



SLOVENSKI STANDARD

SIST EN 13445-6:2002

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Unfired pressure vessels - Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron

Unbefeuerte Druckbehälter - Teil 6: Anforderungen an die Konstruktion und Herstellung von Druckbehältern und Druckbehälterteilen aus Gusseisen mit Kugelgraphit

Réipients sous pression non soumis a la flamme - Partie 6: Exigences pour la conception et la fabrication des réipients sous pression et des parties sous pression moulés en fonte a graphite sphéroïdal

Ta slovenski standard je istoveten z: EN 13445-6:2002

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23.020.30 Pressure vessels, gas cylinders

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Unfired pressure vessels - Part 6: Requirements for the design
and fabrication of pressure vessels and pressure parts
constructed from spheroidal graphite cast iron

Réceptifs sous pression non soumis à la flamme - Partie
6: Exigences pour la conception et la fabrication des
réceptifs sous pression et des parties sous pression
moulés en fonte à graphite sphéroïdal

Unbefeuerte Druckbehälter - Teil 6: Anforderungen an die
Konstruktion und Herstellung von Druckbehältern und
Druckbehälterteilen aus Gusseisen mit Kugelgraphit

This European Standard was approved by CEN on 23 May 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.

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

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EN 13445-6:2002

Foreword

This document (EN 13445-6:2002) has been prepared by Technical Committee CEN/TC 54 "Unfired pressure vessels", 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 November 2002, and conflicting national standards shall be withdrawn at the latest by November 2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

In this standard the Annex A is normative and the Annexes B and C are informative.

This European Standard consists of the following Parts:

Part 1: General

Part 2: Materials

Part 3: Design

Part 4: Fabrication

Part 5: Testing and Inspection

Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron

CR 13445-7, *Unfired pressure vessels - Part 7: Guidance on the use of conformity assessment procedures*

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.

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1 Scope

This European Standard specifies requirements for the design, materials, manufacturing and testing of pressure vessels and pressure vessel parts intended for use with a maximum allowable pressure, *PS*, equal or less 50 bar and shell wall thicknesses not exceeding 60 mm, that are constructed of spheroidal graphite cast iron.

NOTE The grades of spheroidal graphite cast iron allowed are listed in Tables 5.1-1 and 5.1-2. Service conditions are given in clause 4.

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 764-2:2002, *Pressure equipment — Part 2: Quantities, symbols and units*

prEN 764-5:1999, *Pressure equipment — Part 5: Compliance and inspection documentation of materials*

EN 764-7:2002, *Pressure Equipment — Part 7: Safety systems for unfired pressure equipment*

EN 837-1:1996, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

EN 837-3:1996, *Pressure gauges — Part 3: Diaphragm and capsule pressure gauges — Dimensions, metrology, requirements and testing*

EN 1369:1996, *Founding — Magnetic particle inspection*

EN 1370:1996, *Founding — Surface roughness inspection by visual tactile comparators*

EN 1371-1:1997, *Founding — Liquid penetrant inspection — Part 1: Sand, gravity die and low pressure die castings*

EN 1559-1:1997, *Founding — Technical conditions of delivery — Part 1: General*

EN 1559-3:1997, *Founding — Technical conditions of delivery — Part 3: Additional requirements for iron castings*

EN 1563:1997, *Founding — Spheroidal graphite cast irons*

EN 10204:1991, *Metallic products — Types of inspection documents*

EN 12680-3:2000, *Founding — Ultrasonic inspection — Part 3: Spheroidal graphite cast iron castings*

EN 12681:2000, *Founding — Radiographic inspection*

EN 13445-1:2002, *Unfired pressure vessels — Part 1 : General*

EN 13445-2:2002, *Unfired pressure vessels — Part 2 : Materials*

EN 13445-3:2002, *Unfired pressure vessels — Part 3 : Design*

EN 13445-5:2002, *Unfired pressure vessels — Part 5 : Inspection and testing*

EN ISO 945 :1994, *Cast iron — Designation of microstructure of graphite (ISO 945:1975)*

ISO 8062:1994 *Castings — System of dimensional tolerances and machining allowances*

3 Terms, definitions, units and symbols

3.1 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1.1

critical zone

highly stressed area where a fracture is expected to occur in a burst test

NOTE 1 It can be caused, for example, by any of the following:

- sudden change in cross section;
- sharp edges;
- sharp radii;
- peak stresses;
- bending stresses;
- stresses due to other than membrane stress;
- changes in curvature.

NOTE 2 A critical zone is analysed by any appropriate method, e.g. holographic, interferometric method, strain gauge methods, burst test, fatigue testing, FEM analysis, etc.

NOTE 3 Additionally, thermal gradients and thermal stresses due to different operating wall temperatures are to be considered in defining critical zones.

3.1.2

purchaser

individual or organisation that buys pressure equipment, including assemblies or parts, for its own use or on behalf of the user and/or operator

3.1.3

manufacturer

individual or organisation responsible for the design, fabrication, testing, inspection, installation of pressure equipment and assemblies where relevant

NOTE 1 The manufacturer may subcontract one or more of the above mentioned tasks under its responsibility.

NOTE 2 In EU member states the manufacturer is responsible for compliance with the Pressure Equipment Directive 97/23/EC. For those manufacturers outside of the EU their authorized representative inside the EU assumes this responsibility.

3.1.4

casting manufacturer

subcontractor that produces the castings used in the manufacture of pressure equipment.

3.1.5

testing factor

A reduction factor applied to the nominal design stress to take account of possible manufacturing deficiencies.

3.1.6

temperature factor

A reduction factor applied to the 0,2 % proof strength to take account of temperature influence.

3.1.7

wall thickness factor

a reduction factor applied to the nominal design stress to take account of reduced mechanical properties

3.2 Units

For the purposes of this European Standard, the units given in EN 764-2:2002 apply.

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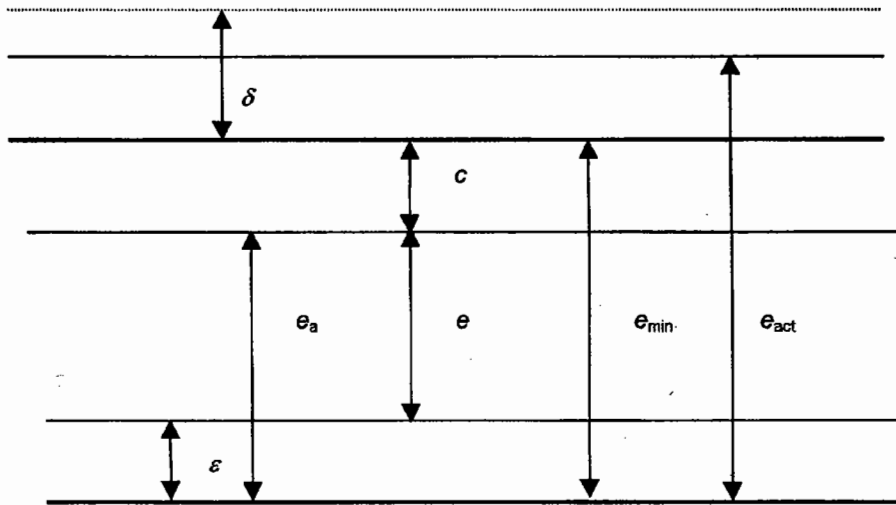
3.3 Symbols

Symbols used in this European Standard are listed in Table 3.3-1.

Table 3.3-1 - Symbols

Symbol	Quantity	Unit
c	corrosion allowance	mm
e	required thickness	mm
e_a	analysis thickness (without corrosion allowance)	mm
e_{min}	minimum thickness including corrosion allowance as specified on drawing	mm
f	nominal design stress	MPa or N/mm ²
P_d	design pressure	MPa, N/mm ²
PS, P_s	maximum allowable pressure	bar, MPa, N/mm ²
R_m	minimum tensile strength	N/mm ² , MPa
$R_{p0,2}$	minimum 0,2 % - proof strength	N/mm ² , MPa
V	internal volume	l
TS	Maximum / minimum allowable temperature	°C
C_e	wall thickness factor	dimensionless
C_t	temperature factor	dimensionless
C_Q	testing factor	dimensionless
e_{act}	actual thickness	mm
$P_{b,act}$	Actual burst test pressure	MPa, N/mm ²
n	factor depending on shape of shell	dimensionless
P_b	bursting test pressure	bar, MPa, N/mm ²
$R_{m(3)}$	average tensile strength of 3 test bars taken from the same cast	N/mm ² , MPa
ϵ	extra thickness due to casting process	mm
δ	casting tolerance	mm

3.4 Inter-relation of thicknesses definitions



Key

- e is the required thickness
- e_a is the analysis thickness
- e_{min} is the minimum thickness including corrosion allowance as indicated on drawings
- e_{act} is the actual thickness
- c is the corrosion allowance
- ϵ is the extra thickness due to casting process
- δ is the casting tolerance

Figure 3.4-1 - Inter-relation of thicknesses definitions

4 Service conditions iTech STANDARD PREVIEW (standards.iteh.ai)

4.1 Cyclic loading

Spheroidal graphite cast iron pressure vessels and vessel parts can be used for non-cyclic or cyclic operation. If the service conditions require more than 200 000 full pressure cycles or equivalent number of cycles with smaller amplitude, then a fatigue analysis shall be performed (see NOTE).

For pressure cycles at a pressure $\bullet P_1$ less than the full pressure, the number of equivalent full cycles n_{eq} is given by equation (4.1-1):

$$n_{eq} = n_i \left(\frac{\Delta P_i}{P_{max.}} \right)^{8,62} \quad (4.1-1)$$

NOTE An annex for fatigue assessment of pressure vessels and vessel parts made of spheroidal graphite cast iron is under preparation by CEN/TC 54 and will be released as an amendment to this standard.

4.2 Limitations on temperature and energy content

The minimum and maximum allowable temperature TS shall be in accordance with the limits given in Tables 5.1-1 and 5.1-2. The maximum allowable temperature TS shall not exceed 300 °C.

The product $PS \cdot V$ for a single casting shall not exceed 1 000 MPa·l (10 000 bar·l).

5 Requirements

5.1 Materials

All spheroidal graphite cast iron materials subject to internal or external pressure shall comply with EN 1563:1997. Only those grades listed in Table 5.1-1 shall be used for applications where the minimum allowable temperature is higher or equal to -10 °C and those in Table 5.1-2 shall be used for applications where the minimum allowable temperature is lower than -10 °C.

Material properties are specified in Annex A.

Design temperatures down to -60 °C can be used, provided that impact testing at the minimum allowable temperature is carried out and the results meets the requirements for EN-GJS-350-22-LT or EN-GJS-350-22U-LT given in Annex A.

The applicable requirements for the delivery conditions are given in EN 1559-1:1997 and EN 1559-3:1997 shall also apply.

NOTE The materials EN-JS 1020, EN-JS 1024, EN-JS 1025, EN-JS 1049, EN-JS 1059 and EN-JS 1062 may be produced in the as-cast or heat treated condition. For materials EN-JS 1010, EN-JS 1014, EN-JS 1015, EN-JS 1019, EN-JS 1029 and EN-JS 1032 a ferritizing heat treatment shall be applied.

Table 5.1-1 — Allowable material grades for normal design temperature

Symbol	Number	Design temperature limits °C
EN-GJS-350-22	EN-JS 1010	$-10 \leq TS \leq 300$
EN-GJS-350-22-RT	EN-JS 1014	$-10 \leq TS \leq 300$
EN-GJS-350-22 U ^a	EN-JS 1032	$-10 \leq TS \leq 300$
EN-GJS-350-22U-RT ^a	EN-JS 1029	$-10 \leq TS \leq 300$
EN-GJS-400-18	EN-JS 1020	$-10 \leq TS \leq 300$
EN-GJS-400-18-RT	EN-JS 1024	$-10 \leq TS \leq 300$
EN-GJS-400-18U ^a	EN-JS 1062	$-10 \leq TS \leq 300$
EN-GJS-400-18U-RT ^a	EN-JS 1059	$-10 \leq TS \leq 300$

^a Mechanical properties verified on test pieces from cast - on samples. These grades should be chosen in preference to the material grades with the separately cast samples when the unit mass of the casting is equal to or greater than 2 000 kg or when the relevant wall thickness varies between 30 mm and 200 mm.

Table 5.1-2 — Allowable material grades for low temperature (LT) design conditions

Symbol	Number	Design temperature limits °C
EN-GJS-350-22-LT	EN-JS 1015	$-40 \leq TS \leq 300$
EN-GJS-350-22U-LT ^a	EN-JS 1019	$-40 \leq TS \leq 300$
EN-GJS-400-18-LT	EN-JS 1025	$-20 \leq TS \leq 300$
EN-GJS-400-18U-LT ^a	EN-JS 1049	$-20 \leq TS \leq 300$

^a Mechanical properties verified on test pieces from cast - on samples. These grades should be chosen in preference to the material grades with the separately cast samples when the unit mass of the casting is equal to or greater than 2 000 kg or when the relevant wall thickness varies between 30 mm and 200 mm.

NOTE When materials specified in these tables are not available other suitable materials may be used when the technical documentation defining the characteristics of the materials has been accepted in accordance with the requirements for European approval for materials (EAM) or particular material appraisal (PMA)

5.2 Design

5.2.1 Technical documentation

The manufacturer shall document those items listed in clause 5 of EN 13445-5:2002 prior to manufacture commencing.

The manufacturer shall state which vessels are covered by the same design documentation.

5.2.2 Design methods

5.2.2.1 General

The loadings to be accounted for shall be in accordance with EN 13445-3:2002, clause 5.

Design methods shall be in accordance with EN 13445-3:2002, design by formulae according to the relevant clauses, or design by analysis according to Annex C. If design by experimental method is used, it shall be in conformity with 5.2.3 of this standard. However, nominal design stresses for materials used according to this part for pressure parts other than bolts shall be calculated in accordance with Table 5.2-1.

In general, the manufacturer shall define to the casting manufacturer which zones are critical related to the design and design loads. Other critical zones may be indicated by the casting manufacturer related to the casting process and should be taken into account by the manufacturer.

The manufacturer has the option to choose a testing factor $C_0 = 0,8$ for visual inspection only, or to use $C_0 = 0,9$ with additional non-destructive testing implied. This can result in smaller required wall thicknesses as is required for visual inspection only. This option has to be determined from the start of the design.