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Neogrevane tlaļne posode - 3. del: Konstruiranje

Unfired pressure vessels - Part 3: Design

Unbefeuerte Druckbehälter - Teil 3: Konstruktion

Récipients sous pression non soumis à la flamme - Partie 3 : conception

Ta slovenski standard je istoveten z: **EN 13445-3:2009**

ICS:

23.020.30	Tlaļne posode, plinske jeklenke	Pressure vessels, gas cylinders

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EUROPEAN STANDARD

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English Version

Unfired pressure vessels - Part 3: Design

Récipients sous pression non soumis à la flamme - Partie 3 : conception

Unbefeuerte Druckbehälter - Teil 3: Konstruktion

This European Standard was approved by CEN on 30 June 2009.

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

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Foreword

This document (EN 13445:2009) 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of an identical text or by endorsement, at the latest by *December 2009*, and conflicting national standards shall be withdrawn at the latest by *December 2009*.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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.

This European Standard consists of the following Parts:

— Part 1: *General*.

— Part 2: *Materials*.

— Part 3: *Design*.

— Part 4: *Fabrication*.

— Part 5: *Inspection and testing*.

— 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*.

— Part 8: *Additional requirements for pressure vessels of aluminium and aluminium alloys.*

— CEN/TR 13445-9, *Unfired pressure vessels — Part 9: Conformance of EN 13445 series to ISO 16528*

This document supersedes EN 13445-3:2002. This new edition incorporates the Amendments which have been approved previously by CEN members, and the corrected pages up to Issue 36 without any further technical charge. Annex Y to EN 13445-1:2009 and Annex Y to this Part provides details of significant technical changes between this European Standard and the previous edition.

Amendments to this new edition may be issued from time to time and then used immediately as alternatives to rules contained herein. It is intended to deliver a new Issue of EN 13445:2009 each year, consolidating these Amendments and including other identified corrections.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This Part of this European Standard specifies requirements for the design of unfired pressure vessels covered by EN 13445-1:2009 and constructed of steels in accordance with EN 13445-2:2009.

EN 13445-5:2009, Annex C specifies requirements for the design of access and inspection openings, closing mechanisms and special locking elements.

NOTE This Part applies to design of vessels before putting into service. It may be used for in service calculation or analysis subject to appropriate adjustment.

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 286-2:1992, *Simple unfired pressure vessels designed to contain air or nitrogen — Part 2: Pressure vessels for air braking and auxiliary systems for motor vehicles and their trailers.*

EN 764-1:2004, *Pressure equipment — Terminology — Part 1: Pressure, temperature, volume, nominal size.*

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

EN 764-3:2002, *Pressure equipment — Part 3: Definition of parties involved.*

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 1092-1:2007, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN-designated.*

EN 1591-1:2001, *Flanges and their joints — Design rules for gasketed circular flange connections — Calculation method.*

EN 1708-1:1999, EN 1708-1:1999/A1:2003, *Welding — Basic weld joint details in steel — Part 1: Pressurized components.*

EN 10222-1:1998, EN 10222-1:1998/A1:2002, *Steel forgings for pressure purposes — Part 1: General requirements for open die forgings.*

EN 13445-1:2009, *Unfired pressure vessels — Part 1: General.*

EN 13445-2:2009, *Unfired pressure vessels — Part 2: Materials.*

EN 13445-4:2009, *Unfired pressure vessels — Part 4: Fabrication.*

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

EN 13445-8:2009, *Unfired pressure vessels — Part 8: Additional requirements for pressure vessels of aluminium and aluminium alloys.*

EN ISO 4014:2000, *Hexagon head bolts — Product grades A and B (ISO 4014:1999).*

EN ISO 4016:2000, *Hexagon head bolts — Product grade C (ISO 4016:1999).*

EN ISO 15613:2004, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test.*

ISO 261:1998, *ISO general purpose metric screw threads — General plan.*

3 Terms and definitions

For the purposes of this Part of this European Standard, the terms and definitions given in EN 13445-1:2009, EN 13445-2:2009 and the following apply:

NOTE EN 13445-1:2009 and EN 13445-2:2009 have adopted terminology, symbols and definitions of EN 764-1:2004, EN 764-2:2002 and EN 764-3:2002.

3.1
action
imposed thermo-mechanical influence which causes stress and/or strain in a structure, e.g. an imposed pressure, force, temperature

3.2
analysis thickness
effective thickness available to resist the loading depending on the load case, see 5.3.2

3.3
assumed thickness
thickness assumed by the designer between the minimum required shell thickness e and the shell analysis thickness e_a

3.4
calculation pressure
differential pressure used for the purpose of the design calculations for a component
[EN 764-1:2004]

3.5
calculation temperature
temperature used for the purpose of the design calculations for a component
[EN 764-1:2004]

3.6
chamber
fluid space within a unit of pressure equipment
[EN 764-1:2004]

3.7
component
part of pressure equipment which can be considered as an individual item for the calculation
[EN 764-1:2004]

3.8
creep range
temperature range in which material characteristics used in design are time dependent

NOTE See also 5.1.

3.9
cryogenic applications
applications involving liquefied gases at low temperature

3.10
design pressure
pressure at the top of each chamber of the pressure equipment chosen for the derivation of the calculation pressure of each component
[EN 764-1:2004]

NOTE Any other location may be specified.

3.11
design temperature
temperature chosen for the derivation of the calculation temperature of each component
[EN 764-1:2004]

3.12
differential pressure
pressure which algebraic value is equal to the pressure difference on either side of a separation wall
[EN 764-1:2004]

3.13
governing weld joint
main full penetration butt joint the design of which, as a result of membrane stresses, governs the thickness of the component

3.14
load case
combination of coincident actions

3.15
main joint
weld joint assembling main pressure bearing parts

3.16
maximum permissible pressure
maximum pressure obtained from the design by formulae or relevant procedures of EN 13445-3:2009 for a given compoment in a given load case, or for the whole pressure vessel the minimum of these maximum permissible pressures of all compoments

NOTE 1 The differences of the nominal design stress f, the analysis thickness e_a and the joint coefficient z for the calculation of the maximum permissible pressure in different load cases are specified in 5.3.2.

NOTE 2 If no explicit formula is given for the maximum permissible pressure P_{max} then P_{max} may be calculated as pressure which gives the required thickness equal to the analysis thickness.

NOTE 3 The maximum permissible pressure P_{max} used for the simplified assessment of fatigue life in clause 17 and for the calculation of the equivalent full pressure in 5.4.2 is calculated for normal operating load cases.

3.17
minimum possible fabrication thickness
minimum possible thickness after fabrication

3.18
nominal design stress
stress value to be used in the formulae for the calculation of pressure components

3.19
nominal thickness
thickness as specified on the drawings

3.20
test pressure
pressure to which the equipment is subjected for test purposes
[EN 764-1:2004]

3.21
test temperature
temperature at which the pressure test of the pressure equipment is carried out
[EN 764-1:2004]

3.22
volume
internal volume of a chamber, including the volume of nozzles to the first connection (flange, coupling, weld) and excluding the volume of internal permanent parts (e.g. baffles, agitators)
[EN 764-1:2004]

3.23
weld throat thickness of a fillet weld
height of the inscribed isosceles triangle measured from the theoretical root point

4 Symbols and abbreviations

For the purposes of this Part of this European Standard, the general symbols and abbreviations shall be in accordance with EN 13445-1:2009, EN 13445-2:2009 and Table 4-1:

Table 4-1 — Symbols, quantities and units [c]

Symbol	Quantity	Unit
a	weld throat thickness	mm
e	required thickness	mm
e_n	nominal thickness	mm
e_{min}	minimum possible fabrication thickness	mm
e_a	analysis thickness	mm
c	corrosion allowance	mm
f	nominal design stress	MPa
f_d	maximum value of the nominal design stress for normal operating load cases	MPa
f_{exp}	maximum value of the nominal design stress for exceptional load cases	MPa
f_{test}	maximum value of the nominal design stress for testing load cases	MPa
η_{eq}	number of equivalent full pressure cycles (see 5.4.2)	-
P	calculation pressure	MPa [a]
P_d	design pressure	MPa [a]
P_{max}	maximum permissible pressure	MPa [a]
PS, P_s	maximum allowable pressure	MPa [a]
P_{test}	test pressure	MPa [a]
R_{eH}	upper yield strength	MPa
R_m	tensile strength	MPa
$R_m/_T$	tensile strength at temperature T	MPa
$R_{p0,2}$	0,2 % proof strength	MPa
$R_{p0,2/T}$	0,2 % proof strength at temperature T	MPa
$R_{p1,0}$	1,0 % proof strength	MPa
$R_{p1,0/T}$	1,0 % proof strength at temperature T	MPa
T	calculation temperature	°C
T_d	design temperature	°C
T_{test}	test temperature	°C
TS_{max}, TS_{min}	maximum/minimum allowable temperatures	°C
V	volume	mm^3 [b]
z	joint coefficient	—
ν	Poisson's ratio	—

[a] MPa for calculation purpose only, otherwise the unit may be bar (1 MPa = 10 bar).

[b] mm^3 for calculation purpose only, otherwise the unit should be litre.

[c] Formulae used in this standard are dimensional.

5 Basic design criteria

5.1 General

EN 13445-3:2009 is applicable only when:

a) materials and welds are not subject to localized corrosion in the presence of products which the vessel is to contain or which can be present in the vessel under reasonably foreseeable conditions.

b) either all calculation temperatures are below the creep range **or** a calculation temperature is in the creep range and time dependent material characteristics are available in the materials standard.

NOTE See definition 3.8 of creep range.

For the purpose of design, the creep range is the temperature range in which time independent material characteristics are no more governing in the determination of the nominal design stress.

The material strength characteristics used shall be related to the specified lifetimes in the various creep load cases

5.2 Corrosion, erosion and protection

5.2.1 General

Whenever the word "corrosion" is used in this standard it shall be taken to mean corrosion, oxidation, scaling, abrasion, erosion and all other forms of wastage.

NOTE 1 Stress corrosion cracking may occur under certain conditions of temperature and environment. A corrosion allowance is not an appropriate way of dealing with stress corrosion. Under such conditions, consideration shall be given to the materials used and the residual stresses in the fabricated vessel.

NOTE 2 It is impossible to lay down definite precautionary guidelines to safeguard against the effects of corrosion owing to the complex nature of corrosion itself, which may occur in many forms, including but not limited to the following:

— chemical attack where the metal is dissolved by the reagents. It may be general over the whole surface or localized (causing pitting) or a combination of the two;

— rusting caused by the combined action of moisture and air;

— erosion corrosion where a reagent otherwise innocuous flows over the surface at velocity greater than some critical value;

— high temperature oxidation (scaling).

Consideration should be given to the effect which corrosion (both internal and external) may have upon the useful life of the vessel. When in doubt, corrosion tests should be undertaken. These should be carried out on the actual metal (including welds or combination of metals) under exposure to the actual chemicals used in service. Corrosion tests should be continued for a sufficiently long period to determine the trend of any change in the rate of corrosion with respect to time.

NOTE 3 It is very dangerous to assume that the major constituent of a mixture of chemicals is the active agent, as in many cases small traces of a substance can exert an accelerating or inhibiting effect out of all proportion to the amount present. Fluid temperatures and velocities from corrosion test data should be equivalent to those met in operation.

5.2.2 Additional thickness to allow for corrosion

In all cases where reduction of the wall thickness is possible as a result of surface corrosion or erosion, of one or other of the surfaces, caused by the products contained in the vessel or by the atmosphere, a corresponding additional thickness sufficient for the design life of the vessel components shall be provided. The value shall be stated on the design drawing of the vessel. The amounts adopted shall be adequate to cover the total amount of corrosion expected on either or both surfaces of the vessel.

A corrosion allowance is not required when corrosion can be excluded, either because the materials, including the welds, used for the pressure vessel walls are corrosion resistant relative to the contents and the loading or are reliably protected (see 5.2.4).

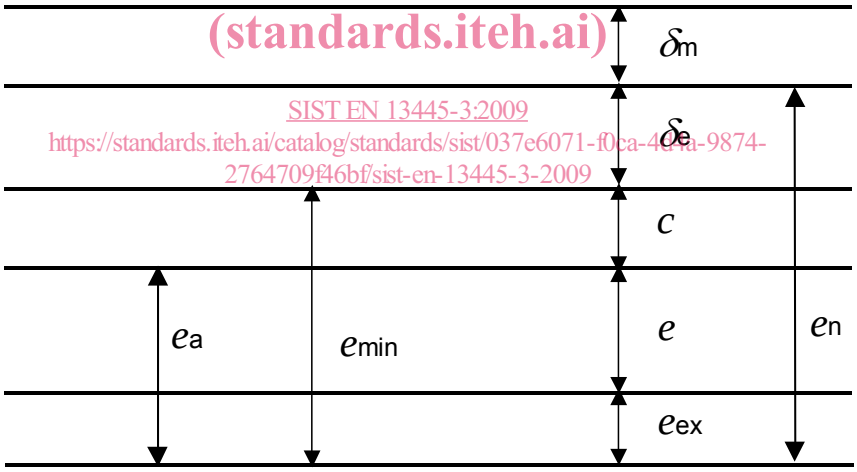
No corrosion allowance is required for heat exchanger tubes and other parts in similar heat exchanger duty, unless a specific corrosive environment requires one.

This corrosion allowance does not ensure safety against the risk of deep corrosion or stress corrosion cracking, in these cases a change of material, cladding, etc. is the appropriate means.

Where deep pitting may occur, suitably resistant materials shall be selected, or protection applied to the surfaces.

5.2.3 Inter-relation of thickness definitions

The inter-relation of the various definitions of thickness is shown in Figure 5-1.



Key

e is the required thickness;
e_n is the nominal thickness;
e_{min} is the minimum possible fabrication thickness ($e_{min} = e_n - \delta_e$);
e_a is the analysis thickness ($e_a = e_{min} - C$);
C is the corrosion allowance;
δ_e is the absolute value of the possible negative tolerance on the nominal thickness (e.g. taken from the material standards);
δ_m is the allowance for possible thinning during manufacturing process;
e_{ex} is the extra thickness to make up to the nominal thickness.

Figure 5-1 — Relationship of thickness definitions