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Neogrevane tlaļ ne posode ï 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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This amendment A5 modifies the European Standard EN 13445-3:2002; it was approved by CEN on 24 June 2005.

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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 Central Secretariat 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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Foreword

This document (EN 13445-3:2002/A5:2006) has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI.

The document includes the text of the amendment itself. The corrected pages of EN 13445-3 will be delivered as Issue 17 of the standard.

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

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of an identical text or by endorsement, at the latest by August 2006, and conflicting national standards shall be withdrawn at the latest by August 2006.

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.

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9.3.2 Symbols

Definition of A_{fw} change the reference to 9.5.2.4 by 9.5.2.3.3

Delete definition of A_s

Definition for $e_{a,m}$ change the reference to equation 9.-36 by 9.5-47.Modify definition of φ :

φ *:* obliquity angle in the longitudinal or transversal cross-section, measured between the normal to the wall at the opening centre and the projection of the nozzle axis on the considered cross-section

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9.4.4 Elliptical or obround openings

In the 1st paragraph, change reference to 9.5.8 by 9.5.2.4.5

9.4.4.2

In the last paragraph (before the Note), change reference to equation 9.5-39 by 9.5-75 and reference to sub-clause 9.5.7.1 by 9.5.2.4.4.1.

9.4.5.2 Openings with reinforcing plates

Add the following sentence after the first paragraph:

Reinforcing plates are normally situated on the external surface of the shell, but they may be situated also on the internal surface or on both surfaces.

9.4.5.3 Openings in dished ends

Replace the text with the following:

For openings in hemispherical ends and dished ends, the ratio d / D_e shall not exceed 0,6. Therefore, if the opening is reinforced by a nozzle or a reinforcing ring d_{ib} / D_e and d_{ir} / D_e shall not exceed 0,6.

9.4.6 Limitations on thickness

Replace the title of sub-clause 9.4.6 and the text with the following three sub-clauses:

9.4.6 Effective thickness for nozzles *:*

9.4.6.1 in fatigue applications (i.e.: when the opening is a critical area as defined in Clause 17)

The ratio $e_b/e_{a,s}$ shall not exceed the value taken from the graph in Figure 9.4-14 and the value of e_b shall never exceed the value of $e_{a,b}$. Nozzle thickness in excess of that calculated using Figure 9.4-14 shall not be included in the reinforcement calculation.

Furthermore the ratio $e_{a,b}/e_{a,s}$ shall not exceed the value taken from the graph in Figure 9.4-15 .

NOTE e_b is the effective thickness of the nozzle, to be used for the verification of the reinforcement; $e_{a,b}$ is the analysis thickness of this nozzle; the ratio $e_b/e_{a,s}$ limits the contribution of the nozzle to the resistance of the opening; the ratio $e_{a,b}/e_{a,s}$ limits the analysis thickness of the nozzle, and thus its manufacturing thickness, in order to limit the stresses which can occur due to great thickness differences and to avoid the fatigue problems which can result.

9.4.6.2 in creep applications (i.e.: when the calculation temperature is situated in the creep range)

The effective thickness e_b may be taken equal to the analysis thickness $e_{a,b}$ of the nozzle.

However the ratio $e_{a,b}/e_{a,s}$ shall not exceed the value taken from the graph in Figure 9.4-15.

9.4.6.3 in applications without creep and without fatigue (i.e.: when the calculation temperature is situated out of the creep range and the opening is not a critical area according to Clause 17):

The effective thickness e_b may be taken equal to the analysis thickness $e_{a,b}$ of the nozzle and no limitations apply to the ratio $e_{a,b}/e_{a,s}$.

9.4.7

In the 3rd paragraph, change reference to 9.5.7.3 by 9.5.2.4.4.2

9.4.8 Openings close to a shell butt-weld

Replace the title of sub-clause 9.4.8 and the text with the following:

9.4.8 Distance between a nozzle and a shell butt-weld

The distance between the centre line of a shell butt-weld (longitudinal or circumferential) and the centre of an opening shall be either less than $d_{ib} / 6$ or greater than the value l_n given by:

$$l_n = \min (0,5\, d_{eb} + 2e_{a,s} \,;\, 0,5\, d_{eb} + 40) \quad (9.4\text{-}4)$$

9.5 Isolated openings

Replace the entire sub-clause 9.5 with the following (keep figures 9.5-1 to 9.5-4):

9.5 Isolated openings

9.5.1 Limitations

An opening is considered isolated if the following condition is satisfied:

$$L_b \geq a_1 + a_2 + l_{so1} + l_{so2} \quad (9.5\text{-}1)$$

where

a_1 and a_2 are shown in Figures 9.6-1 to 4, and l_{so1} and l_{so2} are calculated according to

$$l_{so} = \sqrt{(2r_{is} + e_{c,s}) \cdot e_{c,s}} \quad (9.5\text{-}2)$$

where

$e_{c,s}$ is the assumed shell thickness to be taken as is explained in 9.3.2 ; normally the value of shell analysis thickness $e_{a,s}$ may be taken, but this may be conservative and sometimes it may be advantageous to use a smaller assumed value for $e_{c,s}$ to obtain smaller minimum distances from adjacent shell discontinuities;

r_{is} is given by

— for cylindrical or spherical shells

$$r_{is} = \frac{D_e}{2} - e_{a,s} \qquad (9.5\text{-}3)$$

— for hemispherical or torispherical ends

$$r_{is} = R \qquad (9.5\text{-}4)$$

— for elliptical ends

$$r_{is} = \frac{0{,}44 D_i^2}{2h} + 0{,}02 D_i \qquad (9.5\text{-}5)$$

— for conical shells

$$r_{is} = \frac{D_e}{2 \cos \alpha} - e_{a,s} \qquad (9.5\text{-}6)$$

9.5.2 Reinforcement rules

9.5.2.1 General equation and its derivates

9.5.2.1.1 The general equation for the reinforcement of an isolated opening is given by

$$(Af_s + Af_w)(f_s - 0{,}5P) + Af_p(f_{op} - 0{,}5P) + Af_b(f_{ob} - 0{,}5P) \geq P(Ap_s + Ap_b + 0{,}5\,Ap_\varphi) \qquad (9.5\text{-}7)$$

where

$$f_{ob} = \min(f_s\,;\,f_b) \qquad (9.5\text{-}8)$$

$$f_{op} = \min(f_s\,;\,f_p) \qquad (9.5\text{-}9)$$

Where a reinforcing ring is fitted, Af_r and Ap_r shall be substituted for Af_b and Ap_b.

9.5.2.1.2 For all reinforced openings except small openings and those reinforced by a ring, the equation (9.5-7) applies; in particular:

a) Where either f_b or f_p is not greater than f_s, the reinforcement shall be determined from equation (9.5-7)

and P_{max} shall be obtained as follows

$$P_{max} = \frac{(Af_s + Af_w)\cdot f_s + Af_b \cdot f_{ob} + Af_p \cdot f_{op}}{(Ap_s + Ap_b + 0{,}5Ap_\varphi) + 0{,}5\,(Af_s + Af_w + Af_b + Af_p)} \qquad (9.5\text{-}10)$$

b) Where f_b and f_p are both greater than f_s, the reinforcement shall be determined from

$$(Af_s + Af_w + Af_p + Af_b)\cdot(f_s - 0{,}5P) \geq P(Ap_s + Ap_b + 0{,}5Ap_\varphi) \qquad (9.5\text{-}11)$$

$$P_{max} = \frac{(Af_s + Af_w + Af_b + Af_p) \cdot f_s}{(Ap_s + Ap_b + 0{,}5Ap_\varphi) + 0{,}5(Af_s + Af_w + Af_b + Af_p)} \tag{9.5-12}$$

9.5.2.1.3 For an opening with a reinforcing ring:

a) where f_r is less than f_s, the following shall apply

$$(Af_s + Af_w) \cdot (f_s - 0{,}5P) + Af_r \cdot (f_{or} - 0{,}5P) \geq P\,(Ap_s + Ap_r + 0{,}5Ap_\varphi) \tag{9.5-13}$$

and P_{max} is given by

$$P_{max} = \frac{(Af_s + Af_w) \cdot f_s + Af_r \cdot f_{or}}{(Ap_s + Ap_r + 0{,}5Ap_\varphi) + 0{,}5(Af_s + Af_w + Af_r)} \tag{9.5-14}$$

where f_{or} is given by

$$f_{or} = \min\,(f_s\,;\,f_r) \tag{9.5-15}$$

b) where f_r is greater than or equal to f_s, the following shall apply

$$(Af_s + Af_w + Af_r) \cdot (f_s - 0{,}5P) \geq P\,(Ap_s + Ap_r + 0{,}5Ap_\varphi) \tag{9.5-16}$$

and P_{max} is given by

$$P_{max} = \frac{(Af_s + Af_w + Af_r) \cdot f_s}{(Ap_s + Ap_r + 0{,}5Ap_\varphi) + 0{,}5(Af_s + Af_w + Af_r)} \tag{9.5-17}$$

9.5.2.2 Small opening

A small opening is one which satisfies the following condition

$$d \leq 0{,}15\sqrt{(2r_{is} + e_{c,s}) \cdot e_{c,s}} \tag{9.5-18}$$

Where a small opening lies beyond the distance w_p defined in 9.7.3, no reinforcement check is necessary. Where it lies within this distance, the reinforcement shall be in accordance with equation (9.5-7) or (9.5-11) as appropriate. However the distance w between small opening and shell discontinuity shall respect the minimum value w_{min} as required in 9.7.1.

9.5.2.3 General requirements for reinforcement

9.5.2.3.1 Reinforcing pads

For cases where a reinforcing pad contributes to the reinforcement (see Figures 9.4-3, 9.4-4, 9.4-10):

- reinforcing plates shall be fitted in close contact with the shell.

- the width of a reinforcing plate l'_p to be considered as contributing to reinforcement is given by

$$l'_p = \min(l_{so}; l_p) \tag{9.5-19}$$

- the value of e_p used for the calculation of Af_p shall not exceed the following

$$e_p = \min(e_{a,p}; e_{c,s}) \tag{9.5-20}$$

furthermore the analysis thickness of the reinforcing pad shall meet the following condition

$e_{a,p} \leq 1.5\, e_{a,s}$ (9.5-21)

- $e_{a,p}$ and l_p are dimensions of reinforcing pads used in equations for openings that may be reinforced also by reinforcing pads; if reinforcing pad is not present then the values $e_{a,p}$ and l_p shall be put equal to zero. If the reinforcing pad is contributing to reinforcement then, for all cases:

$$Af_p = l'_p \cdot e_p \qquad (9.5\text{-}22)$$

9.5.2.3.2 Weld joint coefficient

9.5.2.3.2.1 Opening intersecting with a shell governing weld

If an opening intersects with a shell governing weld (see definition in 5.6), the value f_s in equation (9.5-7,11,13 and 16) for the shell material shall be replaced by $f_s \cdot z$, where z is the weld joint coefficient of the shell.

9.5.2.3.2.2 Nozzle with a longitudinal weld

If a nozzle has a longitudinal weld having a weld joint factor z, the value f_b for the nozzle material shall be replaced by $f_b \cdot z$ except for openings in cylindrical or conical shells if the angle θ as defined in subclause 9.3.2 is greater than 45°.

9.5.2.3.3 Fillet weld areas for compensation

For all cases:

- Af_w is the area of any welds connecting together the different components (shell to nozzle, shell to reinforcing ring or reinforcing plate) which is located within length l'_s on the shell (see 9.5.2.4.2) and lengths l'_b and l'_{bi} on the nozzle (see 9.5.2.4.4.1). Areas of welds already included in other areas, e.g. Af_s, Af_r, Af_p or Af_b, shall be omitted from Af_w (see Figures 9.4-6 and 9.4-10).

9.5.2.4 Pressure loaded cross-sectional areas *Ap* and stress loaded cross-sectional areas *Af*

9.5.2.4.1 General

With reference to the general equations and its derivates of paragraph 9.5.2.1 the stress loaded and pressure loaded cross-sectional areas shall be calculated by different formulae depending on different cases of shells and different cases of nozzles.

In presence of reinforcing pads the cross sectional area Af_p shall be calculated according 9.5.2.3.1

For fillet weld areas participating to the reinforcement the cross sectional area Af_w shall be evaluated according 9.5.2.3.4.

For additional pressure loaded cross sectional area Ap_φ due to the obliquity of a nozzle, see 9.5.2.4.5

9.5.2.4.2 Shells with openings without nozzle or reinforcing ring, with or without reinforcing pads

9.5.2.4.2.1 On cylindrical shell, longitudinal cross-section

With reference to Figures 9.4-1 and 9.4-3 the values useful for compensation of opening shall be calculated as follows:

$$a = \frac{d}{2} \qquad (9.5\text{-}23)$$

$$r_{is} = \frac{D_e}{2} - e_{a,s} \qquad (9.5\text{-}24)$$