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Unfired pressure vessels - Part 3: Design

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: Conception

Unbefeuerte Druckbehälter - Teil 3: Konstruktion

This draft amendment is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 54.

This draft amendment A2, if approved, will modify the European Standard EN 13445-3:2002. If this draft becomes an amendment, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for inclusion of this amendment into the relevant national standard without any alteration.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 13445-3:2002/prA2:2004) has been prepared by Technical Committee CEN/TC 54 "Unfired pressure vessels", the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

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).

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

20 Design by experimental methods (Clause entirely new)

20.1 Purpose

The purpose of this clause is to validate the design of vessels or vessel parts by experimental methods when the strength cannot be determined by design by formula or by design by analysis with a satisfactory assurance of accuracy. Experimental methods are based on a burst test completed, if necessary, by other tests. The design is characterised by the determination of the maximum allowable pressure P_S of the vessel or of the vessel part.

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

For this edition, these methods apply to maximum allowable temperatures for which creep effects need not be considered.

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

NOTE For cast parts made of spheroidal graphite cast iron, see Part 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

hydrotest in which specified pressure cycles are applied

20.3 Specific symbols and abbreviations

The following symbols and abbreviations shall apply.

Table 20.3-1 Symbols and abbreviations

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 at design temperature	MPa or N/mm ²
$f_{t_{test}}$	nominal design stress at test temperature	MPa or N/mm ²
F	fatigue factor related to 99,8 % survival	dimensionless
n	factor depending on shape of the shell	dimensionless
N_{req}	required number of pressure cycles	dimensionless
$N_{c, min}$	minimum number of cycles	dimensionless
P_B	required burst test pressure	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/mm ²
P_{lim}	limit pressure	bar, MPa or N/mm ²
P_{min}	minimum pressure provided by the installation	bar, MPa or N/mm ²
$R_{m, avg}$	average tensile strength of 3 specimens from the same heat	MPa or N/mm ²

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

NOTE1 Table 20.3-1 contains all the notations used in the Clause.

NOTE2 For more information regarding thicknesses, see Clause 5.

NOTE3 For more information regarding nominal design stresses, see Clause 6.

20.4 General requirements

20.4.1 Experimental methods without any calculation

- Experimental methods without any calculation shall only apply to vessels where the product $P_s \cdot V < 6000 \text{ bar.L}$.
- Experimental methods without any calculation shall not apply in the context of module B1.
- As a rule design by formula or design by analysis according to Annex B or C is given preference to the design by experiment only.

20.4.2 Experimental methods and other design methods

- When dimensions can be calculated by design by formula this method shall be used. The experimental methods may be used to complement design by formula or design by analysis methods to verify the adequacy of the design. However other parts of the vessel where sizing is determined by design by formula or design by analysis methods shall not lead to a vessel having a maximum allowable pressure P_s which is greater than that determined by the design by experimental methods.
- 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 accepted by the Responsible Authority where it exists. 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 shall not previously have been subjected to a pressure greater than that of the standard hydrostatic test pressure given in paragraph 10.2.3.3.1 of EN 13445-5.

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;
- b) During production no changes in tolerances, production methods or material shall be made;
- 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 paragraph 10.2.3.3.1 of EN 13445-5.

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.