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Oprema in pribor za utekočinjeni naftni plin (UNP) - Premične, ponovno polnljive jeklenke iz kompozitnih materialov za UNP - Konstruiranje in izdelava

LPG equipment and accessories - Transportable refillable composite cylinders for LPG - Design and construction

Flüssiggas-Geräte und Ausrüstungsteile - Ortsbewegliche wiederbefüllbare vollumwickelte Flaschen aus Verbundwerkstoff für Flüssiggas (LPG) - Auslegung und Bau

Équipements pour gaz de pétrole liquéfiés et leurs accessoires - Bouteilles entièrement bobinées en matériau composite, transportables et rechargeables pour gaz de pétrole liquéfié (GPL) - Conception et fabrication

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LPG equipment and accessories - Transportable refillable composite cylinders for LPG - Design and construction

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This European Standard was approved by CEN on 13 March 2022.

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Contents	Page
European foreword.....	4
Introduction	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	8
4 Design and manufacture	11
4.1 General	11
4.2 Liner	12
4.2.1 Metallic liners	12
4.2.2 Non-metallic liners	12
4.2.3 Design drawing	13
4.3 Composite overwrap	13
4.3.1 Materials	13
4.3.2 Winding	14
4.4 Finished cylinder	14
4.4.1 Design drawings	14
4.4.2 Type 5 cylinders	15
4.4.3 Autofrettage	15
4.4.4 Manufacturing requirements for the finished cylinder	16
4.4.5 Neck ring	16
4.4.6 Cylinder stability	16
4.4.7 Establishment of rejection criteria	16
5 Cylinder and material tests	17
5.1 General	17
5.2 Test procedures and test requirements	18
5.2.1 Test No. 1 – Composite material tests	18
5.2.2 Test No. 2 – Liner material tests	19
5.2.3 Test No. 3 – Liner burst test (for metallic liners only)	20
5.2.4 Test No. 4 – Proof pressure test of finished cylinders	21
5.2.5 Test No. 5 – Cylinder burst test	22
5.2.6 Test No. 6 – Pressure cycle test	22
5.2.7 Test No. 7 – Artificial ageing test	23
5.2.8 Test No. 8 – Exposure to elevated temperature at test pressure	25
5.2.9 Test No. 9 – Cylinder body integrity impact tests	26
5.2.10 Test No. 10 – Drop test	30
5.2.11 Test No. 11 – Flawed cylinder test	31
5.2.12 Test No. 12 – Extreme temperature cycle test	31
5.2.13 Test No. 13 – Fire resistance test	33
5.2.14 Test No. 14 – Spike puncture test	34
5.2.15 Permeability test of Type 4 and 5 cylinders	35
5.2.16 Test No. 16 – Torque test	36
5.2.17 Test No. 17 – Neck strength test	36
5.2.18 Test No. 18 – Neck ring test	37
5.3 Failure to meet test requirements	37
5.3.1 Metallic liners	37
5.3.2 Complete cylinder	37
6 Marking	38

Annex A (normative) Prototype testing, design variant testing and production testing	39
A.1 General	39
A.2 Prototype testing	39
A.2.1 General	39
A.2.2 Definition of new design	40
A.2.3 Prototype testing requirements.....	41
A.3 Design variant testing	43
A.3.1 General	43
A.3.2 Definition of a design variant.....	43
A.3.3 Design variant test requirements.....	46
A.4 Production testing.....	49
A.4.1 General	49
A.4.2 Production test requirements	49
A.4.3 Liner batch tests and inspections	49
A.4.4 Composite materials batch tests and inspections.....	50
A.4.5 Tests and inspections of the finished cylinder.....	50
Bibliography	54

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SIST EN 14427:2022

<https://standards.iteh.ai/catalog/standards/sist/ff033134-2702-4bae-bbc2-ca3b23db191b/sist-en-14427-2022>

EN 14427:2022 (E)**European foreword**

This document (EN 14427:2022) 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 October 2022, and conflicting national standards shall be withdrawn at the latest by October 2022.

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 supersedes EN 14427:2014.

In comparison with the previous edition, the following technical modifications have been made:

- Introduction of cylinder types;
- Addition of criteria for design drawings;
- Establishment of rejection criteria;
- Addition of table – cylinder rejection criteria;
- Further update to 4.3.2.4, 5.2.6, 5.2.7, 5.2.9, 5.2.15, Annex A.

This document has been submitted for reference in:

- the RID [12]; and
- the technical annexes of the ADR [11].

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

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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

This document 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 document that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Protection of the environment is a key political issue in Europe and elsewhere, for CEN/TC 286 this is covered in CEN/TS 16765 [5] and this Technical Specification should be read in conjunction with this document. This Technical Specification provides guidance on the environmental aspects to be considered regarding equipment and accessories produced for the LPG industry and the following is addressed:

- a) design;
- b) manufacture;
- c) packaging;
- d) use and operation; and
- e) disposal.

All pressures are gauge pressure unless otherwise stated.

NOTE This document requires measurement of material properties, dimensions and pressures. All such measurements are subject to a degree of uncertainty due to tolerances in measuring equipment, etc. It may be beneficial to refer to the leaflet "Measurement uncertainty leaflet SP INFO 2000 27" [13].

SIST EN 14427:2022

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EN 14427:2022 (E)**1 Scope**

This document:

- 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 at least 30 bar;
- is only applicable to cylinders which are fitted with a pressure relief valve (see 4.1.3);
- 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);
- is also applicable to composite cylinders without liners.

Cylinders manufactured to this document are suitable for temperatures down to $-40\text{ }^{\circ}\text{C}$.

This document does not address the design, fitting and performance of removable protective sleeves. Where these are fitted, the choice of material and sleeve performance are expected to be considered separately.

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 1442, *LPG equipment and accessories - Transportable refillable welded steel cylinders for LPG - Design and construction*

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 12165, *Copper and copper alloys - Wrought and unwrought forging stock*

EN 12807, *LPG equipment and accessories - Transportable refillable brazed steel cylinders for liquefied petroleum gas (LPG) - Design and construction*

EN 13110, *LPG equipment and accessories - Transportable refillable welded aluminium cylinders for liquefied petroleum gas (LPG) - Design and construction*

EN 14140, *LPG equipment and accessories - Transportable refillable welded steel cylinders for LPG - Alternative design and construction*

EN 14717, *Welding and allied processes - Environmental check list*

EN 14894, *LPG equipment and accessories - Cylinder and drum marking*

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 1133-2, *Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics - Part 2: Method for materials sensitive to time-temperature history and/or moisture (ISO 1133-2)*
- EN ISO 1183-1, *Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pycnometer method and titration method (ISO 1183-1)*
- EN ISO 1183-2, *Plastics - Methods for determining the density of non-cellular plastics - Part 2: Density gradient column method (ISO 1183-2)*
- EN ISO 1183-3, *Plastics - Methods for determining the density of non-cellular plastics - Part 3: Gas pycnometer method (ISO 1183-3)*
- EN ISO 2555, *Plastics - Resins in the liquid state or as emulsions or dispersions - Determination of apparent viscosity using a single cylinder type rotational viscometer method (ISO 2555)*
- 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)*
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- EN ISO 7866, *Gas cylinders - Refillable seamless aluminium alloy gas cylinders - Design, construction and testing (ISO 7866)*
- EN ISO 9227:2017, *Corrosion tests in artificial atmospheres - Salt spray tests (ISO 9227:2017)*
- 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)*
- EN ISO 9809-3, *Gas cylinders - Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 3: Normalized steel cylinders and tubes (ISO 9809-3)*
- EN ISO 14245, *Gas cylinders - Specifications and testing of LPG cylinder valves - Self-closing (ISO 14245)*
- EN ISO 15995, *Gas cylinders - Specifications and testing of LPG cylinder valves - Manually operated (ISO 15995)*
- EN ISO 15512, *Plastics - Determination of water content (ISO 15512)*

EN 14427:2022 (E)

EN ISO 16474-3:2021, *Paints and varnishes - Methods of exposure to laboratory light sources - Part 3: Fluorescent UV lamps (ISO 16474-3:2021)*

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

ISO 8521, *Glass-reinforced thermosetting plastic (GRP) pipes — Test methods for the determination of the initial circumferential tensile wall strength*

ISO 11357-3, *Plastics — Differential scanning calorimetry (DSC) — Part 3: Determination of temperature and enthalpy of melting and crystallization*

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

ASTM D 2290A, *Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe*

ASTM D 2291, *Standard practice for fabrication of ring test specimens for glass-resin composites*

ASTM D 2343, *Standard test method for tensile properties of glass fibre strands, yarns and rovings used in reinforced plastics*

ASTM D 2344, *Standard test method for short-beam strength of polymer matrix composite materials and their laminates*

ASTM D 3418, *Standard test method for transition temperatures and enthalpies of fusion and crystallization of polymers by differential scanning calorimetry*

ASTM D 4018, *Standard test methods for tensile properties of continuous filament carbon and graphite fibre tows*

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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:

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

— IEC Electropedia: available at <https://www.electropedia.org/>

3.1**liquefied petroleum gas****LPG**

low pressure liquefied gas composed of one or more light hydrocarbons which are assigned to UN 1011, UN 1075, UN 1965, UN 1969 or UN 1978 only and which consists mainly of propane, propene, butane, butane isomers, butene with traces of other hydrocarbon gases

3.2**ambient test temperature**

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

3.3

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

3.4

batch

<fibres> quantity of fibres, pre-impregnated fibres or components of the matrix system homogeneous quantity of material, identified and certified as such by the supplier

3.5

batch

<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

3.6

batch

<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

3.7

batch

<finished cylinders with liners> quantity of finished cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design

Note 1 to entry: 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.¹²²

3.8

batch

<finished cylinders with no liners> quantity of finished cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design

3.9

burst pressure

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

3.10

composite overwrap

fibres, or fibres embedded in a matrix taken together as a combined unit

3.11

elastomeric material

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

3.12

exterior coating

layer of clear or pigmented material applied to the cylinder as protection

EN 14427:2022 (E)**3.13****fibre strand**

load-carrying part of the composite overwrap

EXAMPLE glass, aramid or carbon

3.14**fully wrapped composite cylinder**

cylinder reinforced by wrapping to take both circumferential and longitudinal stress

Note 1 to entry: These are referred within this document as types 3, 4 and 5 (refer to 3.23, 3.24 and 3.25).

3.15**liner**

metallic or non-metallic vessel that retains the LPG in the cylinder, but may also contribute to the mechanical behaviour of the cylinder

Note 1 to entry: This is a load sharing liner.

3.16**neck ring**

collar or ring with or without external threads, securely attached to the cylinder neck by means other than welding, brazing or soldering

3.17**non-load sharing liner**

liner made of material(s) with a stiffness (e-modulus) that is less than 1/10 of the fibre stiffness and is intended only to prevent diffusion of LPG

3.18**non-metallic liner**

liner made from thermoplastic, thermosetting, or elastomer material or a combination thereof

3.19**matrix**

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

3.20**thermoplastic**

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

3.21**thermoset**

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

3.22**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

3.23

permanent protective attachment

integral part of the cylinder design affixed to composite cylinders (type 2 to 5) covering part of or the entire surface of the cylinder, providing functions during handling, transport, and use

3.24

Type 3 cylinder

fully wrapped cylinder with a load-sharing metal liner and composite reinforcement on both cylindrical and dome ends

3.25

Type 4 cylinder

fully wrapped cylinder with a non-load sharing liner and composite reinforcement on both cylindrical and dome ends

3.26

Type 5 cylinder

fully wrapped cylinder without a liner and with composite reinforcement on both the cylindrical portion and the dome ends

3.27

major interruption

where a process is halted for more than 6 hours, due to an unscheduled event

EXAMPLE break down of production equipment needing replacement

4 Design and manufacture

4.1 General

SIST EN 14427:2022

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4.1.1 Fully wrapped composite LPG cylinders may be manufactured with a metallic or non-metallic liner or without a liner. The composite overwrap shall not be manufactured from two or more parts joined together regardless of the joining methods (e.g. using 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 permanent protective attachments. 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.

The design of the cylinder shall take the following into account:

- minimizing the use of materials;
- the fittings required for the cylinder;
- minimizing the environmental impact of in service maintenance and end of life disposal;
- efficient transport of finished product.

For the welding associated with metallic liners, the environmental impact of welding and allied processes shall be assessed in accordance with EN 14717.

EN 14427:2022 (E)

The manufacturer should endeavour to minimize wastage of material by selecting appropriately sized materials related to the finished parts required for manufacture. Unavoidable waste/scrap material should be recycled where possible.

Noise levels and harmful emissions from the production process should be evaluated and measures put into place to minimize the impact upon the external environment.

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; and
- 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 their limited volumetric expansion, cylinders designed to this document are intended to be used only when fitted with a pressure relief valve, see EN 13953 [3].

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 ISO 9809-1, EN ISO 9809-2 or EN ISO 9809-3, as appropriate; |
| b) seamless stainless steel liners: | EN 1964-3; |
| c) seamless aluminium alloy liners: | EN ISO 7866; |
| d) welded steel liners: | EN 1442 or EN 14140; |
| e) brazed steel liners: | EN 12807; |
| f) welded aluminium liners: | EN 13110; |
| g) Brass boss inserts | EN 12165 or equivalent (composition). |

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 document for the design of the composite cylinder.

4.2.2 Non-metallic liners

4.2.2.1 A non-metallic liner shall be designed as non-load sharing. The liner material shall be compatible with LPG. Guidance to material compatibility is given in EN ISO 11114-2 [6].

4.2.2.2 Where a metal end boss or end boss insert 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 4.2.1.1.

4.2.3 Design drawing

4.2.3.1 A fully dimensioned drawing of the liner shall be produced which shall include the specification of the material and material properties.

4.2.3.2 The following properties shall be specified for metallic liners:

- minimum yield stress;
- minimum tensile strength;
- minimum elongation; and
- minimum burst pressure.

4.2.3.3 The following properties shall be specified for non-metallic liners:

- density;
- for thermoplastics, the melting point, as determined by EN ISO 3146 or ISO 11357-3;
- for thermoset materials, the temperature of deflection under load, as determined by EN ISO 75-1 and EN ISO 75-3;
- for thermoset materials, the glass transition temperature as determined by differential scanning calorimetry;
- composition;
- compatibility with LPG, guidance is provided in EN ISO 11114-2 [6]; and
- end boss material specification.

The end boss material specifications includes:

- minimum tensile strength at yield;
- minimum elongation of the boss material at yield.

4.3 Composite overwrap

4.3.1 Materials

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

If glass fibre is used as the structural reinforcement of the cylinder, then only boron free glass fibre shall be used.