SLOVENSKI STANDARD

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Industrijski ventili - Trdnost ohišja - 1. del: Tabelarična metoda za ohišja jeklenih ventilov

Industrial valves - Shell design strength - Part 1: Tabulation method for steel valve shells

Industriearmaturen - Gehäusefestigkeit - Teil 1: Tabellenverfahren für drucktragende Gehäuse von Armaturen aus Stahl

Robinetterie industrielle - Résistance mécanique des enveloppes - Partie 1 : Méthode tabulaire relative aux enveloppes d'appareils de robinetterie en acier

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This European Standard was approved by CEN on 9 August 2014 and includes Amendment 1 approved by CEN on 16 March 2018.

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European foreword

This document (EN 12516-1:2014+A1:2018) has been prepared by Technical Committee CEN/TC 69 "Industrial valves", 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of an identical text or by endorsement, at the latest by March 2019, and conflicting national standards shall be withdrawn at the latest by March 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1 approved by CEN on 2018-03-16.

This document supersedes [A1) EN 12516-1:2014 (A1].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1) (A1].

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 [A1) EU Directive 2014/68/EU (A1].

For relationship with [A1) EU Directive 2014/68/EU (A1], see informative Annex ZA, which is an integral part of this document.

EN 12516 comprises the following parts:

— *Industrial valves — Shell design strength — Part 1: Tabulation method for steel valve shells;*

— *Industrial valves — Shell design strength — Part 2: Calculation method for steel valve shells;*

— *Valves — Shell design strength — Part 3: Experimental method;*

— *Industrial valves — Shell design strength — Part 4: Calculation method for valve shells manufactured in metallic materials other than steel.*

The main changes between EN 12516-1:2005 and EN 12516-1:2014 are listed below:

a) addition of new PN values PN 160, PN 250, PN 320, PN 400;

b) B designation rating have been replaced by the PN designation;

c) B20 rating values have been replaced by Class 150 and use of the calculation method given in ASME B16.34;

d) new PN values have been added to Table 7 for the valve body minimum wall thickness values;

e) material tables have been updated to be in line with EN 1092-1 for the EN materials;

f) materials 1.0345 and 1.4458 have been deleted;

g) Annex B material groups has been updated and made normative;

h) special Class in EN material have been moved to an informative Annex C;

i) EN materials properties for pressure temperature calculation have been modified (R_m/3,5) to be consistent with the new ASME rules, and using $R_{p1\,\%}$ for stainless steel consistent with EN 12516-2;

j) ASTM material properties used for rating calculation have been updated to the new ASME B16.34 rules;

k) in the pressure-temperature calculation formula the stress factor S has been changed to 120,7 MPa in order to get a Ps of 775,7 bar which is the ceiling pressure when calculating the Special Class 4 500;

l) pressure/temperature ratings have been recalculated. For PN values they are now limited to the PN number; this has been done by increasing the Pc value in the pressure rating calculation method consequently the wall thickness for the PN designation has been increased;

m) Annexes D, E, F, G for NDE have been updated to the new EN standards and made informative;

n) Annex H limited Class has been made informative;

o) ASTM/ASME materials have been moved to an informative Annex I;

p) an informative Annex J on the relationship between DN, NPS, pipe inside diameter and outside diameter has been added;

q) Annex ZA has been updated.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

EN 12516, *Industrial valves — Shell design strength*, is in four parts. EN 12516-1 and EN 12516-2 specify methods for determining the thickness of steel valve shells by tabulation or calculation methods respectively. EN 12516-3 establishes an experimental method for assessing the strength of valve shells in steel, cast iron and copper alloy as a type test by applying an elevated hydrostatic pressure at ambient temperature. EN 12516-4 specifies method for calculating the thickness for valve shells in metallic material other than steel.

The tabulation method, EN 12516-1, is similar in approach to ASME B16.34 in that the designer can look up the required minimum wall thickness dimension of the valve body from a table. The internal diameter of the inlet bore of the valve, gives the reference dimension from which the tabulated wall thickness of the body are calculated. It applies only to valve bodies, bonnets and covers with essentially circular cross-section. For valve shells with oval or rectangular shapes and for additional loads, EN 12516-2 should be used (see 8.6).

The calculation method, EN 12516-2 is similar in approach to the former DIN 3840 where the designer is required to calculate the wall thickness for each point on the pressure temperature curve using the allowable stress at that temperature for the material he has chosen. The allowable stress is calculated from the material properties using the safety factors that are defined in EN 12516-2. The formulae in EN 12516-2 consider the valve as a pressure vessel and ensure that there will be no excessive deformation or plastic instability.

EN 12516-1 specifies Standard and Special pressure/temperature ratings for valve shells with bodies having the tabulated thickness.

The tabulation method gives one thickness for the body for each PN (see 3.1) or Class designation depending only on the inside diameter, D_i, of the body at the point where the thickness is to be determined.

The thicknesses are calculated using the thin cylinder formula that is also used in EN 12516-2. The allowable stress used in the formula is equal to 120,7 MPa and the calculation pressure Pc varies according PN and Class designation.

For the Class designations, the rules for determining the pressure/temperature ratings are the same for both valve shells and flanges.

For PN designations rules for determining the pressure /temperature ratings are different for flanges and for valves, but this revision of the standard has adjusted the rules to get at room temperature the same pressure. The change of pressure in temperature needs to be taken into account by the piping/assembler.

The main reasons for the differences are due to the treatment of ceiling values. In PN flanges, a constant ceiling stress of 140 MPa at room temperature is applied. In PN and Class designations, the EN 12516-1 ceiling criteria apply, which are temperature dependent.

The reason for the down rating of Standard rating values relative to Special rating is that the Standard rating body is not subject to the specified non-destructive examination procedures and acceptance levels.

The thicknesses for all designations are approximately proportional to the Class 4 500 thickness in the ratio of the pressures.

This standard tabulates the commonly used ratings. It is possible to design shells to suit particular applications or markets using intermediate ratings. This data can be obtained using linear interpolation of the tabulated data in EN 12516-1.

A merit of the tabulation method, which has a fixed set of shell dimensions irrespective of the material of the shell, is that it is possible to have common patterns and forging dies. The allowable pressure/temperature rating for each material group varies proportional to the selected stresses of the material group to which the material belong.

A merit of the calculation method is that it allows the most efficient design for a specific application using the allowable stresses for the actual material selected for the application.

The two methods are based on different assumptions, and as a consequence the detail analysis is different. Both methods offer a safe and proven method of designing pressure-bearing components of valve shells.

1 Scope

This European Standard specifies the tabulation method for determining the wall thickness of valve bodies, bonnets and covers with essentially circular cross-section made in forged, cast or fabricated steel.

For valve shells with oval, rectangular or non-circular shapes, see 8.6.

The range of PN or Class designations for which thicknesses are tabulated is:

PN 2,5, PN 6, PN 10, PN 16, PN 25, PN 40, PN 63, PN 100, PN 160, PN 250, PN 320, PN 400, Class 150, Class 300,Class 600, Class 900, Class 1 500, Class 2 500, Class 4 500.

Pressure/temperature ratings are specified for each material group for the above PN Standard Class and Special Class designations.

The non-destructive examination procedures and acceptance levels that need to be applied to the valve shell components in order for the valve to be used at Special Class pressure/temperature ratings are defined.

Details are also given for the alternative rules for small bore valves of DN 65 and smaller designated as Limited Class.

This standard does not apply to threaded end valves:

— DN 80 or larger;

— or which have pressure ratings greater than Class 2 500;

— or which operate at temperatures greater than 540 °C.

Socket welding end valves DN 80 or larger are outside the scope of this standard.

2 Normative references

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

A1〉 EN 19:2016 〈A1, *Industrial valves - Marking of metallic valves*

A1〉 EN 736-1:2018 〈A1, *Valves — Terminology — Part 1: Definition of types of valves*

A1〉 EN 736-2:2016 〈A1, *Valves - Terminology - Part 2: Definition of components of valves*

A1〉 EN 736-3:2008 〈A1, *Valves - Terminology - Part 3: Definition of terms*

EN 1092-1:2007+A1:2013, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1759-1:2004, *Flanges and their joint - Circular flanges for pipes, valves, fittings and accessories, Class designated - Part 1: Steel flanges, NPS ½ to 24*

EN 10028-2:2009, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2009, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2009, *Flat products made of steels for pressure purposes — Part 4: Nickel alloy steels with specified low temperature properties*

EN 10028-7:2007, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

EN 10213:2007, *Steel castings for pressure purposes*

EN 10222-2:1999, *Steel forgings for pressure purposes — Part 2: Ferritic and martensitic steels with specified elevated temperature properties*

EN 10222-3:1998, *Steel forgings for pressure purposes — Part 3: Nickel steels with specified low temperature properties*

EN 10222-4:1998, *Steel forgings for pressure purposes — Part 4: Weldable fine grain steels with high proof strength*

EN 10222-5:1999, *Steel forgings for pressure purposes — Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels*

EN 12516-2:2014, *Industrial valves - Shell design strength - Part 2: Calculation method for steel valve shells*

EN 12627:1999, *Industrial valves — Butt welding ends for steel valves*

EN ISO 9692-1:2013, *Welding and allied processes - Types of joint preparation - Part 1: Manual metal arc welding, gas-shielded metal arc welding, gas welding, TIG welding and beam welding of steels (ISO 9692-1:2013)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 736-1, EN 736-2 and EN 736-3 and the following apply.

3.1
PN (body)
alphanumeric designation used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system

Note 1 to entry: It comprises the letter PN followed by a dimensionless number.

Note 2 to entry: See EN 736-3.

3.2
Class
alphanumeric designation used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system

Note 1 to entry: It comprises the word Class followed by a dimensionless whole number.

Note 2 to entry: See EN 736-3.

3.3
Special
designation associated Special Class threaded end or welding end valves which indicates that the shell components have been subjected to the specified levels of non-destructive examination (NDE) and that the valve can be used for a higher pressure/temperature rating

4 Symbols and units

Table 1 — Symbols and units

Symbol	Characteristic	Unit
A	Minimum diameter of socket	mm
A_σ	Metal area	mm^2
A_f	Fluid area	mm^2
B	Minimum depth of socket	mm
c	Constant	mm
d'	Body neck inside diameter	mm
D'_i	Body neck inside diameter beyond flow passage	mm
D''_i	Body neck inside diameter used for wall thickness determination	mm
D_i	Inside diameter of the valve	mm
$D_{i,max}$	Maximum inside diameter of the valve	mm
$D_{i,min}$	Minimum inside diameter of the valve	mm
D_{ni}	Inside diameter at the body end port	mm
e_b	Neck wall thickness	mm
e_{min}	Minimum wall thickness	mm
e_r	Body run wall thickness	mm
e_{soc}	Wall thickness of socket welding	mm
J	Diameter of the boss	mm
OD	Outlet diameter of pipe	mm
$p_{ceil/std}$	Ceiling pressure for standard rating	bar
p_c	Calculation pressure	MPa
$p_{ceil/spe}$	Ceiling pressure for special rating	bar
p_{ld}	Limited class allowable pressure at temperature	bar
p_r	Pressure rating index	dimensionless
p_s	Allowable pressure at temperature	bar
r	Filet radius at crotch	mm
S	Stress factor	MPa
$S_{sel/spe}$	Selected stress for special rating	MPa
$S_{sel/std}$	Selected stress for standard rating	MPa
t	Temperature	°C
T	Length of thread	mm
y	Temperature coefficient	dimensionless
f	Allowable stress	MPa

5 Material groups and material temperature limitations

The materials for the body, bonnet and cover are allocated to a material group for the purposes of determining the pressure/temperature ratings as given in Table 8.

The temperature limitations for EN materials shall be as given in the material standard.

The choice of material groupings is explained in Annex B.

6 Pressure/temperature (*p/t*) ratings

6.1 General

The pressure/temperature ratings are established according Annex A.

The rating Tables 9 to 31 specify the allowable pressures at different temperatures for bodies, bonnets and covers with PN and Class designations made from the appropriate material group (see Annex B). The temperature of the valve is generally the temperature of the contained fluid.

6.2 Standard rating

In conformance with the present standard, standard rating applies to flanged (see 6.6) and butt welding end valves in all sizes and to valves with threaded and socket welding ends up to DN 65 (NPS 2 1/2).

When a valve body or bonnet is manufactured by welding parts together, it shall be classified as suitable for Standard rating provided that 10 % of the welds are subject to random non-destructive testing in such a manner that it results in a joint efficiency of 0,85.

6.3 Special Class

The bodies, bonnets and covers that have been subjected to the levels of NDE specified in Annex J can be used at a higher pressure/temperature rating than Standard Class.

When a valve body or bonnet is manufactured by welding parts together, it shall only be classified as suitable for Special rating if it meets the requirements of Annex C.

6.4 Limited Class

Welding and threaded end valves in sizes DN 65 (NPS 2 1/2) and smaller designated as Limited Class, shall follow the requirements of Annex H. Ratings shall not exceed the values calculated in accordance with Annex H.

6.5 Intermediate ratings

Any pressure/temperature ratings in either Standard Class or Special Class ratings, between those listed in the tables may be assigned to welding or threaded end valves providing all the requirement of this standard are met.

Intermediate ratings are determined by linear interpolation of tabulated values.

6.6 Flanged ratings

The decrease of pressure versus temperature for valves with PN flanges designed according to this standard differs from EN 1092-1. The user shall take this into account when selecting the flange rating.

7 Temperature effects

7.1 Temperature limits

Bolted flange joints operating in the creep range or those which experience substantial thermal gradients will be subject to decreasing bolt loads as relaxation of flanges, bolts and gaskets take place. The designer shall take into account that decreasing bolt loads will reduce the capacity of the bolted joint to remain leak tight. Material shall be used within their established limits. If no material properties are available, an individual material assessment is required.

Some materials are suitable for temperatures below room temperature, RT but the pressure rating shall not be greater than that given for room temperature.

7.2 Fluid thermal expansion

It is possible, in some valve designs, for sealed cavities within the valve body to be filled with liquid, for example during hydrostatic test. If this liquid is not released, by partially opening the valve or some other means, and it is subject to a temperature increase, excessive pressure sufficient to cause pressure boundary failure can be generated. Where such a condition is possible, the design, installation, or operating procedures shall assure that the pressure in the valve will not exceed that allowed in this standard.

8 Dimensions

8.1 Minimum wall thickness

The wall thickness of valve bodies, at the time of manufacture and excluding all linings or liners, shall be not less than e_{min} as listed in Table 7 except as allowed in 8.3, 8.4 and 8.5. Intermediate values between those listed in Table 7 may be obtained by linear interpolation. The specified thickness only applies from internally wetted surfaces.

The thickness tabulated in Table 7 includes a 1,0 mm standardized allowance for erosion and linear corrosion.

8.2 Inside diameter

For the purpose of determining the wall thickness, e_{min}, of a full bore valve the inside diameter, D_i, is taken as the minimum diameter of the flow passage but not less than 90 % of the body end port inside diameter at (D_{ni}).

For the purpose of determining the wall thickness, e_{min}, of a reduced bore valve the inside diameter, D_i, is taken as the diameter of the flow passage in a plane at a distance, e_{min}, from the outside surface of the body neck as measured along the body run (see Figure 1 a)).

For socket welding and threaded end valves, the socket or thread diameters and associated counterbores or tapped bores need not be taken into account in establishing the value of D_i.

For the case of valves used between high and low pressure sections of a system then the inside diameter of the higher pressure end shall be used for D_i. Local variations in bore associated with the butt weld end profile need not be considered. Where linings or inserts of any kind are used to form the whole or part of the flow passage, they shall be ignored when determining e_{min}.