**SLOVENSKI STANDARD**
**SIST EN 14025:2004**

**01-junij-2004**

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**Posode za prevoz nevarnih snovi ï Kovinske tlaļ ne cisterne ï Konstruiranje in izdelava**

Tanks for the transport of dangerous goods - Metallic pressure tanks - Design and construction

Tanks für die Beförderung gefährlicher Güter - Drucktanks aus Metall - Auslegung und Bau



Citernes destinées au transport de matieres dangereuses - Citernes métalliques sous pression - Conception et fabrication



**Ta slovenski standard je istoveten z:** **EN 14025:2003**

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**ICS:**

| | | |
|---|---|---|
| 13.300 | Varstvo pred nevarnimi izdelki | Protection against dangerous goods |
| 23.020.20 | Posode in vsebniki, montirani na vozila | Vessels and containers mounted on vehicles |

**SIST EN 14025:2004** **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 14025

November 2003

ICS 13.300; 23.020.20

English version

# Tanks for the transport of dangerous goods - Metallic pressure tanks - Design and construction

Citernes destinées au transport de matières dangereuses - Citernes métalliques sous pression - Conception et fabrication

Tanks für die Beförderung gefährlicher Güter - Drucktanks aus Metall - Auslegung und Bau

This European Standard was approved by CEN on 25 September 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.



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

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



Ref. No. EN 14025:2003 E

# Contents

## Foreword

This document (EN 14025:2003) has been prepared by Technical Committee CEN/TC 296 “Tanks for the transport of dangerous goods”, the secretariat of which is held by AFNOR.

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 April 2004, and conflicting national standards shall be withdrawn at the latest by April 2004.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports the objectives of the framework Directives on Transport of Dangerous goods.

The standard is submitted for reference into the RID and/or in the technical annexes of the ADR.

Therefore the standards listed in the normative references and covering basic requirements of the RID/ADR not addressed within the present standard are normative only when the standards themselves are referred to in the RID and/or in the technical annexes of the ADR.

Annexes A and B are informative.



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

## 1 Scope

This European Standard specifies the minimum requirements for the design and construction of metallic pressure tanks having a maximum working pressure exceeding 50 kPa (0,5 bar) for the transport of dangerous goods by road and rail. This standard includes requirements for openings, closures and structural equipment; it does not cover requirements of service equipment. For road tankers for the transport of LPG see EN 12493. For tanks for the transport of cryogenic liquids see EN 13530-1 and -2.

## 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 287–1, *Approval testing of welders - Fusion welding - Part 1: Steels.*

EN 287–2, *Approval testing of welders - Fusion welding - Part 2: Aluminium and aluminium alloys.*

EN 288, *Specification and qualification of welding procedures for metallic materials — Parts 1 - 9*

EN 473, *Non destructive testing — Qualification and certification of NDT personnel — General principles.*



EN 729-1, *Quality requirements for welding – Fusion welding of metallic materials – Part 1: Guidelines for selection and use.*



EN 729-2, *Quality requirements for welding – Fusion welding of metallic materials–- Part 2: Comprehensive quality requirements.*

EN 729-3, *Quality requirements for welding – Fusion welding of metallic materials–- Part 3: Standard quality requirements.*

EN 970, *Non-destructive examination of fusion welds — Visual examination.*

EN 1435, *Non-destructive examination of welds — Radiographic examination of welded joints.*

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

EN 1708–1, *Welding — Basic weld joint details in steel — Part 1: Pressurized components.*

EN 1714, *Non destructive examination of welds — Ultrasonic examination of welded joints.*

EN 12285-1 : 2003, *Workshop fabricated steel tanks - Part 1: Horizontal cylindrical single skin and double skin tanks for the underground storage of flammable and non-flammable water polluting liquids*

EN 12493, *Welded steel tanks for liquefied petroleum gas (LPG) — Road tankers — Design and manufacture.*

EN 12561–6, *Railway applications – Tank wagons – Part 6: Manholes.*

prEN 13094 : 2000, *Tanks for the transport of dangerous goods — Low-pressure metallic tanks — Design and construction.*

EN 13445-2 : 2002, *Unfired pressure vessels — Part 2: Materials.*

EN 13445-3 : 2002, *Unfired pressure vessels — Part 3: Design.*

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

EN 25817, *Arc-welded joints in steel - Guidance on quality levels for imperfections (ISO 5817:1992).*

EN 30042, *Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections (ISO 10042:1992).*

ISO 1496–3, *Series 1 freight containers — Specification and testing — Part 3 : Tank containers for liquids, gases and pressurized dry bulk.*

ISO 7005–1, *Metallic flanges — Part 1 : Steel flanges.*

# 3 Definitions and Symbols

## 3.1 Definition

For the purpose of this standard the term "pressure-tank" means a tank as defined in the international regulations for the transport of dangerous goods by road or rail having a maximum working pressure or a test pressure exceeding 50 kPa (0,5 bar).

## 3.2 Symbols

The following general symbols are used throughout the text; they are listed in alphabetical order. Special symbols are explained with the relevant formulae.



$A$, $A_{p\,;\,fm\,;\,fb\,;\,fp}$ cross sectional areas reached for the calculation of nozzles reinforcement (see 6.3.5.2 and Figure 7)

$d_i$ inside diameter of an opening

$D_C$ mean diameter of the cylindrical part of the tank at the junction of a cone

$D_e$ outside diameter of the cylindrical part of the tank or the straight flange of the dished end

$D_i$ inside diameter of the cylindrical part of the tank or the straight flange of dished end

$e$ minimum required wall thickness (in mm) of the tank

$e_k$ wall thickness of a conical part of a tank

$e_R$ wall thickness of a hemispherical end

$E$ Young's modulus

$f_d$ nominal design stress (allowable stress)

$h$ inside height of an ellipsoidal dished end

$K$ shape factor of ellipsoidal ends

$MWP$ maximum working pressure, in MPa

$p$ design pressure, in MPa

$p_{dyn}$ equivalent dynamic pressure

$p_{test}$ test pressure, in MPa

$p_{vap}$ vapour pressure at 50 °C or at the design temperature, whichever is the higher; to be taken as the numerical value of the absolute pressure

$r$ inner knuckle radius, in mm

$R$ inside spherical radius of the central part of a torispherical end

$R_e$ guaranteed (upper) minimum yield strength, in N/mm² or guaranteed minimum 0,2 % proof strength in N/mm² (for austenitic steel the 1 % proof strength may be chosen)

$R_m$ guaranteed minimum tensile strength, in N/mm²

$\lambda_S$ welding coefficient

# 4 Materials

## 4.1 General

The tank shell shall be fabricated from metallic materials which shall be resistant to brittle fracture and of adequate impact strength within the design temperature range. The material shall be suitable for shaping. EN 13445-2 applies, but see also A.2.7.

Welded shells shall be fabricated from a material which has been shown to have acceptable welding characteristics.

## 4.2 Compatibility



Shells, fittings, and pipework shall be constructed from materials which are:

a) Substantially immune to attack by the substance(s) intended to be transported; or

b) Properly passivated or neutralised by chemical reaction; or



c) Lined with corrosion-resistant material directly bonded to the shell or attached by equivalent means.

Gaskets shall be made of materials not subject to attack by the substances intended to be transported. The materials of the tank, including any devices, gaskets, linings and accessories, shall not adversely affect the substances intended to be transported in the tank.

Guidelines on material specifications in relation to the substances to be transported may be taken from annex A of EN 12285-1 : 2003.

# 5 Design

## 5.1 General

Tanks shall be designed to withstand without loss of contents the

1) Operating conditions including static and dynamic forces in normal conditions of carriage;

2) Test conditions;

3) Explosion pressure proof conditions (if required).

under consideration of clause 6.

NOTE The requirements coming from the relevant regulations (i. e. RID and ADR) are given in annex A for information.

### 5.2 Reduction of shell thickness

The minimum wall thickness of shells (see A.2.12) are allowed to be reduced by a maximum of 2 mm in the case of mild steel or of an equivalent thickness of another metal, if protection of the shell against damage through lateral impact or overturning is provided (see 5.3 and A.2.13).

For shells of rail tank wagons no reduction of the minimum wall thickness due to protection is allowed.

### 5.3 Protection of the shell

Shells of tank containers are protected against damage if one of the following measures is provided:

— a structure, in which the shell is supported by a complete skeleton including longitudinal and transverse structural members. This structure shall conform to the requirements of ISO 1496-3;

— a double wall construction, where the aggregate thickness of the outer metal wall and the shell wall itself is not less than the minimum wall thickness prescribed in A.2.12 for reduced wall thickness;

— a "sandwich" construction, which means shells made with double walls having an intermediate layer of rigid solid materials (e. g. foam, at least 50 mm thick), where the outer wall has a thickness of at least 0,5 mm of steel, 0,8 mm of aluminium or 2 mm of a plastics material reinforced with glass fibre. For other layer materials (e.g. mineral wool, at least 100 mm thick), the outer wall has a thickness of at least 0,8 mm of austenitic steel. Other combinations of materials used to provide protection against damage shall be shown to have equivalent strength to the minimum thickness required in accordance with A.2.12. One method of comparing the strength of sheets of materials is given in annex C of prEN 13094:2000.



For shells of road tankers see also 5.3.2 of prEN 13094:2000.



## 6 Calculation

### 6.1 General

The calculation scheme given in Figure 1 shows how to determine the wall thickness of a shell to meet the requirements of this standard and the relevant regulations (i. e. RID and ADR).

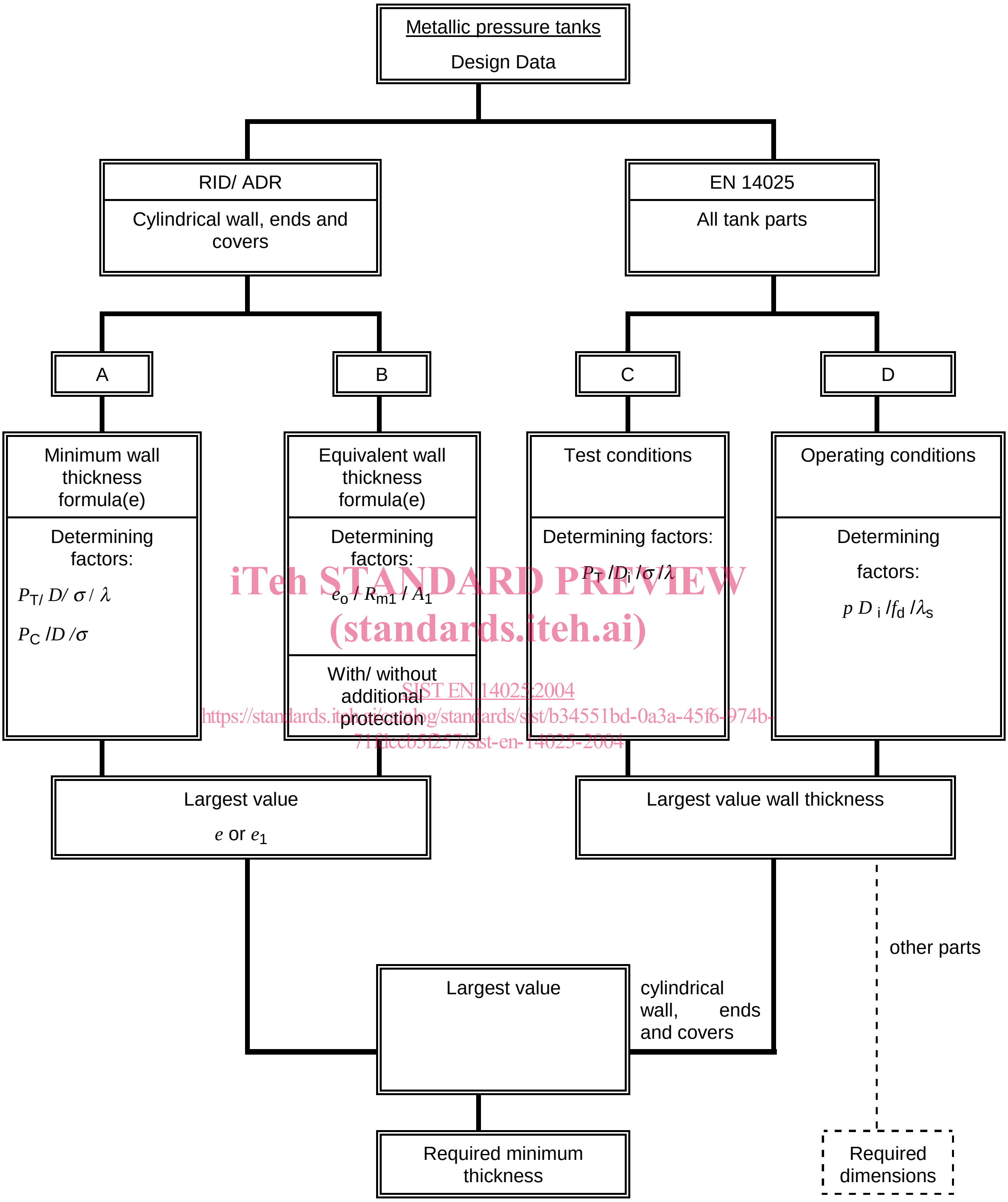





**Figure 1 — Calculation scheme for the wall thickness of metallic pressure tanks for the transport of dangerous goods**

The wall thickness shall not be less than the maximum value given by the following equations applied for the operating and for the test conditions.

## 6.2 Design criteria

Design criteria (loads, allowable stresses, design temperature etc.) to be applied shall be taken from Table 1.

**Table 1 — design criteria**

| | Operating conditions | Test conditions |
|---|---|---|
| $p$ | $MWP$<br>but not less than<br>$p_{vap} + p_{dyn}$ [if applicable] [a] | $p_{test}$ [b] |
| $f_d$ for ferritic steels and aluminium alloys | min { $R_e$ / 1,5; $R_m$ / 2,4} | min { 0,75 $R_e$ ; 0,5 $R_m$} [b] |
| $f_d$ for austenitic steels with 30 % ≤ $A$ ≤ 35 % | $R_e$ / 1,5 | |
| $f_d$ for austenitic steels with $A$ > 35 % | max { $R_e$ / 1,5; min ($R_e$ / 1,2 ; $R_m$ / 3)} | |
| Design temperature | 20 °C provided that the operating temperature of the tank is within the range – 20 °C to + 50 °C. When the operating temperature is outside this range then the design temperature shall be taken as the extreme value of the operating temperature. | Temperature at the pressure test (normally +20 °C). |

[a] The dynamic forces shall be taken into account. This may be done by introducing an equivalent dynamic pressure $p_{dyn}$ determined on the basis of the dynamic forces specified in the relevant regulations (see annex A) but not less than 35 kPa ( 0,35 bar). The largest compartment shall be taken into account.

[b] To be taken from the relevant regulation, (see also annex A).



## 6.3 Calculation for internal pressure

### 6.3.1 General

The thickness of the cylindrical section of the shell shall be determined in accordance with 6.3.2. The thickness of the ends (including partitions) of the shell shall be determined in accordance with 6.3.3; for partitions and surge plates see also A.2.16. The thickness of a conical section and the reinforcement of the cone to cylinder junction shall be determined in accordance with 6.3.4. For flanges, joints and their bolts see 6.3.6.

Openings in the shell shall be designed in accordance with 6.3.5.

### 6.3.2 Wall thickness of the cylindrical section

The wall thickness shall not be less than the value given by equation (1).

$$e = \frac{p \times D_i}{2\ f_d \times \lambda_S - p} \quad (1)$$

### 6.3.3 Wall thickness of ends

#### 6.3.3.1 General

The thickness of the ends, subject to the limitations in 6.3.3.2, shall not be less than that given by 6.3.3.3 and 6.3.3.4, 6.3.3.5 or 6.3.3.6 as applicable.

#### 6.3.3.2 Design limitations

The following design limitations shall apply to the tank ends (compare Figure 2):

| | | | | |
|---|---|---|---|---|
| (a) Hemispherical ends | $0{,}001\,D_e \leq$ | $e$ | $\leq$ | $0{,}16\,D_e$ |
| (b) Torispherical ends | $0{,}001\,D_e \leq$ | $e$ | $\leq$ | $0{,}08\,D_e$ |
| | $0{,}06\,D_i \leq$ | $r$ | $\leq$ | $0{,}2\,D_i$ |
| | | $r$ | $\geq$ | $2\,e$ |
| | | $R$ | $\leq$ | $D_e$ |
| (c) Ellipsoidal ends | $0{,}001 D_i \leq$ | $e$ | $\leq$ | $0{,}08\,D_i$ |
| | $3{,}4 \leq$ | $D_i/h$ | $\leq$ | $4{,}4$ |

The four relationships in (b) and the two relationships in (c) shall be simultaneously fulfilled.

NOTE Kloepper and Korbbogen-type ends are particular cases of torispherical ends:

**kloepper type**
torispherical end for which $R/D_e = 1{,}0$ and $r/D_e = 0{,}1$

**korbbogen type**
torispherical end for which $R/D_e = 0{,}8$ and $r/D_e = 0{,}154$



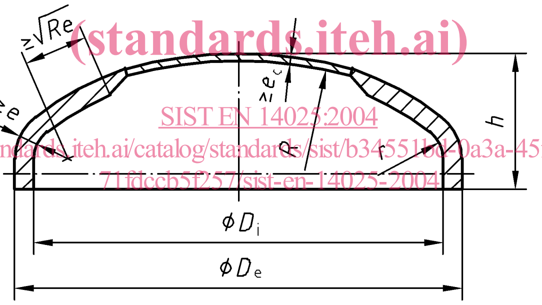





**Figure 2 — Geometry of ends**

**6.3.3.3** Thickness of the flange of the end

The wall thickness of the cylindrical or straight flange of the end shall not be less than the thickness as determined in accordance with 6.3.2 for a cylindrical section having the same inside diameter $D_i$ .

**6.3.3.4** Thickness of hemispherical ends

The thickness of a hemispherical end shall be not less than that determined by equation (2).

$$e = \frac{p \times D_i}{4\, f_d \times \lambda_S - p} \tag{2}$$

**6.3.3.5** Thickness of torispherical ends

**6.3.3.5.1** General

The minimum thickness of torispherical ends shall be the greatest of the values of $e_y$, $e_s$ or $e_b$ as determined by equations (3) to (5).

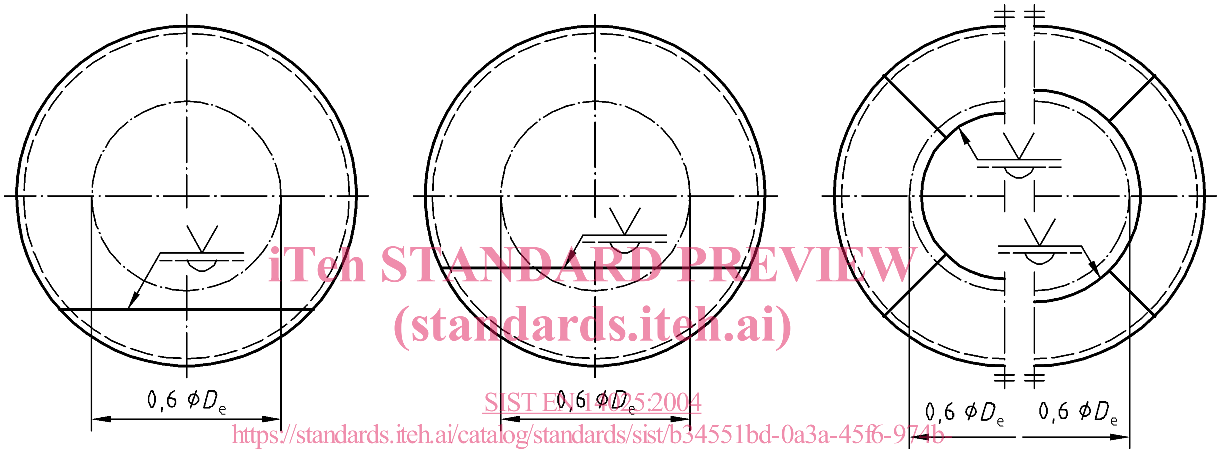
$$e_y = \beta_e \frac{p\,(0{,}75 \times R + 0{,}2 \times D_i)}{f_d} \qquad (3)$$

where $\beta_e$ is calculated from formulae (6) to (14).

$$e_s = \frac{p \times R}{2\; f_d \times \lambda_S - 0{,}5 \times p} \qquad (4)$$

$$e_b = (0{,}75 \times R + 0{,}2 \times D_i) \left( \frac{p}{111\; f_d} \left( \frac{D_i}{r} \right)^{0{,}825} \right)^{\left(\frac{2}{3}\right)} \qquad (5)$$

If ends are manufactured from several elements then the welding coefficient $\lambda_S$ may be taken equal to 1,0 (for thickness calculations only) if the weld crosses the crown area 0,6 $D_e$ (see Figure 3).






$\lambda_S$ = 0,8 resp. 1,0 according to 7.4.3 — $\lambda_S$ = 1,0 — $\lambda_S$ = 1,0 — $\lambda_S$ = 0,8 resp.1,0 according to 7.4.3

a) weld outside 0,6 $D_e$ b) weld inside 0,6 $D_e$ c) composed ends

**Figure 3 — Position of welds in ends**

**6.3.3.5.2** Formulae for calculation of $\beta_e$

$$Y = \min\,(e / R\,;\, 0{,}04) \qquad (6)$$

$$Z = \log\,(1/Y) \qquad (7)$$

$$X = r / D_i \qquad (8)$$

$$N = 1{,}006 - \frac{1}{6{,}2 + (90\;Y)^4} \qquad (9)$$

For $X$ = 0,06:

$$\beta_{e\,0{,}06} = N\,(-0{,}3635\;Z^3 + 2{,}2124\;Z^2 - 3{,}2937\;Z + 1{,}8873) \qquad (10)$$

For 0,06 < $X$ < 0,1:

$$\beta_e = 25\,[(0{,}1 - X)\beta_{e\,0{,}06} + (X - 0{,}06)\beta_{e\,0{,}1}] \qquad (11)$$

For $X$ = 0,1:

$$\beta_{e\,0,1} = N\,(-0{,}1833\,Z^3 + 1{,}0383\,Z^2 - 1{,}2943\,Z + 0{,}837) \quad (12)$$

For 0,1 < $X$ < 0,2:

$$\beta_e = 10\,[(0{,}2 - X)\beta_{e\,0,1} + (X - 0{,}1)\beta_{e\,0,2}] \quad (13)$$

For $X$ = 0,2:

$$\beta_{e\,0,2} = \max\{\,0{,}95\,(0{,}56 - 1{,}94\,Y - 82{,}5\,Y^2)\,;\,0{,}5\,\} \quad (14)$$

**6.3.3.5.3** Openings within the knuckle area of Kloepper- and Korbbogen-type ends

**6.3.3.5.3.1** In this clause rules are given for increasing the thickness of a dished end to compensate for branches within the knuckle area.

The rules are limited in application to Kloepper- and Korbbogen-type ends for which

a) $d_i / D_e \le 0{,}6$ (15)

b) $\dfrac{d_i}{\sqrt{e \times D_e}} \le 6{,}7$ (16)



The increased thickness required by this clause applies to the whole knuckle area. Welded-on compensation is not permitted.



**6.3.3.5.3.2** Determine $\beta_k$ from the procedure in Table 2.

Replace $p$ by ($\beta_k\,p$) in equation (3) to arrive at the required thickness. Equations (4) and (5) continue and apply without modification.

**Table 2 — Procedure for calculation of weakening factor $\beta_k$ for openings in the knuckle region (design)**

| Step | Kloepper type end | Korbbogen type end |
|---|---|---|
| 1 | $V = \log\left(1000\,\dfrac{p}{f_d}\right)$ | $V = \log\left(1000\,\dfrac{p}{f_d}\right)$ |
| 2 | $A = \max\{0{,}5\,;\,0{,}264 + 0{,}938\,V - 0{,}592\,V^2 + 0{,}14\,V^3\}$ | $A = 0{,}54 + 0{,}41\,V + 0{,}0441\,V^2$ |
| 3 | $B = \min\{4{,}2\,;\,4{,}91 - 2{,}165\,V + 0{,}151\,V^2\}$ | $B = 7{,}77 - 4{,}53\,V + 0{,}7441\,V^2$ |
| 4 | $\beta_k = \max\left(A + B\,\dfrac{d_i}{D_e}\,;\,1 + 0{,}3\,B\,\dfrac{d_i}{D_e}\right)$ | $\beta_k = \max\left(A + B\,\dfrac{d_i}{D_e}\,;\,1 + 0{,}5\,B\,\dfrac{d_i}{D_e}\right)$ |

**6.3.3.6** Thickness of ellipsoidal ends

An ellipsoidal end is an end that is made on a former that has a true ellipsoidal shape. Ellipsoidal ends shall have a shape factor $K$ with a value between 1,7 and 2,2.

$$K = \frac{D_i}{2\,h} \quad (17)$$

Ellipsoidal ends shall be designed as torispherical ends in accordance with 6.3.3.5 with values of $r$ and $R$ as given by the following:

$$r = \left( \frac{0{,}5}{K} - 0{,}08 \right) D_{\mathrm{i}} \tag{18}$$

$$R = (0{,}44\ K + 0{,}02)\ D_{\mathrm{i}} \tag{19}$$

### 6.3.4 Wall thickness of conical sections

**6.3.4.1** General

The conical section of the tank shell shall conform to the design limitations in 6.3.4.2. The wall thickness shall be determined in accordance with 6.3.4.3. For more information compare also EN 13445-3.

**6.3.4.2** Design limitations of the conical section

This clause gives rules for right circular cones and cone/cylinder intersections where the cone and the cylinder are of the same axis of rotation. It applies only to cones with an apex angle not greater than 120 ° and cones for which

$e \times \cos\alpha / D_{\mathrm{c}} > 0{,}001$ For the angle α see Figure 4. (20)

For offset cones between two cylinders the cylinders shall have parallel centrelines offset from each other by a distance not greater than the difference of the radii. A required thickness shall be calculated in accordance with 6.3.4.3.3 for the junction at the large end and in accordance with 6.3.4.3.4 for the junction at the small end. Since the thickness calculated above is the minimum allowable at that point along the case, it is permissible to build a cone from plates of different thickness provided that at every point the minimum is achieved.



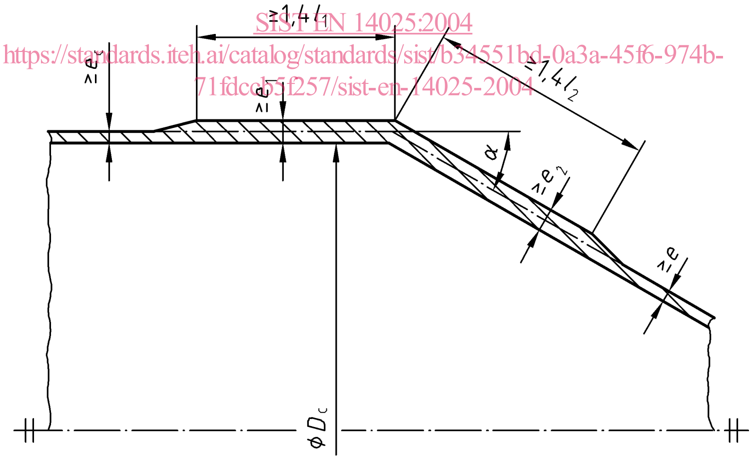



**Figure 4 — Junction between cylinder and cone; angle $\alpha$**

**6.3.4.3** Determination of the wall thickness of the conical section

**6.3.4.3.1** The minimum thickness of the wall of the conical section $e_{\mathrm{k}}$ of the shell shall be not less than the lowest value given by equation (21), unless otherwise required by the subclauses of 6.3.4.3.

$$e_{\mathrm{k}} = \left( \frac{p \times D_{\mathrm{i}}}{2\ f_{\mathrm{d}} \times \lambda_{\mathrm{S}} - p} \right) \left( \frac{1}{\cos\alpha} \right) \tag{21}$$

**6.3.4.3.2** Wall thickness at the junction of cylindrical and conical sections of the shell.

The conditions and design calculations for the large end of the cone are given in 6.3.4.3.3 and for the small end of the cone in 6.3.4.3.4.