



SLOVENSKI STANDARD

SIST EN 15776:2011

01-november-2011

Neogrevane tlačne posode - Zahteve za konstruiranje in izdelavo tlačnih posod in njihovih delov iz litega železa z raztežkom ob poružitvi, enakim ali manjšim kot 15 %

Unfired pressure vessels - Requirements for the design and fabrication of pressure vessels and pressure parts constructed from cast iron with an elongation after fracture equal or less than 15 %

Unbefeuerte Druckbehälter - Zusätzliche Anforderungen an die Konstruktion und Herstellung von Druckbehältern und Druckbehälterteilen aus Gusseisen mit einer Dehnungseigenschaft von 15% oder weniger

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Réipients sous pression non soumis à la flamme - Exigences supplémentaires pour la conception et la fabrication des réipients sous pression et des parties sous pression moulés en fonte à allongement inférieur ou égal à 15 %

Ta slovenski standard je istoveten z: EN 15776:2011

ICS:

23.020.30	Tlačne posode, plinske jeklenke	Pressure vessels, gas cylinders
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EUROPEAN STANDARD

EN 15776

NORME EUROPÉENNE

EUROPÄISCHE NORM

February 2011

ICS 23.020.30

English Version

Unfired pressure vessels - Requirements for the design and
fabrication of pressure vessels and pressure parts constructed
from cast iron with an elongation after fracture equal or less than
15 %

Réipients sous pression non soumis à la flamme -
Exigences pour la conception et la fabrication des
réipients sous pression et des parties sous pression
moulés en fonte à allongement après rupture inférieur ou
égal à 15 %

Unbefeuerte Druckbehälter - Anforderungen an die
Konstruktion und Herstellung von Druckbehältern und
Druckbehälterteilen aus Gusseisen mit einer Bruchdehnung
von 15 % oder weniger

This European Standard was approved by CEN on 1 January 2011.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 15776:2011) 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 August 2011, and conflicting national standards shall be withdrawn at the latest by August 2011.

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

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Introduction

For pressure equipment, special precautions are required when using grey cast iron grades or spheroidal graphite cast iron grades with an elongation after fracture equal to or less than 15 % to attain the same safety level as when using spheroidal graphite cast iron grades with an elongation after fracture higher than 15 %. Service restrictions and limitations are given in Clause 4.

Attention is drawn to the references to EN 13445-6 for design and fabrication according to specific grades of material standards EN 1563 and EN 13835 which are found in some clauses of this standard, EN 15776. Requirements for the design, material, manufacturing and testing of pressure vessels and pressure vessel parts made from ferritic or austenitic spheroidal graphite cast iron grades with an elongation after fracture higher than 15 % are given in EN 13445-6.

Cast iron with elongation after fracture equal or less than 15 % may only be used for pressure equipment when operational and technical advantages are dictating its use instead of the cast iron grades given in EN 13445-6 with elongation after fracture higher than 15 %.

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1 Scope

This European Standard specifies requirements for the design, material, manufacturing and testing of pressure vessels and pressure vessel parts made from materials for which details are specified from the following material standards for specific grades which meet the criterion of an elongation after fracture less than or equal to 15 %:

- EN 1561, *Founding — Grey cast irons*;
- EN 1563, *Founding — Spheroidal graphite cast irons*;
- EN 13835, *Founding — Austenitic cast irons*.

The allowed content of the vessel or pressure part is a fluid of group 2 only, according to the Directive 97/23/EC.

2 Normative references

The following referenced documents are indispensable for the application 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 764-5:2002, *Pressure Equipment — Part 5: Compliance and Inspection Documentation of Materials*

EN 1370, *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*

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

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

EN 1561, *Founding — Grey cast irons*

EN 1563, *Founding — Spheroidal graphite cast irons*

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

EN 13445-3:2009, *Unfired pressure vessels — Part 3: Design*

EN 13445-5:2009, *Unfired pressure vessels — Part 5: Inspection and testing*

EN 13445-6:2009, *Unfired pressure vessels — Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

EN 13835, *Founding — Austenitic cast irons*

EN ISO 8062-3, *Geometrical Product Specifications (GPS) — Dimensional and geometrical tolerances for moulded parts — Part 3: General dimensional and geometrical tolerances and machining allowances for castings (ISO 8062-3:2007)*

EN 15776:2011 (E)

3 Terms, definitions, units and symbols**3.1 Terms and definitions**

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

3.1.1**grey cast iron**

cast material, mainly iron and carbon based, carbon being present mainly in the form of flake (lamellar) graphite particles (EN 1561)

NOTE Grey cast iron is also known as flake graphite cast iron, and less commonly as lamellar graphite cast iron.

3.1.2**spheroidal graphite cast iron**

cast material, mainly iron and carbon-based, the carbon being present mainly in the form of spheroidal graphite particles (EN 1563)

NOTE Spheroidal graphite cast iron is also known as ductile iron, and less commonly as nodular iron.

3.1.3**austenitic cast iron**

cast material with an austenitic matrix which is iron and carbon based and alloyed with nickel and manganese, copper and/or chromium in order to stabilize the austenitic structure at room temperature

NOTE The graphite can be present in flake or spheroidal form (EN 13835).

3.1.4**relevant wall thickness**

section of the casting, agreed between the manufacturer and the purchaser, to which the guaranteed mechanical properties apply

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3.1.5**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.

3.1.6**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

3.1.7**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.

3.1.8**casting manufacturer**

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

3.1.9**temperature factor**

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

3.1.10**wall thickness factor**

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

3.1.11**stress factor**

ratio of peak stress to total stress

3.1.12**total stress**

total stress in a design model which includes all stress concentration effects, non-local and local

3.2 Symbols

For the purposes of this document, symbols used in EN 13445-6:2009 are listed in Table 1.

Table 1 — Symbols

Symbol	Quantity	Unit
c	corrosion allowance	mm
e	required thickness	mm
e_a	analysis thickness	mm
e_{act}	actual thickness	mm
e_{max}	maximum local thickness at the location of a possible fatigue crack initiation	mm
e_{min}	minimum thickness as specified on drawing	mm

Table 1 (continued)

Symbol	Quantity	Unit
f	nominal design stress	MPa
f_e	thickness correction factor	
f_m	mean stress correction factor	
f_{test}	nominal design stress for testing condition	MPa
f_T	temperature correction factor	
f_s	surface finish correction factor	
m_C	exponent in equation of fatigue design curve	
n	shell shape factor	
n_{eq}	number of equivalent full pressure cycles	
T, T_c	calculation temperature	°C
A, A_5	minimum elongation after fracture	%
C_C	coefficient in equation of fatigue design curve	
C_e	wall thickness reduction factor	
C_T	temperature reduction factor	
E	modulus of elasticity	MPa
F	test factor used in experimental fatigue assessment	
K_{eff}	effective stress concentration factor	
K_t	theoretical elastic stress concentration factor	
M	mean stress sensitivity factor	MPa
m_c	value from appropriate Tables 10, 11, 13, 14 in the appropriate number of cycle number range used in fatigue calculations	
N	total number of envisaged types of pressure cycles with different amplitude	
N_{all}	allowable number of cycles obtained from the fatigue design curve	
N_{min}	minimum number of cycles obtained in experimental fatigue assessment	
n_i	number of cycles with amplitude ΔP_i	
PC, p_c	calculation pressure	MPa ^a
P_b	burst test pressure	MPa ^a
$P_{b,\text{act}}$	actual burst test pressure	MPa ^a

Table 1 (continued)

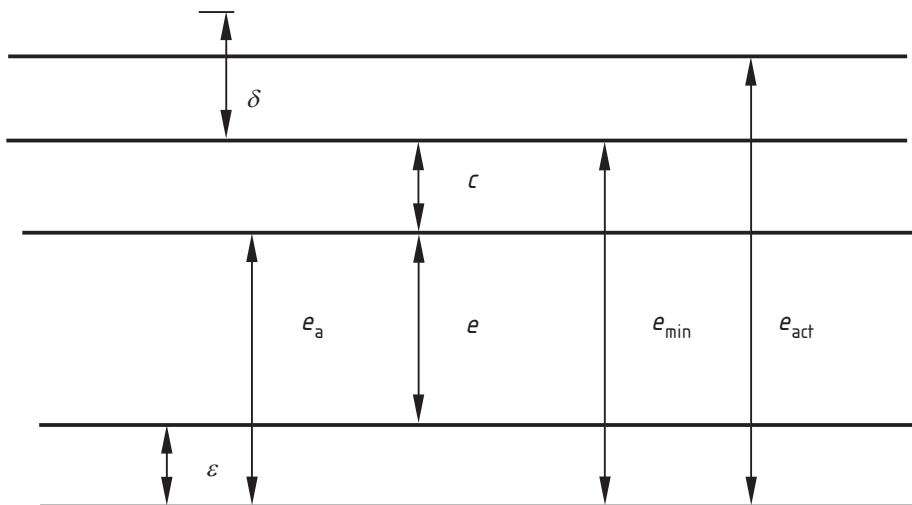
Symbol	Quantity	Unit
PD, p_d	design pressure	MPa ^a
P_{max}	maximum permissible pressure ^b	MPa ^a
PS, p_s	maximum allowable pressure ^b	bar ^a
PT, p_t	test pressure ^b	MPa
R_m	minimum tensile strength	MPa
R_m^*	average tensile strength of three test bars taken from the same cast for design according to DBE route	MPa
$R_{p0,2}$	minimum 0,2 % - proof strength	MPa
$R_{p0,2/T}$	minimum 0,2 % - proof strength at temperature T in degrees Celsius	MPa
R_z	surface roughness parameter – peak – to – valley height	μm
RM	material strength parameter	MPa
S	safety factor	
TS_{max}, TS_{min}	maximum / minimum allowable temperature	$^{\circ}\text{C}$
V	volume	L
ΔP	pressure range	MPa ^a
ΔP_i	pressure cycle amplitude	
$\Delta\sigma$	allowable stress range	MPa
$\Delta\sigma^*$	pseudo elastic stress range	MPa
$\Delta\sigma_{cut}$	cut-off limit	MPa
$\Delta\sigma_D$	endurance limit	MPa
$\Delta\sigma_{eq, struc}$	structural stress range	MPa
$\Delta\sigma_R$	stress range in fatigue design curve	MPa
δ	casting tolerance	mm
ε	extra thickness due to casting process	mm
γ_R	partial safety factor	
η	Stress factor	
ν	Poisson's ratio	
σ_e	nominal design stress for external pressure	MPa

^a MPa for calculation purposes only, otherwise the unit shall be bar (1 MPa = 10 bar).

^b See also EN 13445-3:2009, Table 4-1.

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3.3 Inter relation of thicknesses definitions (EN 13445-6)



Key

e required thickness

e_a analysis thickness

e_{\min} minimum thickness including corrosion allowance as indicated on drawings

e_{act} actual thickness

c corrosion allowance

ε extra thickness due to casting process

δ casting tolerance

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Figure 1

4 Materials, limitations and service conditions

4.1 Materials and limitations on temperature, maximum allowable pressure and energy content

All material grades subject to internal or external pressure shall comply with EN 1561 for grey cast iron, EN 1563 for spheroidal graphite cast iron and EN 13835 for austenitic cast iron. The material grades and corresponding limitations are given in Table 2 and Table 3.

Table 2 — Allowable material grades and limitations for grey cast iron and austenitic lamellar graphite cast iron

Material standard	Material designation		Design temperature limits	Maximum allowable pressure PS	Maximum energy content $PS \times V$ for a single casting
	Symbol	Number	°C	bar	$bar \cdot L$
EN 1561	EN-GJL-200	EN-JL1030	- 10 ≤ T ≤ 200	25	65 000
	EN-GJL-250	EN-JL1040			
	EN-GJL-300	EN-JL1050	- 10 ≤ T ≤ 200		
	EN-GJL-350	EN-JL1060			
EN 13835	EN-GJLA-XNiCuCr15-6-2	EN-JL3011	- 10 ≤ T ≤ 200		
	EN-GJLA-XNiMn13-7	EN-JL3021			

The product $PS \times V$ and the design temperature limit of Table 2 for a single casting may be exceeded when all the following conditions are met:

- maximum allowable temperature $TS_{max} \leq 300$ °C;
- maximum allowable pressure $PS \leq 15$ bar;
- material grades shall be limited to EN-GJL-300 or EN-GJL-350;
- documented stress factor ≤ 2 throughout the casting;
- stress relief heat treatment is carried out when the maximum cooling rate in the mould exceeds 30 °C/h for the temperature range from 600 °C decreasing to 150 °C.

NOTE An in-service inspection to Annex B of this standard may be considered to be mentioned in the operating instructions of the part or vessel.