperature (+20 °C) and at –20 °C. At each temperature three specimens shall be tested.

As an alternative, the cylinder impact tests (Test No. 9, see 5.2.9) with the cylinders at –20 °C shall be carried out.