SLOVENSKI STANDARD
SIST EN 1964-3:2002

01-maj-2002

Premiļ ne plinske jeklenke - Specifikacije za zasnovo in izdelavo ponovno polnljivih jeklenk iz celega iz jekla z vodno prostornino med 0,5 in vkljuļ no 150 litri - 3. del: Jeklenke iz celega iz nerjavnega jekla z Rm manj kot 1100 MPa

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

Ortsbewegliche Gasflaschen - Gestaltung und Konstruktion von nahtlosen wiederbefüllbaren ortsbeweglichen Gasflaschen aus Stahl mit einem Fassungsraum von 0,5 Liter bis einschließlich 150 Liter - Teil 3: Nahtlose Flaschen aus nichtrostendem Stahl mit einem Rm-Wert von weniger als 1100 MPa

Bouteilles a gaz transportables - Spécifications pour la conception et la fabrication de bouteilles a gaz rechargeables et transportables en acier sans soudure, d'une capacité en eau comprise entre 0,5 litre et 150 litres inclus - Partie 3: Bouteilles en acier inoxydable sans soudure ayant une valeur Rm inférieure a 1100 MPa

Ta slovenski standard je istoveten z: EN 1964-3:2000

ICS:

23.020.30	Tlaļ ne posode, plinske jeklenke	Pressure vessels, gas cylinders

SIST EN 1964-3:2002 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1964-3

February 2000

ICS 23.020.30

English version

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 R_m value of less than 1100 MPa

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Ortsbewegliche Gasflaschen – Gestaltung und Konstruktion von nahtlosen wiederbefüllbaren ortsbeweglichen Gasflaschen aus Stahl mit einem Fassungsraum von 0,5 Liter bis einschließlich 150 Liter – Teil 3: Nahtlose Flaschen aus nicht rostendem Stahl mit einem R_m-Wert von weniger als 1100 MPa

This European Standard was approved by CEN on 1999-12-11.

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

The European Standards exist 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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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 1964-3 : 2000 E

Contents

Foreword

This European Standard 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 2000, and conflicting national standards shall be withdrawn at the latest by August 2000.

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, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

This European Standard has been submitted for reference into the RID and/or in 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 in the technical annexes of the ADR.

This standard supports the objectives of EU directives 94/55 and 96/49.

This standard is one of a series of three standards concerning refillable seamless steel gas cylinders of water capacities from 0,5 l up to and including 150 l for compressed, liquefied and dissolved gases:

- Part 1: Cylinders made of seamless steel with an R_m value of less than 1100 MPa
- Part 2: Cylinders made of seamless steel with an R_m value of 1100 MPa and above
- Part 3: Cylinders made of seamless stainless steel with an R_m value of less than 1100 MPa

Introduction

The purpose of this standard is to provide a specification for the design, manufacture, inspection and approval of refillable, transportable seamless steel gas cylinders made of materials belonging to the group generally known as stainless steels.

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

The standard specifies minimum requirements for the material, design, construction and workmanship, manufacturing processes and tests at manufacture of refillable transportable seamless steel gas cylinders of water capacities from 0,5 l up to and including 150 l for compressed, liquefied and dissolved gases. This standard is applicable to cylinders manufactured from stainless steel with an R_m value of less than 1100 MPa.

NOTE This standard is also suitable for the manufacture of cylinders of water capacity less than 0,5 l.

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.

EN 473	Qualification and certification of NDT personnel - General principles
EN 1089-1:1996	Transportable gas cylinders - Gas cylinder identification (excluding LPG) - Part 1: Stampmarking
EN 10002-1	Metallic materials - Tensile testing - Part 1: Method of test
EN 10003-1	Metallic materials - Brinell hardness test - Part 1: Test method
EN 10028-1	Flat products made of steels for pressure purposes - Part 1: General requirements
EN 10045-1	Metallic materials - Charpy impact test - Part 1: Test method
EN 10052	Vocabulary of heat treatment terms for ferrous products
EN 10088-1	Stainless steels - Part 1: List of stainless steels
EN 10088-2	Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip for general purposes
EN ISO 3651-2	Determination of resistance to intergranular corrosion of stainless steels - Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels - Corrosion test in media containing sulfuric acid (ISO 3651-2:1998)

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

EURONORM 6-55 Bend test for steel

3 Definitions and symbols

For the purposes of this Standard the following definitions and symbols apply:

3.1 Definitions

3.1.1
yield stress
value corresponding to the 0,2 % proof stress, or, for austenitic steels in the solution annealed condition, 1% proof stress.

3.1.2
quenching
hardening heat treatment in which a cylinder, which has been heated to a uniform temperature above the upper critical point (Ac_3, as defined in EN 10052) of the steel, is cooled rapidly in a suitable medium.

3.1.3
tempering
softening heat treatment which follows quenching, in which the cylinder is heated to a uniform temperature below the lower critical point (Ac_1, as defined in EN 10052) of the steel.

3.1.4
solution annealing
softening heat treatment for austenitic steels in which a cylinder is heated to a uniform temperature above the upper critical point (Ac_3, as defined in EN 10052) of the steel followed by rapid cooling.

3.1.5
cryoforming
a process where the cylinder is subjected to a controlled low temperature deformation treatment that results in a permanent increase in strength.

3.1.6
batch
a quantity of up to 200 cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design made from the same steel cast and subjected to the same heat treatment for the same duration of time.

3.1.7
burst pressure
highest pressure reached in a cylinder during a burst test.

3.1.8
design stress factor (F) (variable)
the ratio of equivalent wall stress at test pressure (p_h) to guaranteed minimum yield stress (R_e).

3.2 Symbols

a Calculated minimum thickness, in millimetres, of the cylindrical shell.

a' Guaranteed minimum thickness, in millimetres, of the cylindrical shell (see figure 1).

a_1 Required minimum thickness, in millimetres, of a concave base at the knuckle (see figure 2).

a_2 Required minimum thickness, in millimetres, at the centre of a concave base (see figure 2).

A Percentage elongation.

b Required minimum thickness, in millimetres, at the centre of a convex base (see figure 1).

d_1 Dimension, in millimetres, of acceptable burst profile for quenched and tempered cylinders (see figure 8).

d_2 Dimension, in millimetres, of acceptable burst profile for cryoformed or solution annealed cylinders less than 7,5 mm wall thickness (see figure 9)

D Outside diameter of the cylinder, in millimetres (see figure 1).

D_f Diameter of former, in millimetres (see figure 5)

F Design stress factor (variable) see 3.1.9

h Outside height (concave base end), in millimetres (see figure 2)

H Outside height of domed part (convex head or base end), in millimetres (see figure 1)

L Overall length of cylinder, in millimetres.

L_o Original gauge length, in millimetres, according to EN 10002-1 (see figure 4)

n Ratio of diameter of bend test former to actual thickness of test piece (t).

p_b Measured burst pressure, in bar[1], above atmospheric pressure.

p_h Hydraulic test pressure, in bar[1], above atmospheric pressure.

p_{lc} Lower cyclic pressure, in bar[1], above atmospheric pressure.

p_w Working pressure, in bar[1], above atmospheric pressure.

p_y Observed yield pressure, in bar[1], above atmospheric pressure.

r Inside knuckle radius, in millimetres (see figure 1).

R_e Minimum guaranteed value of yield stress (see 3.1.1), in megapascals.

R_{ea} Value of the actual yield stress in megapascals determined by the tensile test (see 7.1.2.1).

R_g Minimum guaranteed value of tensile strength, in megapascals.

R_m Actual value of tensile strength, in megapascals, determined by the tensile test (see 7.1.2.1).

S_o Original cross-sectional area of tensile test piece, in square millimetres, according to EN 10002-1.

t Actual thickness of the test specimen in millimetres.

u Ratio of distance between platens in flattening test to actual thickness of test piece.

V Water capacity of cylinder, in litres.

w Width, in millimetres, of tensile test piece (see figure 4).

4 Materials

4.1 General provisions

4.1.1 Materials for the manufacture of gas cylinders shall fall within one of the following categories:

a) Internationally recognised cylinder steels.

b) Nationally recognised cylinder steels.

c) New cylinder steels resulting from technical progress.

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[1] 1 bar = 10^5 Pa = 0,1 MPa

For all categories the requirements of 4.2 shall be satisfied. For all categories, the relevant conditions specified in 4.3 or 4.4 shall be fulfilled.

4.1.2 There is a risk of sensitisation to intergranular corrosion resulting from the hot processing of austenitic and duplex stainless steels. Intergranular corrosion testing shall be carried out for such materials in accordance with 7.1.2.5.

4.1.3 The cylinder manufacturer shall identify the cylinders with the cast of steel from which they are made.

4.1.4 Grades of steel used for cylinder manufacture shall be compatible with the intended gas service, e.g. corrosive gases, embrittling gases. (See EN ISO 11114-1:1997).

Some grades of stainless steel may be susceptible to environmental stress corrosion cracking. Special precautions shall be taken in such cases.

4.1.5 Some grades of stainless steel may be susceptible to phase transformation at low temperatures resulting in a brittle alloy. Special precautions shall be taken in such cases.

4.2 Controls on chemical composition

4.2.1 The following are the four broad categories of stainless steels:

Category

Ferritic
Martensitic
Austenitic
Austenitic/Ferritic (Duplex)

Recognised steels are listed in EN 10088-1. Other grades of stainless steel may also be used.

4.2.2 The cylinder manufacturer shall obtain and provide certificates of cast analyses of the steels supplied for the manufacture of gas cylinders.

Should check analyses be required, they shall be carried out either on specimens taken during manufacture from material in the form as supplied by the steelmaker to the cylinder manufacturer, or from finished cylinders avoiding decarburized zones, on those stainless steel grades where applicable, from the cylinder surface. In any check analysis, the maximum permissible deviation from the limits specified for cast analyses shall conform to the values specified in EN 10028-1.

NOTE EN 10028-1 is a general standard which cross references the actual permissible deviations given in the other parts of EN 10028.

4.3 Heat treatment

4.3.1 The cylinder manufacturer shall provide a certificate stating the heat treatment process applied to the finished cylinders.

4.3.2 Ferritic and martensitic steel categories shall be quenched and tempered. Austenitic and duplex (austenitic/ferritic) steel categories shall be solution annealed.

4.3.3 The actual temperature to which a type of steel is subjected for a given tensile strength shall not deviate by more than 30 °C from the temperature specified by the cylinder manufacturer.

4.4 Cold working or cryoforming

Cold working or cryoforming is used to enhance finished mechanical properties in certain stainless steel materials.

For cylinders that are subjected to cold working or to the cryoforming process, all heat treatment requirements refer to the cylinder preform operations. Cold worked or cryoformed cylinders shall not be subjected to any subsequent heat treatment.

4.5 Test requirements

The material of the finished cylinders shall satisfy the requirements of clause 7.

5 Design

5.1 General provisions

5.1.1 The calculation of the wall thickness of the pressure-containing parts shall be related to the yield stress (R_e) of the material.

5.1.2 The internal pressure upon which the calculation of wall thickness is based shall be the hydraulic test pressure (p_h).

5.2 Calculation of cylindrical shell thickness

The guaranteed minimum wall thickness of the cylindrical shell (a') shall not be less than the thickness calculated using the equation:

$$a = \frac{D}{2}\left(1 - \sqrt{\frac{10 \cdot F \cdot R_e - \sqrt{3} \cdot p_h}{10 \cdot F \cdot R_e}}\right)$$

Where the value of F is the lesser of $\dfrac{0{,}65}{(R_e / R_g)}$ or 0,77

R_e/R_g shall be limited to 0,90.

The calculated minimum wall thickness shall also satisfy the equation:

$$a \geq \frac{D}{250} + 1 \text{ mm}$$

with an absolute minimum of $a = 1,5$ mm.

When choosing the minimum guaranteed value of the thickness of the cylindrical shell (a'), the manufacturer shall take into account all requirements for prototype and production testing, particularly the burst and yield pressure test requirements of 7.2.2.2.

The guaranteed minimum wall thickness (a') shall be equal to or greater than the calculated wall thickness (a).

5.3 Calculation of convex ends (heads and base ends)

5.3.1 The shapes shown in figure 1 are typical for convex heads and base ends. Shapes A and B are base ends formed from tubing, shapes D and E are base ends formed during the piercing of a billet, and shapes C and F are heads.

5.3.2 The thickness (b) at the centre of the convex end shall be not less than that required by the following criteria:

Where the inside knuckle radius (r) is not less than 0,075 D, then

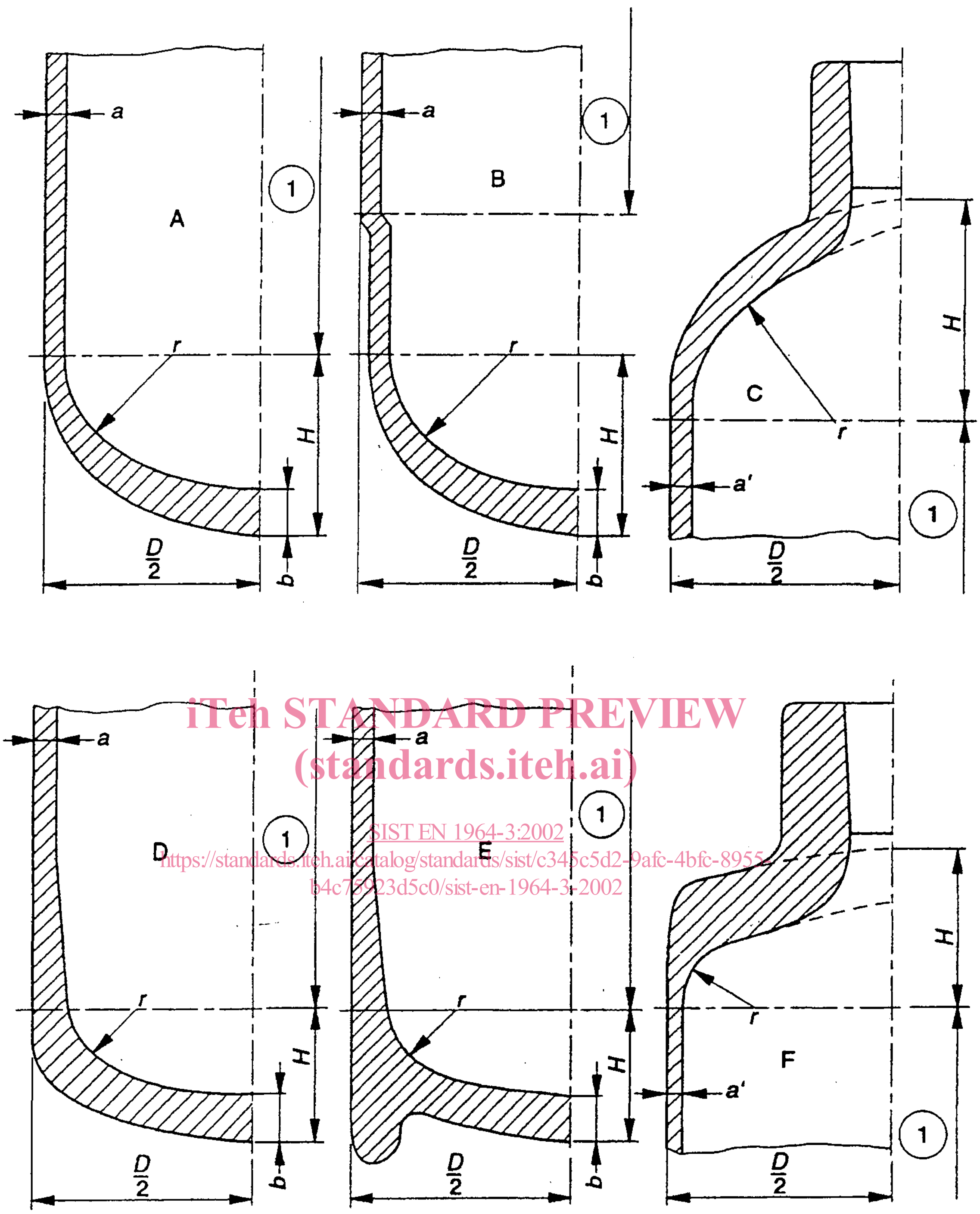
$b \geq 1,5a$ for $0,40 > H/D \geq 0,20$

$b \geq a$ for $H/D \geq 0,40$

In order to obtain a satisfactory stress distribution in the region where the end joins the cylindrical part, any thickening of the end that may be required shall be gradual from the point of juncture. For the application of this rule, the point of juncture between the cylindrical part and the end is defined by the horizontal line indicating dimension H in figure 1.

Shape B shall not be excluded from this requirement.

The cylinder manufacturer shall prove by the pressure cycling prototype test as required in A.1 that the design is satisfactory.



Key
1 Cylindrical part

Figure 1 - Typical convex ends

5.4 Calculation of concave base ends

When concave base ends are used, the dimensions defined in figure 2 shall be not less than the following calculated values:

$a_1 = 2a$; $a_2 = 2a$; $h = 0{,}12D$; $r = 0{,}075D$

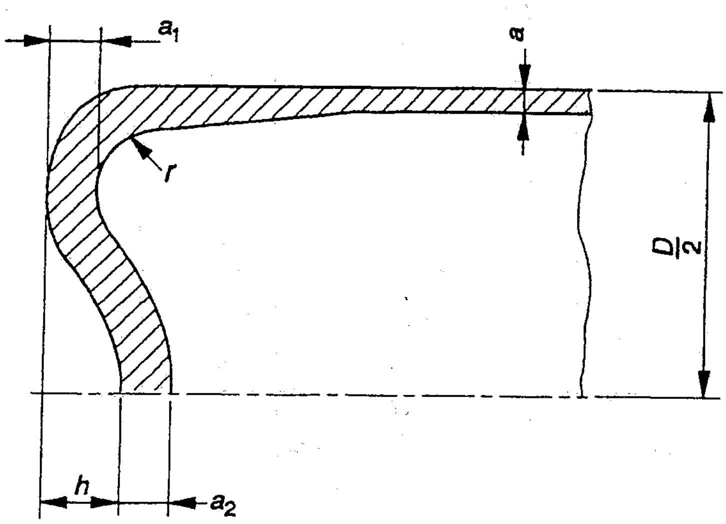


Figure 2 - Concave base ends

In order to obtain a satisfactory stress distribution, the thickness of the cylinder shall increase progressively in the transition area region between the cylindrical part and the base, and the wall shall be free from defects.

The cylinder manufacturer shall prove by the pressure cycling prototype test as required in A.1 that the design is satisfactory.

5.5 Neck design

5.5.1 The external diameter and thickness of the formed neck end of the cylinder shall be adequate for the torque applied in fitting the valve to the cylinder. The torque may vary according to the diameter of thread, the form of thread, and the sealant used in the fitting of the valve.

NOTE For recommended valving torques see EN ISO 13341.

5.5.2 The thickness of the wall in the cylinder neck shall be sufficient to prevent permanent expansion of the neck during initial and subsequent fitting of the valve into the cylinder.Where the cylinder is specifically designed to be fitted with neck reinforcement, such as a neck ring or shrunk-on collar, this may be taken into account (see EN ISO 13341).

5.6 Foot-rings

As agreed between the parties, a foot-ring, if provided, shall be sufficiently strong and made of material compatible with that of the cylinder. In addition, the shape should preferably be cylindrical and shall give the cylinder sufficient stability. The foot-ring shall be secured to the cylinder by a method other than welding, brazing or soldering. Any gaps which may form water traps shall be sealed to prevent ingress of water, by a method other than welding, brazing or soldering.

5.7 Neck-rings

As agreed between the parties, a neck ring, if provided, shall be sufficiently strong and made of material compatible with that of the cylinder, and shall be securely attached by a method other than welding, brazing or soldering.

The manufacturer shall ensure that the axial load to remove the neck-ring is greater than 10 times the weight of the empty cylinder and not less than 1000 N, also that the minimum torque required to turn the neck-ring is greater than 100 N·m.

5.8 Design drawing

A fully dimensioned drawing shall be prepared which includes the specification of the material, and details of the permanent fittings.