SLOVENSKI STANDARD
SIST EN 13293:2003

01-december-2003

Premične plinske jeklenke - Specifikacija za konstruiranje in izdelavo ponovno polnljivih jeklenk iz celega iz normaliziranega jekla z vodno prostornino do 0,5 litra za stisnjene, utekočinjene in pod tlakom raztopljene pline ter do 1 litra za ogljikov dioksid

Transportable gas cylinders - Specification for the design and construction of refillable transportable seamless normalized carbon manganese steel gas cylinders of water capacity up to 0,5 litre for compressed, liquefied and dissolved gases and up to 1 litre for carbon dioxide

Ortsbewegliche Gasflaschen - Konstruktion und Aufbau von wiederbefüllbaren ortsbeweglichen Gasflaschen aus nahtlosem normalgeglühtem Kohlenstoff-Mangan-Stahl mit einem Fassungsraum bis 0,5 Liter für verdichtete, verflüssigte und unter Druck gelöste Gase und bis 1 Liter für Kohlendioxid

Bouteilles a gaz transportables - Spécifications pour la conception et la fabrication de bouteilles a gaz rechargeables et transportables sans soudure en acier au carbone manganese normalisé, de capacité de l'eau jusqu'a 0,5 litre pour gaz comprimés, liquéfiés et dissous et jusqu'a 1 litre pour le dioxyde de carbone

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English version

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This European Standard was approved by CEN on 12 August 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document EN 13293:2002 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 April 2003, and conflicting national standards shall be withdrawn at the latest by April 2003.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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.

For relationships with EC directives, RID and ADR see informative annex C, which is an integral part of this document.

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 and testing of refillable, transportable seamless steel gas 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 material design, construction and workmanship, manufacturing processes and tests at manufacture of refillable seamless normalized gas cylinders made from carbon manganese steel of water capacities up to and including 0,5 litre for compressed, liquefiable and dissolved gases and up to 1 litre for carbon dioxide.

This standard is applicable to cylinders manufactured from normalized carbon manganese steel with an R_m value of less than 850 MPa.

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 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 at ambient temperature.*

EN 10028-1, *Flat products made of steels for pressure purposes - Part 1: General requirements.*

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).*

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

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
yield stress
value corresponding to the lower yield stress R_{eL} or, for steels that do not exhibit defined yield, the 0,2 % proof stress $R_{p0,2}$

3.1.2
normalizing
heat treatment 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 and then cooled in still air

3.1.3
batch
quantity of cylinders plus cylinders for destructive testing, defined in Table 3, of the same nominal diameter, thickness and design made from the same cast of steel and subjected to the same heat treatment for the same duration of time. The length of the cylinder in a heat treatment batch may vary by up to 20 %

3.1.4
burst pressure
highest pressure reached in a cylinder during a burst test

3.1.5
design stress factor (*F*)
variable ratio of equivalent wall stress at test pressure (p_h) to guaranteed minimum yield stress (R_e)

3.1.6
controlled hot forming
cylinder end-forming operation carried out on normalized steel, above the austenitization temperature AC_3, followed by cooling in still air, to produce a metallurgical condition equivalent to normalizing

3.2 Symbols

a Calculated minimum thickness, in millimetres, of the cylindrical shell (see Figure 2)

a' Guaranteed minimum thickness, in millimetres, of the cylindrical shell

a_1 Guaranteed minimum thickness, in millimetres, of a concave base at the knuckle (see Figure 2)

a_2 Guaranteed minimum thickness, in millimetres, of a concave base (see Figure 2)

A Percentage elongation

b Guaranteed minimum thickness, in millimetres, at the centre of a convex base (see Figure 1)

c Dimension, in millimetres, of acceptable burst profile (see Figure 4)

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

F Design stress factor, see 3.1.5

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_o Original gauge length, in millimetres, according to EN 10002-1 (see Figure 5)

p_b Actual 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 (see 7.3.2)

p_y Observed pressure when cylinder starts yielding during hydraulic bursting test, in bar[1)], above atmospheric pressure

r Inside knuckle radius, in millimetres (see Figures 1 and 2)

R_e Minimum guaranteed value of yield stress in megapascals

R_{ea} Value of the actual yield stress in megapascals determined by the tensile test (see 8.4.3)

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 8.4.3)

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

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

t Actual thickness of the test specimen in millimetres (see Figure 5)

w Width, in millimetres, of tensile test piece (see Figure 5)

4 Materials and heat treatment

4.1 General provisions

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

— internationally recognized cylinder steels;

— nationally recognized cylinder steels.

For all categories the requirements of 4.2 shall be satisfied.

For all categories the relevant conditions specified in 5.3 shall be fulfilled.

4.1.2 The materials used for the fabrication of gas cylinders shall be killed steels.

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

4.1.4 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).

4.2 Chemical composition

4.2.1 The chemical composition of all steels shall be defined at least by:

— maximum sulphur and phosphorus content;

— carbon, manganese and silicon content;

— chromium content where this element is intentionally added.

Carbon, manganese, silicon and chromium contents shall be given with tolerances such that the differences between the maximum and minimum values (maximum range) in the specified analysis do not exceed the values in Table 1.

Table 1 — Chemical composition tolerances

Element	Nominal content	Maximum permissible range
Carbon	< 0,30 %	0,06 %
	≥ 0,30 %	0,07 %
Manganese	All values	0,30 %
Silicon	All values	0,30 %
Chromium	< 0,25	

NOTE The maximum permissible range for each element is not required to be centred on its nominal content. As an example, for a steel with nominal carbon content of 0,10 %, the following three maximum permissible ranges are equally acceptable:

+ 0,00 %, -0,06 %

+ 0,06 %, -0,0 %

+ 0,03 %, -0,03 %

4.2.2 The following limits on sulphur and phosphorus shall not be exceeded in the cast analysis of material used for the fabrication of gas cylinders as shown in Table 2.

Table 2 — Sulphur and phosphorus limits

Element	Content
Sulphur	0,020 %
Phosphorus	0,020 %
Sulphur + phosphorus	0,030 %

4.2.3 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 steel maker to the cylinder manufacturer, or from finished cylinders avoiding decarburized zones 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-refers the actual tables of permissible deviations given in the other parts of EN 10028.

4.3 Heat treatment

The cylinder manufacturer shall ensure that the normalizing process has been correctly applied to the finished cylinder. The normalizing process shall be consistent with achieving the required mechanical properties.

Cylinders made from normalized tube of low carbon manganese steels with carbon equivalent ≤ 0,3 % need not be heat treated after controlled hot forming provided that they were formed above AC_3 temperature, cooled in still air and the manufacturing route including controlled hot forming has been agreed during design approval.

Carbon equivalent shall be calculated from the formula:

$$\text{Carbon equivalent} = \text{C} + \frac{\text{Mn}}{6} + \frac{(\text{Cr} + \text{Mo} + \text{V})}{5} + \frac{(\text{Cu} + \text{Ni})}{15}$$

where all quantities are expressed as % by weight.

4.4 Test requirements

The material properties of the finished cylinders shall satisfy the requirements of clauses 7, 8 and 9.

4.5 Reheat treatment

4.5.1 Reheat treatment following a test failure is permitted only for those materials where finished properties are developed by heat treatment. A maximum of two reheat treatments is permitted.

4.5.2 Whenever cylinders are reheat treated, the minimum design wall thickness (a') shall be maintained.

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 For calculation purposes, the value of the yield stress (R_e) is limited to a maximum of 0,75 R_g.

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

5.1.4 The compatibility of cylinder materials with gas contents is given by EN ISO 11114-1:1997.

5.1.5 The steel used for the manufacture of the gas cylinders shall have an R_m value of less than 850 MPa.

5.2 Calculation of cylindrical wall thickness

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

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

where the value of $F \leq 0{,}77$.

R_e/R_g shall not exceed 0,75.

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 thickness of the cylindrical shell (a'), the manufacturer shall take into account all requirements for design and batch testing, particularly the burst and yield pressure test requirements of 7.3.

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 When convex base ends are used, the following minimum values are recommended:

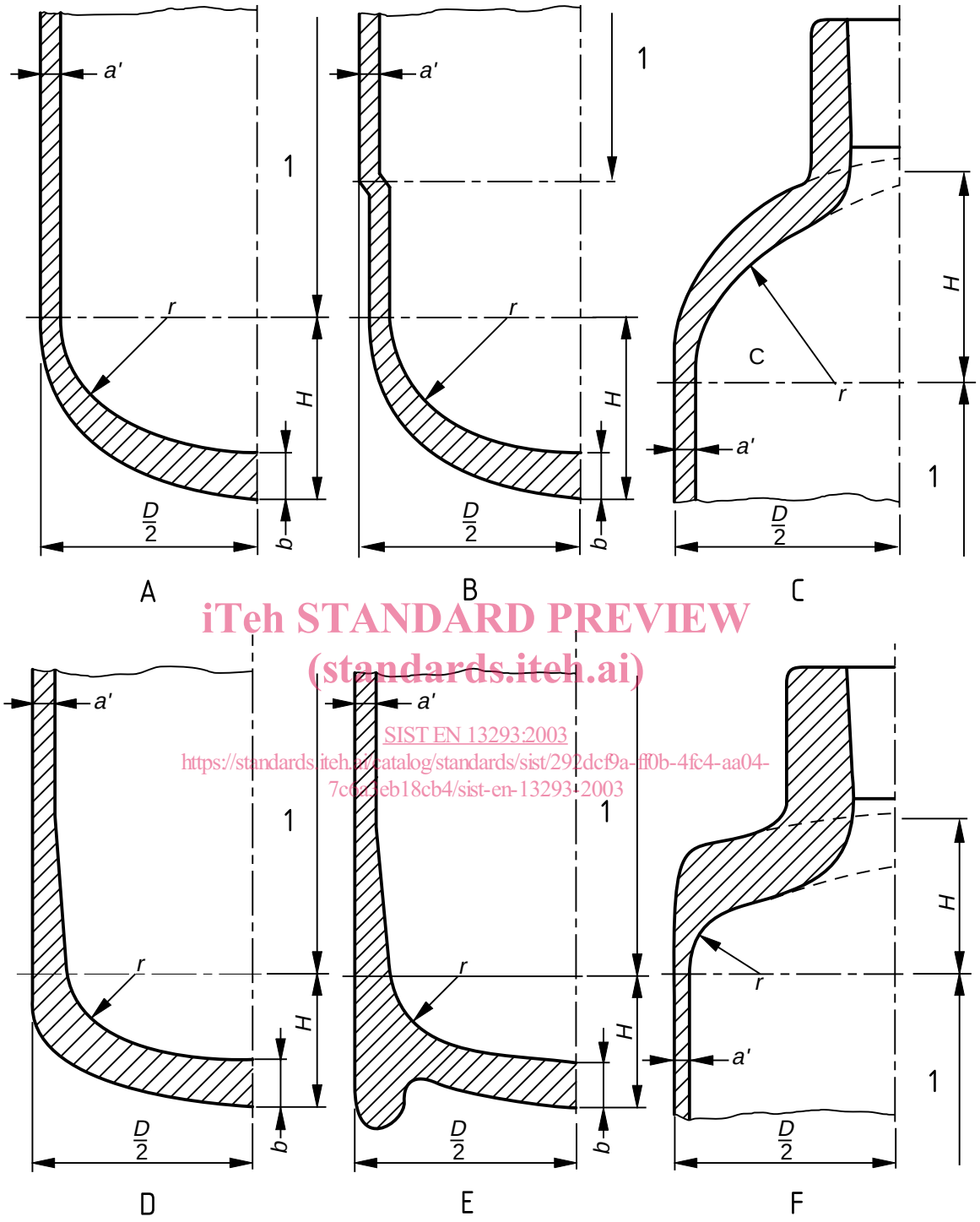
$r = 0{,}075 \cdot D$

$b = 1{,}5\ a$ for $> H/D \geq 0{,}20$

$b = a$ 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 shell and the end is defined by the horizontal line indicating dimension H in Figure 1.

test as required in clause 7 that the design is satisfactory.



Key

1 Cylindrical part

Figure 1 — Typical convex ends