SIST

SLOVENSKI STANDARD
SIST EN 15776:2022

01-september-2022

Nadomešča:
SIST EN 15776:2011+A1:2016

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

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

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

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

Ta slovenski standard je istoveten z: **EN 15776:2022**

ICS:

23.020.32	Tlačne posode	Pressure vessels
77.140.80	Železni in jekleni ulitki	Iron and steel castings

SIST EN 15776:2022 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15776

July 2022

ICS 23.020.30

Supersedes EN 15776:2011+A1:2015

English Version

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This European Standard was approved by CEN on 6 May 2020.

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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 CEN-CENELEC 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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Ref. No. EN 15776:2022 E

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European foreword

This document (EN 15776:2022) 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of an identical text or by endorsement, at the latest by January 2023, and conflicting national standards shall be withdrawn at the latest by January 2023.

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 15776:2011+A1:2015.

Compared to the previous edition EN 15776:2011+A1:2015, the following changes have been made:

— clarifications to a number of the formulaes and tables;

— update of references.

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

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part 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 is a stand-alone document and may be used for cast iron pressure equipment with certain restrictions and limitations.

Attention is drawn to the references to EN 13445-6:2021 for design and fabrication according to specific grades of material standards EN 1563:2018 and EN 13835:2012 which are found in some clauses of this document, EN 15776:2022. 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 13445-6:2021.

Cast iron with elongation after fracture equal or less than 15 % may only be used for pressure equipment when operational and technical advantages are indicating its use instead of the cast iron grades given in EN 13445-6:2021 with elongation after fracture higher than 15 %.

NOTE For the design and fabrication of cast iron pressure equipment standards with higher elongations and ductility, see EN 13445-6:2021.

1 Scope

This document specifies requirements for the design, material, manufacturing and testing of cast iron 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 1561:2011, *Founding — Grey cast irons*;

— EN 1563:2018, *Founding — Spheroidal graphite cast irons*;

— EN 13835:2012, *Founding — Austenitic cast irons.*

The application of this document is limited to pressure equipment and pressure parts containing a fluid of group 2 (non-hazardous fluid) according to the European legislation for pressure equipment.

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 764-5:2014, *Pressure equipment — Part 5: Inspection documentation of metallic materials and compliance with the material specification*

EN 1370:2011, *Founding — Examination of surface condition*

EN 1371-1:2011, *Founding — Liquid penetrant testing— Part 1: Sand, gravity die and low pressure die castings*

EN 1559-1:2011, *Founding — Technical conditions of delivery — Part 1: General*

EN 1559-3:2011, *Founding — Technical conditions of delivery — Part 3: Additional requirements for iron castings*

EN 1561:2011, *Founding — Grey cast irons*

EN 1563:2018, *Founding — Spheroidal graphite cast irons*

EN 12680-3:2011, *Founding — Ultrasonic testing — Part 3: Spheroidal graphite cast iron castings*

EN 13445-3:2021, *Unfired pressure vessels — Part 3: Design*

EN 13445-5:2021, *Unfired pressure vessels — Part 5: Inspection and testing*

EN 13445-6:2021, *Unfired pressure vessels — Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

EN 13835:2012, *Founding — Austenitic cast irons*

EN ISO 8062-3:2007, *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)*

3 Terms, definitions, units and symbols

3.1 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:

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

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

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

Note 1 to entry: Grey cast iron is also known as flake graphite cast iron, and less commonly as lamellar graphite cast iron.

Note 2 to entry: Grey cast irons contain 2,0 % - 4,5 % carbon and 1 % - 3 % silicon. The structure consists of branched and interconnected graphite flakes in a matrix which is pearlite, ferrite or a mixture.

[SOURCE: EN 1561:2011, 3.1, modified — The content of Note 2 to entry was changed.]

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

Note 1 to entry: Spheroidal graphite cast iron is also known as ductile iron, and less commonly as nodular iron.

Note 2 to entry: The mechanical properties of grey irons can be greatly improved if the graphite shape is modified if molten iron, having a composition in the range 3,2 % - 4,5 % carbon and 1,8 % - 2,8 % silicon, is treated with magnesium. This produces castings with graphite in spheroidal form instead of flakes, known as nodular, spheroidal graphite or ductile iron. Nodular irons are available with pearlite, ferrite or pearlite-ferrite matrices which offer a combination of greater ductility and higher tensile strength than grey cast irons.

[SOURCE: EN 1563:2018, 3.1, modified — The start of the definition was altered and Note 2 to entry was added.]

3.1.3
austenitic cast iron
cast material with an austenitic matrix which is iron and carbon and silicon based and alloyed with nickel and manganese, copper and/or chromium in order to stabilize the austenitic structure at room temperature

Note 1 to entry: The graphite can be present in flake or spheroidal form.

[SOURCE: EN 13835:2012, 3.1, modified — The start of the definition was altered and the final sentence to the definition is now comprised in Note 1 to entry.]

3.1.4
relevant wall thickness
wall thickness representative of the casting defined for the determination of the size of the cast samples to which the guaranteed mechanical properties apply

3.1.5
critical zone
highly stressed area where a fracture is expected to occur in a burst test

Note 1 to entry: 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 to entry: 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 to entry: 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 organization 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 organization responsible for the design, fabrication, testing, inspection, installation of pressure equipment and assemblies where relevant

Note 1 to entry: 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
thickness factor
factor applied to the nominal design stress to take account of reduced mechanical properties

3.1.11
stress factor
factor for the determination of the maximum structural stress that may occur in a vessel detail, due to the geometrical configuration of component(s)

[SOURCE: EN 13445-3:2021, 17.2.3]

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 13445-6:2021 are listed in Table 1.

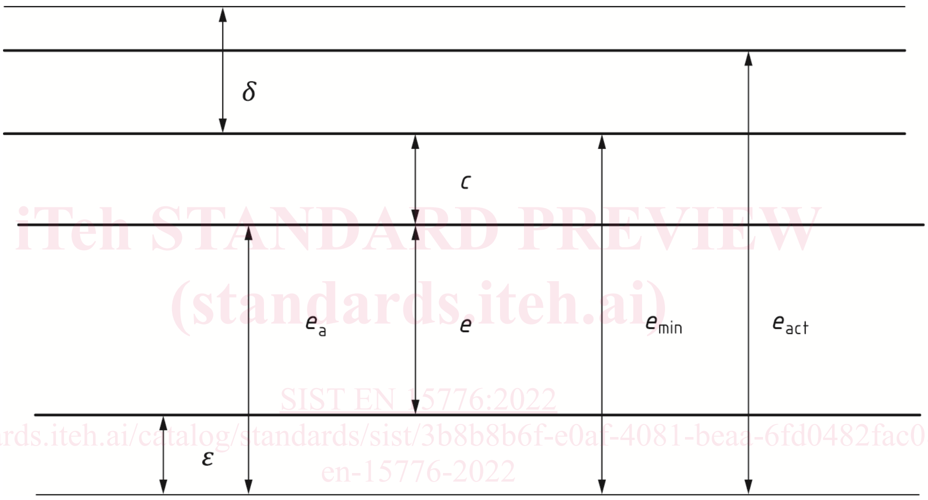
Table 1 — Symbols

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
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	factor depending on shape of shell	
n_{eq}	number of equivalent full pressure cycles	
T	calculation temperature	°C
A, A_5	minimum elongation after fracture	%
C_C	coefficient in equation of fatigue design curve	
C_e	wall thickness factor	
C_T	temperature factor	
E	modulus of elasticity	MPa
F	fatigue factor related to 99,8 % survival	
K_{eff}	effective stress concentration factor	

Symbol	Quantity	Unit
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 ΔPi	
P_b	minimum required bursting pressure	MPa [a]
$P_{b,act}$	actual burst test pressure	MPa [a]
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	tensile strength	MPa
$R_{p0,2}$	minimum 0,2 % - proof strength	MPa
$Rp_{0,2/T}$	minimum 0,2 % - proof strength at temperature T in degrees Celsius	MPa
R_z	surface roughness parameter – peak – to - valley height	µm
R_M	material strength parameter	MPa
$RM3$	average strength from 3 tensile test samples	MPa
S	safety factor	
TS_{max}, TS_{min}	maximum / minimum allowable temperature	°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

Symbol	Quantity	Unit
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 13445-3:2021, Table 4–1.		

3.3 Inter relation of thicknesses definitions (EN 13445-6:2021)



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

Figure 1 — Inter-relation of thicknesses definitions

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 1561:2011 for grey cast iron, EN 1563:2018 for spheroidal graphite cast iron and EN 13835:2012 for austenitic cast iron. The material grades and corresponding limitations are given in Table 2 and Table 3.