SLOVENSKI STANDARD
SIST EN 13445-3:2002/A1:2009

01-februar-2009

Neogrevane tlaļ ne 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

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Ta slovenski standard je istoveten z: EN 13445-3:2002/A1:2007

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ICS:

23.020.30	Tlaļ ne posode, plinske jeklenke	Pressure vessels, gas cylinders

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EUROPEAN STANDARD

NORME EUROPÉENNE

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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 amendment A1 modifies the European Standard EN 13445-3:2002; it was approved by CEN on 22 March 2007.

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Foreword

This document (EN 13445-3:2002/A1:2007 - 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of an identical text or by endorsement, at the latest by December 2007, and conflicting national standards shall be withdrawn at the latest by December 2007.

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 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

This amendment is based on EN 13445-3 up to issue 26 (April 2007).

The document includes the text of the amendment itself. The corrected pages of EN 13445-3 will be delivered as issue 27 of the standard.

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 United Kingdom.

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2 Normative references

Amend the third reference to read:

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

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3 Terms and definitions

Add a new definition 3.23:

3.23
creep range
temperature range in which material characteristics used in design are time dependent

Add a NOTE:

NOTE See also 5.1.

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5 Basic design criteria

5.1 General

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Replace the existing text with:

Part 3 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 3.23 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

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5.3.3 Failure modes considered in this Part

Add:

f) creep rupture;

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g) creep deformation;

h) creep fatigue.

5.4.2 Vessels of all testing groups, pressure loading of predominantly non-cyclic nature

Change the beginning of the first paragraph to:

The DBF requirements specified in Clauses 7 to 16, Annexes G and J and in Clause 19 (**for testing subgroups 1c and 3c only**), and the DBA requirements of Annex B and Annex C provide satisfactory

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5.4.3 Vessels of testing group 4

Change to:

Pressure vessels to testing group 4, as defined in EN 13445-5, are intended for predominantly non-cyclic operation and ***calculation temperatures below the creep range***. They are limited for operation up to 500 full pressure cycles or equivalent full pressure cycles.

NOTE When the number of equivalent full pressure cycles has reached 500, a hydraulic test should be performed and followed by a complete visual examination. If the test is successfully passed, then the operation can be continued for a new 500 cycles period.

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Change the heading 5.4.4 to:

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5.4.4 Vessels of testing group 1, 2, and 3, working below the creep range, pressure loading of predominantly cyclic nature

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5.7.1 General requirements

Replace the last sentence with:

Specific requirements are included when Design by Analysis – Direct Route of Annex B is used for vessels or vessel parts working in the creep range.

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6 Maximum allowed values of the nominal design stress for pressure parts

In 6.1.1 add the following at the end of the first paragraph:

The values to be used within the creep range are given in Clause 19.

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Add the following new clause:

19 Creep design

19.1 Purpose

This clause is for the design of vessels or vessel parts if the calculation temperature is in the creep range. It may be applied for pressure and mechanical loading.

NOTE 1 A definition of the creep range is given in 3.8. See also 5.1b.

NOTE 2 A pre-supposition of the requirements in this clause is usage of sufficiently creep ductile materials. In that regard, the steels and steel castings listed in Table A.2-1 of EN 13445-2:2002 for which, for the relevant temperature range, creep strengths are given in the referred to material standards, are considered to be sufficiently creep ductile.

19.2 Specific definitions

period
duration of a load case with constant loading and constant temperature inside the creep range.

NOTE All individual intervals of time with identical creep conditions (same temperature and same applied loading) occurring separately during the vessel life should be grouped to form a unique period.

single creep load case
case where only one period occurs in the whole lifetime of the vessel.

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multiple creep load case
case where more than one period occur in the whole lifetime of the vessel.

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lifetime monitoring
requirements for control and examination as stated in the operating instructions with the minimum requirement for continuous recording of pressure and temperature and retention of records.

NOTE See Annex M for guidance.

19.3 Specific symbols and abbreviations

n is the total number of periods of f_{Fi}, T_i.

SF_c is the safety factor for mean creep rupture strength (see 19.5.1 and 19.5.2)

$R_{p1,0/T/t}$ is the mean 1% creep strain limit at calculation temperature T and lifetime t

$R_{m/T/t}$ is the mean creep rupture strength at calculation temperature T and lifetime t

NOTE The creep rupture strengths given in harmonised material standards are always mean values.

T is the calculation temperature in °C

t is the specified lifetime in hours (h) of the pressure vessel (see 19.4)

t_i is the duration (h) of the i-th period, during which the fictitious design stress f_{Fi} acts at the calculation temperature T_i.

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t_{D,f_{Fi},T_i} is the allowable time (h) to damage (caused by creep rupture or creep strain) for the material at fictitious design stress f_{Fi} and temperature T_i, taken from the creep design curve or formula (19-11) respectively.

t_{P,f_{Fi},T_i} is the allowable time (h) to reach the 1% creep strain limit for the material at fictitious design stress f_{Fi} and temperature T_i calculated according to formula (19-20).

t_{R,f_{Fi},T_i} is the allowable time (h) to creep rupture for the material at fictitious design stress f_{Fi} and temperature T_i calculated according to formula (19-12) or (19-17) respectively.

f_{Fi} is the fictitious design stress for creep design of the i-th period, as defined in 19.8.2.

f_{nc} is the nominal design stress based solely on time independent behaviour, as defined in 19.5.1

z_c is the weld creep strength reduction factor, as defined in 19.6.

19.4 Design in the creep range

This sub-clause applies for the design by formula in Clauses 7, 9, 10, 11, 12, 15 and 16 with the exception of bolts according to Clause 11 and 12 and the exception of compressive stresses in 16.14.

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For Clauses 8, 13, 14, 16.14 and Annexes G and J the design in the creep range is only applicable as far as the modulus of elasticity is known in the creep range. In this case in Clause 8 the minimum yield strength $R_{p0,2/T}$ has to be replaced by $\frac{R_{p1,0/T/t}}{1,3}$.

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— When the vessel has to be designed for a single creep load case only: the design procedure described in 19.8.1 shall be used. This procedure is based on use of the nominal design stress defined in 19.5. For determination of that nominal design stress, the lifetime t = 100.000 h shall be used if no lifetime t is specified.

— When the vessel has to be designed for multiple creep load cases: the design procedure based on cumulative damage described in 19.8.2 shall be used. Alternatively, a simplified and conservative design may also be made, using the procedure described in 19.8.1, replacing the various applied creep load cases by a unique one whose temperature shall be the highest among all individual creep load cases and whose duration shall be the total of that of all individual creep load cases.

In both procedures, the weld joint factor shall be modified by the weld creep strength reduction factor according to 19.6.

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19.5 Nominal Design stress in the creep range

19.5.1 Case where no lifetime monitoring is provided

19.5.1.1 General

$$f = \min\left\{ f_{nc} ; \frac{R_{m/T/t}}{SF_c} ; R_{p1,0/T/t} \right\} \tag{19-1}$$

where:

$SF_c = 1{,}5$

Determination of f_{nc} shall be made in accordance with Clause 6, with the following provisions:

— For calculation temperatures T not exceeding by more than 200 °C the highest temperature T_H at which material characteristics are available in the material standard, extrapolated values of f_{nc} can be taken as given in Annex S.

— For calculation temperatures $T > T_H + 200\ °C$ the nominal design stress f_{nc} shall be ignored in formula (19-1) and the further terms in this formula shall be determined for a lifetime not shorter than the lowest lifetime for which material creep characteristics are available in the material standard.

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NOTE The extrapolated values given in Annex S for $T > T_H + 200°C$ are useful only for determination of the hydrotest pressure (See 10.5.3.3 in EN 13445-5:2002)

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19.5.1.2 Case where material creep characteristics are available for the specified lifetime but not for the calculation temperature

19.5.1.2.1 General

In the case where for the calculation temperature T no mean creep rupture strength or no mean 1% creep strain limit is available in the harmonised materials standard, the interpolation formulae (19-3), (19-4) or (19-5), (19-6) respectively may be used (or the value in the harmonised material standard for the higher temperature may be used as a conservative value) to determine the appropriate creep characteristics.

If the calculation temperature is higher than the highest temperature for which a mean creep rupture strength or a mean 1 % creep strain limit is available, application of Clause 19 is not permitted.

19.5.1.2.2 Mean creep rupture strength

$$R_{m/T/t} = \frac{R_{m/T_1/t} \cdot (T_2 - T) + R_{m/T_2/t} \cdot (T - T_1)}{(T_2 - T_1)} \quad \text{for } T_2\text{-}T_1 \le 20\ °C \tag{19-2}$$

$$R_{m/T/t} = R_{m/T_1/t} \cdot \left(\frac{R_{m/T_2/t}}{R_{m/T_1/t}} \right)^{Z_R} \quad \text{for } T_2\text{-}T_1 > 20\ °C \tag{19-3}$$

where:

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$$z_R = \frac{\lg T - \lg T_1}{\lg T_2 - \lg T_1} \qquad \text{with: } \lg = \log_{10} \qquad (19\text{-}4)$$

T_1 is the nearest temperature below T for which a mean creep rupture strength is available in the harmonised material standard

T_2 is the nearest temperature above T for which a mean creep rupture strength is available in the harmonised material standard

19.5.1.2.3 Mean 1% creep strain limit

$$R_{p1,0/T/t} = \frac{R_{p1,0/T_1/t} \cdot (T_2 - T) + R_{p1,0/T_2/t} \cdot (T - T_1)}{(T_2 - T_1)} \qquad \text{for } T_2\text{-}T_1 \leq 20\ °C \qquad (19\text{-}5)$$

$$R_{p1,0/T/t} = R_{p1,0/T_1/t} \cdot \left(\frac{R_{p1,0/T_2/t}}{R_{p1,0/T_1/t}} \right)^{z_P} \qquad \text{for } T_2\text{-}T_1 > 20\ °C \qquad (19\text{-}6)$$

where:

$$z_P = \frac{\lg T - \lg T_1}{\lg T_2 - \lg T_1} \qquad \text{with: } \lg = \log_{10}$$

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T_1 is the nearest temperature below T for which a mean 1 % creep strain limit is available in the harmonised material standard

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T_2 is the nearest temperature above T for which a mean 1 % creep strain limit is available in the harmonised material standard.

19.5.1.3 Case where material creep characteristics are available for the calculation temperature (including cases where these values are calculated by 19.5.1.2) but not for the specified lifetime *t*

19.5.1.3.1 General

In the case where for the specified lifetime t no mean creep rupture strength value or no mean 1 % creep strain limit is available in the harmonised material standard the interpolation formula (19-7) or (19-9) respectively may be used (or the value in the harmonised material standard for a lifetime longer than the specified lifetime can be used as a conservative value) to determine the appropriate creep characteristics.

In the case where the specified lifetime t is longer than the highest lifetime for which a **mean creep rupture strength** is available in the harmonised materials standard, the extrapolation method given in the informative Annex R may be applied.

In the case where the specified lifetime t is longer than the highest lifetime for which a **mean 1 % creep strain limit** is available in the harmonised material standard, the value for the highest lifetime for which a mean 1% creep strain limit is available shall be used in formula (19-1).

NOTE In the case of the last paragraph, the accumulated creep strain may exceed the 1% limit before the end of the lifetime.

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19.5.1.3.2 Mean creep rupture strength

$$R_{m/T/t} = R_{m/T/t_A} \cdot \left(\frac{R_{m/T/t_B}}{R_{m/T/t_A}} \right)^{X_R} \tag{19-7}$$

where:

$$X_R = \frac{\lg t - \lg t_A}{\lg t_B - \lg t_A} \qquad \text{with: } \lg = \log_{10} \tag{19-8}$$

$R_{m/T/t_A}$ is the mean creep rupture strength for the nearest lifetime t_A below t for which a mean creep rupture strength is available

$R_{m/T/t_B}$ is the mean creep rupture strength for the nearest lifetime t_B above t for which a mean creep rupture strength is available

In the case where the **specified lifetime** t **is shorter** than the lowest lifetime for which a mean creep rupture strength is available in the material standard, then the following terms may be used in formulae (19-7) and (19-8) respectively:

$R_{m/T/t_A}$ and $R_{m/T/t_B}$ are the mean creep rupture strengths for the two shortest lifetimes t_A and t_B for which a mean creep rupture strength is available.

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An alternative method for extrapolation to shorter time is given in Annex R.

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19.5.1.3.3 Mean 1 % creep strain limit

$$R_{p1,0/T/t} = R_{p1,0/T/t_A} \cdot \left(\frac{R_{p1,0/T/t_B}}{R_{p1,0/T/t_A}} \right)^{X_P} \tag{19-9}$$

where:

$$X_P = \frac{\lg t - \lg t_A}{\lg t_B - \lg t_A} \qquad \text{with: } \lg = \log_{10}$$

$R_{p1,0/T/t_A}$ is the mean 1 % creep strain limit for the nearest lifetime t_A below t for which a mean 1 % creep strain limit is available

$R_{p1,0/T/t_B}$ is the mean 1 % creep strain limit for the nearest lifetime t_B above t for which a mean 1 % creep strain limit is available

In case where the **specified lifetime** t **is shorter** than the lowest lifetime for which a mean 1 % creep strain limit is available in the material standard then the third term (creep strain) within the minimum in formula (19-1) does not apply.

NOTE In that case the accumulated creep strain may exceed the 1 % limit before the end of the lifetime.