SLOVENSKI STANDARD
SIST EN 14025:2008

01-oktober-2008

Nadomeģ a:
SIST EN 14025:2004
SIST EN 14025:2004/AC:2005

Posode za prevoz nevarnih snovi - Kovinske tlaļ ne cisterne - 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 matières dangereuses - Citernes métalliques sous pression - Conception et fabrication

Ta slovenski standard je istoveten z: **EN 14025:2008**

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 14025:2008 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14025

May 2008

ICS 13.300; 23.020.20

Supersedes EN 14025:2003

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

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Ref. No. EN 14025:2008: E

Contents

Foreword

This document (EN 14025:2008) has been prepared by Technical Committee CEN/TC 296 “Tanks for 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of an identical text or by endorsement, at the latest by November 2008, and conflicting national standards shall be withdrawn at the latest by November 2008.

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 supersedes EN 14025:2003.

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.

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

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.

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 EN 13530-2.

NOTE Design and construction of pressure tanks according to the scope of this standard are primarily subject to the requirements of RID/ADR, 6.8.2.1, 6.8.3.1 and 6.8.5, as relevant. In addition, the relevant requirements of RID/ADR, columns 12 and 13 of Table A to chapter 3.2, 4.3 and 6.8.2.4 shall be met. For the structural equipment subsections 6.8.2.2 and 6.8.3.2 apply, as relevant. The definitions of RID/ADR 1.2.1 are referred to.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 287–1, *Qualification test of welders - Fusion welding - Part 1: Steels*

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

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

EN 13094:2008, *Tanks for the transport of dangerous goods — Metallic tanks with a working pressure not exceeding 0,5 bar — Design and construction*

EN 13445-2, *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 ISO 3834-1, *Quality requirements for fusion welding of metallic materials — Part 1: Criteria for the selection of the appropriate level of quality requirements (ISO 3834-1:2005)*

EN ISO 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements (ISO 3834-2:2005)*

EN ISO 5817, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2003, corrected version:2005, including Technical Corrigendum 1:2006)*

EN ISO 9606-2, *Qualification test of welders - Fusion welding Part 2:— Aluminium and aluminium alloys (ISO 9606-2:2004)*

EN ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections (ISO 10042:2005)*

EN ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607:2003)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15609-3, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 3: Electron beam welding (ISO 15609- 3:2004)*

EN ISO 15609-4, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 4: Laser beam welding (ISO 15609-4:2004)*

EN ISO 15610, *Specification and qualification of welding procedures for metallic materials — Qualification based on tested welding consumables (ISO 15610:2003)*

EN ISO 15611, *Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience (ISO 15611:2003)*

EN ISO 15612, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure (ISO 15612:2004)*

EN ISO 15613, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test (ISO 15613:2004)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

EN ISO 15614-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005)*

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 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this standard, the following term and definition applies.

3.1.1
pressure-tank
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 and special symbols are explained with the relevant formulae. Additional symbols used in the text are explained in Annex A.

A, $A_{\text{p ; fm ; fb ; fp}}$ 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 or guaranteed minimum 0,2 % proof strength, in N/mm² (for austenitic steel the 1 % proof strength may be chosen)

$R_{e,t}$ guaranteed (upper) minimum yield strength or guaranteed minimum 0,2 % proof strength, at the relevant design temperature, in N/mm² (for austenitic steel the 1 % proof strength at the relevant design temperature may be chosen)

R_m guaranteed minimum tensile strength, in N/mm²

$R_{m,t}$ guaranteed minimum tensile strength at the relevant design temperature, in N/mm²

λ_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 and A.3. For aluminium and aluminium alloys see also EN 14286.

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;

(see also A.2).

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 B 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 international regulations are given in Annex A for information.

5.2 Reduction of shell thickness

The minimum wall thickness of shells (see A.2) 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).

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:

— 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;

— 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 for reduced wall thickness;

— "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. One method of comparing the strength of sheets of materials is given in Annex B of EN 13094:2008.

For shells of road tank vehicles see also 6.8.2 of EN 13094:2008.

5.4 Protection of equipment

Items of equipment shall be protected against the risk of being wrenched off or damaged during transport or handling.

Equipment shall be protected by strengthening rings, protective canopies or transverse or longitudinal members. The protection of equipment shall comply with 6.14 of EN 13094:2008.

Items of equipment of tank containers are protected if placed within the contours of a skeleton structure (frame).

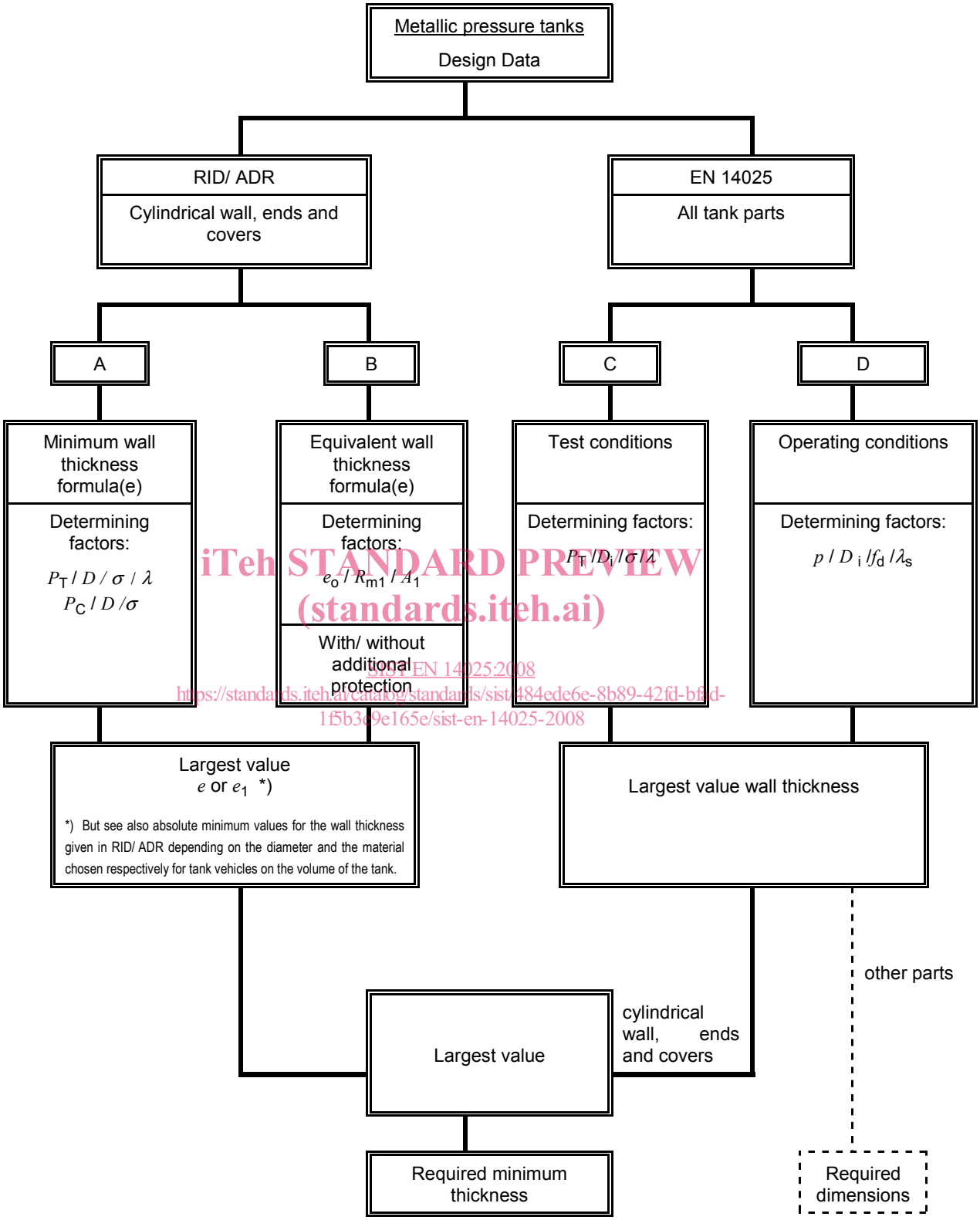
Equipment used on tanks for the transport of substances to which the special provision TE 19 of ADR (see subsection 6.8.4 ADR) is allocated need additional protection.

NOTE For vacuum-operated waste tanks RID/ADR 6.10.3.1 applies.

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 international regulations (i.e. RID and ADR).



The wall thickness chosen, shall not be less than the maximum value resulting from the wall thickness determined according to the relevant international regulations (i.e. RID/ADR, branches A and B in Figure 1 and A.2) on the one hand and according to the following equations relevant to the test and service conditions (branches C and D in Figure 1) on the other.

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

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 but not less than $(p_{vap}$ – 1 bar) + p_{dyn} if applicable [a]	p_{test} [b]
f_d for ferritic steels and aluminium alloys	min { $R_{e,t}$ / 1,5; R_m / 2,4}	min { 0,75 R_e ; 0,5 R_m }
f_d for austenitic steels with 30 % ≤ A ≤ 35 %	$R_{e,t}$ / 1,5	
f_d for austenitic steels with A > 35 %	max { $R_{e,t}$ / 1,5; min ($R_{e,t}$ / 1,2 ; $R_{m,t}$ / 3)} [c]	
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 pressure p_{dyn} determined on the basis of the forces specified in the relevant international regulations (see Annex A) but not less than 35 kPa (0,35 bar) and add it to the vapour gauge pressure
(p_{vap} – 1 bar). The largest compartment needs to be taken into account.

[b] To be taken from the relevant international regulation, (see also A.4).

[c] It needs to be noted that the guaranteed minimum mechanical values differ with the temperature, and have to be chosen accordingly. If no standard values are available, applicable values have to be determined otherwise.

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. 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.

The calculation for construction types not given hereafter shall be in accordance with to EN 13445-3.

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

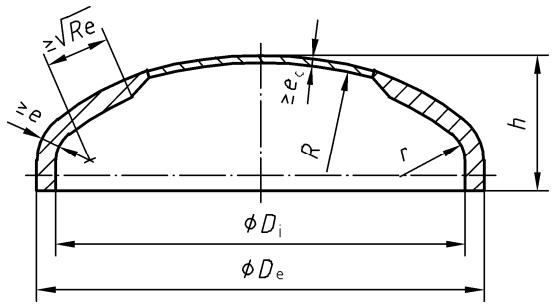


Figure 2 — Geometry of ends

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).

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

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).

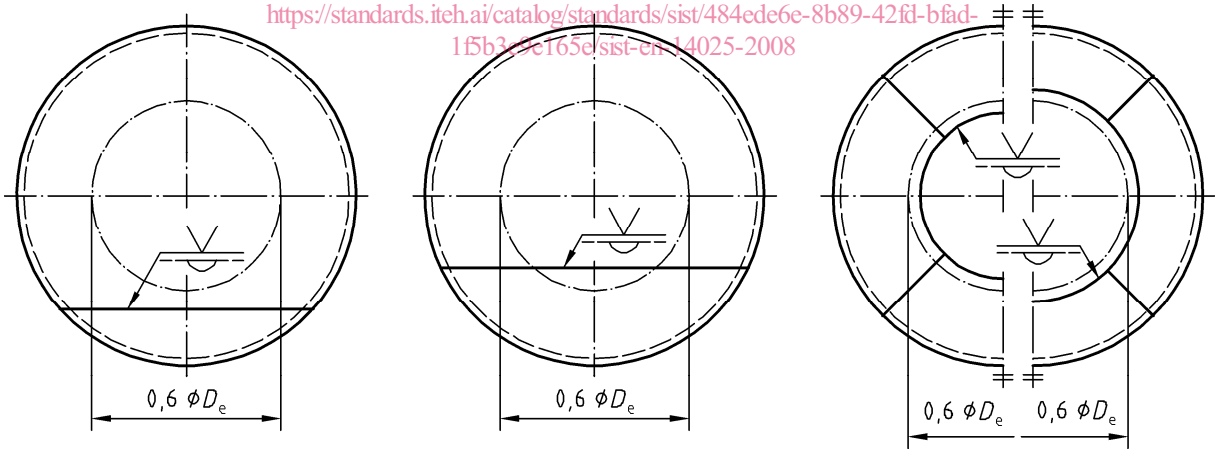
$$e_y = \beta_e \frac{p\,(0{,}75 \times R + 0{,}2 \times D_i)}{f_d} \tag{3}$$

where β_e is calculated from Equations (6) to (14).

$$e_s = \frac{p \times R}{2\, f_d \times \lambda_S - 0{,}5 \times p} \tag{4}$$

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

If ends are manufactured from several elements then the welding coefficient λ_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).



λ_S = 0,8 resp. 1,0 according to 7.4.3 — λ_S = 1,0 — λ_S = 1,0 — λ_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 β_e

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

$$Z = \log_{10}\,(1/Y) \tag{7}$$

$$X = r / D_i \tag{8}$$

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

For X = 0,06:

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

For 0,06 < X < 0,1:

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

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

b) $\dfrac{d_i}{\sqrt{e \times D_e}} \leq 6{,}7$ (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 β_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.