SLOVENSKI STANDARD
SIST EN 13445-3:2002/A2:2009

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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 a la flamme - Partie 3 : Conception

Ta slovenski standard je istoveten z: **EN 13445-3:2002/A2:2007**

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English Version

Unfired pressure vessels - Part 3: Design

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

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This amendment A2 modifies the European Standard EN 13445-3:2002; it was approved by CEN on 26 January 2007.

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This amendment 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 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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Contents

Page

Foreword

This document (EN 13445-3:2002/A2:2007) has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI.

This Amendment to the European Standard EN 13445-3:2002 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2007, and conflicting national standards shall be withdrawn at the latest by October 2007.

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.

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.

This amendment is based on EN 13445-3:2002 up to issue 16 (October 2005).

The document includes the text of the amendment itself. The corrected pages of EN 13445-3 and EN 13445-5 will be delivered as issue 25 of the standard.

2 Normative references

In Clause 2, insert:

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

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

18 Detailed assessment of fatigue life

In Clause 18, replace 18.10.3 with:

18.10.3 Unclassified details

Details not fully covered in Tables 18-4 and Annex P shall be treated as Class 32 unless superior resistance to fatigue is proved by special tests or reference to relevant fatigue test results. To justify a particular design $\Delta\sigma_R$-N curve, at least two tests shall be performed on specimens that are representative of the design, manufacture and quality of the relevant detail in the actual vessel. Test stress levels shall be chosen to result in lives no more than 2 x 10^6 cycles. The geometric mean fatigue life obtained from the tests at a particular stress range shall be not less than that from the $\Delta\sigma_R$-N curve at that stress range multiplied by the factor F from Table 18-6.

Table 18-6 — Values of the factor F

Number of tests	F
2	15,1
3	13,1
4	12,1
5	11,4
6	11,0
7	10,6
8	10,3
9	10,1
10	9,9

NOTE F is based on assumed standard deviation of $\log N$ of 0,283, the largest value found from fatigue tests of pressure vessels failing from a weld detail. If a lower value is known to be applicable, it may be applied in conjunction with the test factors presented in 20.6.3.

Add the new Clause 20 as follows:

20 Design by experimental methods

20.1 Purpose

The purpose of this clause is to validate the design of vessels or vessel parts against pressure loading by experimental methods. These are based on burst testing supplemented, if necessary, by other tests, i.e. control of deformation and fatigue tests. The design is characterised by the determination of the maximum allowable pressure P_S of the vessel or of the vessel part. Note that validation of the design of a vessel part does not validate the design of the whole vessel.

Experimental methods are applicable to vessels made of steels according to EN 13445-2, manufactured according to EN 13445-4, inspected and tested according to EN13445-5 and to vessels made of aluminium and aluminium alloys according to EN 13445-8 with limitations (See 20.5.1).

In the present edition of the standard, the application of this clause is limited to the design of vessels having a maximum allowable temperature at which creep effects may be ignored.

The experimental methods of this clause are not applicable for bellows.

NOTE For cast parts made of spheroidal graphite cast iron, see EN 13445-6.

20.2 Specific definitions

burst test
hydrotest in which the pressure is increased up to a pre-determined pressure which is anticipated as being the burst pressure

burst test with global deformation control
hydrotest in which pressure is recorded versus volume variation

fatigue test
cyclic pressure test according to this clause

20.3 Specific symbols and abbreviations

The following symbols shall apply.

Table 20.3-1 Symbols

Symbol	Quantity	Unit
c	corrosion or erosion thickness allowance	mm
e_a	analysis thickness	mm
e_{act}	actual thickness	mm
e_n	nominal thickness	mm
e_{min}	minimum possible fabrication thickness	mm
f_t	nominal design stress for normal operating load cases at design temperature	MPa or N/mm²
$f_{t\,test}$	nominal design stress for normal operating load cases at test temperature	MPa or N/mm²
F	fatigue factor related to 99,8 % survival	dimensionless
k	one-sided tolerance limit factor (see 20.6.3.2.)	dimensionless
n	number of tests	dimensionless
n_s	factor depending on shape of the shell	dimensionless
N	number of pressure cycles	dimensionless
N_{req}	required number of pressure cycles	dimensionless
$N_{c,gm}$	Geometric mean number of cycles	dimensionless
$P_{B,req}$	required burst pressure for a tested vessel or part	bar, MPa or N/mm^2
P_s	maximum allowable pressure	bar, MPa or N/mm^2
$P_{B,act}$	maximum pressure actually applied in burst test	bar, MPa or N/mm²
P_{lim}	Limit pressure	bar, MPa or N/mm²
P_{min}	minimum pressure provided by the installation	bar, MPa or N/mm²

Symbol	Quantity	Unit
$R_{m,avg}$	average tensile strength of 3 specimens from the same heat	MPa or N/mm²
$R_{m(3)}$	average tensile strength of 3 test specimens taken from the part after the test is completed	MPa or N/mm²
$R_{p0,2}$	minimum yield strength or 0,2 % proof strength at test temperature, as given in the technical specification for the material	MPa or N/mm²
SF	safety factor used to determine P_s	dimensionless
V	volume of the vessel	mm^3
W_e	energy of elastic deformation	N·m or J
W_p	energy of plastic deformation	N·m or J
δ_e	absolute value of the possible negative tolerance on the nominal thickness (e.g. taken from the material standards)	mm
σ	standard deviation of $\log N$	dimensionless
ΔP	pressure range in the fatigue test	bar, MPa or N/mm²
ΔV	volume variation	mm^3
ΔV_e	elastic part of the volume variation	mm^3

NOTE 1 Table 20.3-1 contains all the notations used in the clause.

NOTE 2 For more information regarding thicknesses, see Clause 5.

NOTE 3 For more information regarding nominal design stresses, see Clause 6.

20.4 General requirements

20.4.1 Experimental methods without any calculation

a) Experimental methods without any calculation shall only apply to vessels where the product $P_s \cdot V < 6000 \text{ bar} \cdot \text{L}$.

b) Experimental methods without any calculation shall not apply in the context of PED module B1.

c) As a general rule design by formulae or design by analysis according to Annex B or C is given preference to the design by experiment only.

NOTE PED means the Pressure Equipment Directive (97/23/EC).

20.4.2 Experimental methods and other design methods

a) When dimensions can be calculated by design by formulae this method shall be used. The experimental methods may be used to supplement design by formulae or design by analysis methods to verify the adequacy of the design. In all cases, the lowest of the allowable pressures of all parts shall be used as maximum allowable pressure P_S for the whole vessel, whatever the design method used.

b) The test vessel or part shall not be used as a pressurized part after the burst or fatigue test, even when the vessel or part has shown no sign of burst or leak.

20.4.3 Test programme

The test programme shall be defined prior to test and approved by an organisation or a body appropriately qualified in the domain of design by experiment. It shall contain:

a) Essential dimensions and material characteristics of the test part;

b) Test conditions;

c) Description of instrumentation;

d) Criteria for acceptance or refusal.

20.4.4 Requirements for a vessel or part for burst test

a) The test vessel or part shall be representative of the production envisaged;

b) During production no changes in tolerances, production methods or material shall be made;

c) A family of vessels or parts are allowed based on only one test by extending the results to larger or smaller scale within certain limits, as specified in 20.7;

d) The vessel or part for which the maximum allowable pressure is to be established by method A (See 20.5) shall not previously have been subjected to a pressure greater than that of the anticipated standard hydrostatic test pressure given in 10.2.3.3.1 of EN 13445-5:2002.

e) The vessel or part for which the maximum allowable pressure is to be established by method B or C (See 20.5) shall not previously have been subjected to a pressure greater than that of the anticipated maximum allowable pressure.

20.4.5 Requirements for a vessel or part for fatigue test

a) The test vessel or part shall be representative of the production envisaged, including materials, tolerances and manufacturing methods;

b) Since shape deviations can have a detrimental influence on fatigue behaviour of the vessel or part, it is advisable to include the largest allowable deviations in the test samples;

c) The vessel or part for which the maximum allowable pressure is to be established shall not previously have been subjected to a pressure greater than that of the standard hydrostatic test pressure given in 10.2.3.3.1 of EN 13445-5:2005.

20.4.6 Test medium

A liquid shall be used as the test medium. It shall be such as to prevent both corrosion and any detrimental residual solids. Vents shall be provided at all high points of the vessel to purge possible air pockets while pressurizing the vessel.

20.4.7 Safety

The pressure test shall always be carried out under controlled conditions, with appropriate safety precautions and equipment, and in such a way that the persons responsible for the test are able to make adequate inspections of all pressurised parts.

NOTE Safety measures should be in accordance with national laws and regulations applicable at the place where the test is performed.

20.4.8 Non-destructive testing of welded joints

The required extent of non-destructive testing of welded joints for final acceptance purposes depends both upon the testing group and the type of the welded joint, as specified for vessels designed by formulae or by analysis.

The testing group to be considered for the vessel or vessel part shall be determined according to the rules given in EN 13445-5:2002 (Table 6.6.1-1) for steel pressure vessels and EN 13445-8:2006 (Table 8.1-1) for aluminium vessels.

NOTE 1 The weld joint coefficient is not used in design by the experimental method without calculation.

The required extent of non-destructive testing of welded joints shall be determined according to the rules given in EN 13445-5:2002 (Table 6.6.2-1) for steel pressure vessels and EN 13445-8:2006 (Table 8.2-1) for aluminium vessels.

In case where it is not obvious whether the welded joint is a governing one or not, due to the complex shape of the vessel and/or the particular location of that joint, a conservative assumption shall be made, i.e. the welded joint shall be considered as a governing welded joint and tested accordingly.

NOTE 2 For definition of governing welded joint, see Clause 3, definition 3.12. For examples of governing welded joints, see 5.6.

If no weld is present in the vessel or vessel part, testing group 1 shall be assumed.

Non-destructive testing methods, techniques, characterisation and acceptance criteria shall be in accordance with the rules given in EN 13445-5:2002 (6.6.3) for steel pressure vessels and EN 13445-8:2006 (8.3) for aluminium pressure vessels.

NOTE 3 For pressure loading of predominantly cyclic nature 6.6.3 requires the use of Annex G of EN 13445-5:2002.

20.4.9 Final assessment

Each completed vessel shall be subject to a final assessment as specified for vessels designed by formulae or by analysis in Clause 10 of EN 13445-5:2002. The modifications to Clause 10 included in 8.5 of EN 13445-8:2006 for aluminium pressure vessels shall be taken into account.

NOTE In Clause 10, 10.2.3.3.1 c) is not applicable in design by the experimental method without calculation.

20.5 Methods

20.5.1 Methods for pressure loading of predominantly non-cyclic nature

20.5.1.1 General

Several methods can be used to determine the maximum allowable pressure of a pressure vessel or a part for a pressure loading of predominantly non-cyclic nature, as defined in 5.4.2. These methods allow for margins towards the following failure modes: