BS EN 593:2017

BSI Standards Publication

Industrial valves - Metallic butterfly valves for general purposes

bsi.

National foreword

This British Standard is the UK implementation of EN 593:2017. It supersedes BS EN 593:2009+A1:2011, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/18/3, Industrial valves, steam traps, actuators and safety devices against excessive pressure - Part turn valves (Ball, plug and butterfly).

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Industrial valves - Metallic butterfly valves for general purposes

Robinetterie industrielle - Robinets métalliques à papillon d'usage général

Industriearmaturen - Metallische Klappen für den allgemeinen Gebrauch

This European Standard was approved by CEN on 31 August 2017.

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European foreword

This document (EN 593:2017) 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of an identical text or by endorsement, at the latest by April 2018, and conflicting national standards shall be withdrawn at the latest by April 2018.

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 supersedes EN 593:2009+A1:2011.

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 2014/68/EU.

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

The main technical changes compared to the previous edition are:

a) the extension of the dimensions to cover PN 2,5 to PN 160, Class 150 to Class 900 and DN 20 to DN 4 000;

b) the inclusion of single, double and triple eccentric designs;

c) a reference to EN 16668 for valves subject to European legislation on pressure equipment;

d) the addition of informative Annex D giving the correspondence between DN and NPS;

e) the addition of informative Annex E on valve torque curves at different flow velocities;

f) the updating of Annex ZA according to the new PED.

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, 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.

1 Scope

This European Standard specifies minimum general requirements for butterfly valves having metallic bodies for use with all type of pipe end connections (e.g. wafer, lug, flange, butt welding) and used for isolating, regulating or control applications.

The PN and Class ranges are:

— PN 2,5; PN 6; PN 10; PN 16; PN 25; PN 40; PN 63; PN 100; PN 160;

— Class 150; Class 300; Class 600; Class 900.

The size range is:

— DN 20; DN 25; DN 32; DN 40; DN 50; DN 65; DN 80; DN 100; DN 125; DN 150; DN 200; DN 250; DN 300; DN 350; DN 400; DN 450; DN 500; DN 600; DN 700; DN 750; DN 800; DN 900; DN 1 000; DN 1 050; DN 1 100; DN 1 200; DN 1 400; DN 1 500; DN 1 600; DN 1 800; DN 2 000; DN 2 200; DN 2 400; DN 2 600; DN 2 800; DN 3 000; DN 3 200; DN 3 400; DN 3 600; DN 3 800; DN 4 000.

DN 750 and DN 1 050 are used only for Class 150 and Class 300.

Intermediate DNs are allowed upon agreement between manufacturer and customer.

For valves subject to European legislation on pressure equipment, EN 16668 applies together with this European Standard.

For industrial process control valves, EN 1349 and EN 60534-2-1 apply together with this European Standard.

For water supply application, EN 1074-1 and EN 1074-2 apply together with this European Standard.

NOTE 1 Butterfly valves for water supply application do not comply with Annex ZA and are not CE marked because they are excluded from the pressure equipment European legislation.

NOTE 2 The range of DN, applicable to each PN, for wafer and wafer lug valve types is as given in the appropriate part of EN 1092 for Type 11 flanges for the applicable material. The range of DN, applicable to each PN, for flanged valve types is as given in the appropriate part of EN 1092 for Type 21 flanges for the applicable material.

The correspondence between DN and NPS is given for information in Annex D.

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.

EN 19:2016, *Industrial valves — Marking of metallic valves*

EN 558:2017, *Industrial valves — Face-to-face and centre-to-face dimensions of metal valves for use in flanged pipe systems — PN and Class designated valves*

EN 736-1:1995, *Valves — Terminology — Part 1: Definition of types of valves*

EN 736-2:2016, *Valves — Terminology — Part 2: Definition of components of valves*

EN 736-3:2008, *Valves — Terminology — Part 3: Definition of terms*

EN 1074-2:2000, *Valves for water supply — Fitness for purpose requirements and appropriate verification tests — Part 2: Isolating valves*

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 1092-2:1997, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges*

EN 1092-3:2003, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 3: Copper alloy flanges*

EN 1092-4:2002, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 4: Aluminium alloy flanges*

EN 1267:2012, *Industrial valves — Test of flow resistance using water as test fluid*

EN 1759-1:2004, *Flanges and their joint — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 1: Steel flanges, NPS 1/2 to 24*

EN 1759-3:2003, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 3: Copper alloy flanges*

EN 1759-4:2003, *Flanges and their joint — Circular flanges for pipes, valves, fittings and accessories, class designated — Part 4: Aluminium alloy flanges*

EN 10269:2013, *Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties*

EN 12266-1:2012, *Industrial valves — Testing of metallic valves — Part 1: Pressure tests, test procedures and acceptance criteria — Mandatory requirements*

EN 12266-2:2012, *Industrial valves — Testing of metallic valves — Part 2: Tests, test procedures and acceptance criteria — Supplementary requirements*

EN 12516-1:2014, *Industrial valves — Shell design strength — Part 1: Tabulation method for steel valve shells*

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

EN 12516-3:2002, *Valves — Shell design strength — Part 3: Experimental method*

EN 12516-4:2014, *Industrial valves — Shell design strength — Part 4: Calculation method for valve shells manufactured in metallic materials other than steel*

EN 12570:2000, *Industrial valves — Method for sizing the operating element*

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

EN 12982:2009, *Industrial valves — End-to-end and centre-to-end dimensions for butt welding end valves*

EN 16668:2016, *Industrial valves — Requirements and testing for metallic valves as pressure accessories*

EN 60534-2-3:2016, *Industrial-process control valves — Part 2-3: Flow capacity — Test procedures (IEC 60534-2-3:2015)*

EN ISO 1043-1:2011, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics (ISO 1043-1:2011)*

EN ISO 5211:2017, *Industrial valves — Part-turn actuator attachments (ISO 5211:2017)*

EN ISO 9606-1:2017, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606-1:2012 including Cor 1:2012 and Cor 2:2013)*

EN ISO 10497:2010, *Testing of valves — Fire type-testing requirements (ISO 10497:2010)*

EN ISO 14732:2013, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732:2013)*

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

ISO 1629:2013, *Rubber and latices — Nomenclature*

ASME B1.1:2003, *Unified Inch Screw Threads, (UN and UNR Thread Form)*

3 Terms and definitions

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

3.1
maximum allowable pressure
PS
maximum pressure for which the pressure equipment is designed as specified by the manufacturer

[SOURCE: EN 764-1:2015+A1:2016, 3.2.87]

3.2
maximum allowable temperature
TS_{max}
maximum temperature for which the pressure equipment is designed as specified by the manufacturer

[SOURCE: EN 764-1:2015+A1:2016, 3.1.9]

3.3
end of line service
condition that occurs when the downstream side of the valve is opened to atmosphere

3.4
driving shaft
shaft connected to the obturator to operate the valve in the case of a multi-shaft valve

3.5
trim
parts in contact with the fluid

3.6
eccentration
offset
deviation of the operating axes in respect to the reference axes of the pipe/valve

4 Design requirements

4.1 General

Valves subject to pressure equipment European legislation shall comply with the requirements of EN 16668.

The valve shall be of either concentric design (see Figure 1) or eccentric design (see Figures 2 to 4). The offset may be single, double or triple.

A first offset is an axial offset of the shaft to the seat contact.

A second offset is an offset from the pipe centreline to the valve obturator centerline.

In the triple offset design, the seat and seal contact surface centreline is inclined in respect to the pipe / valve centreline, whatever the form of the contact.

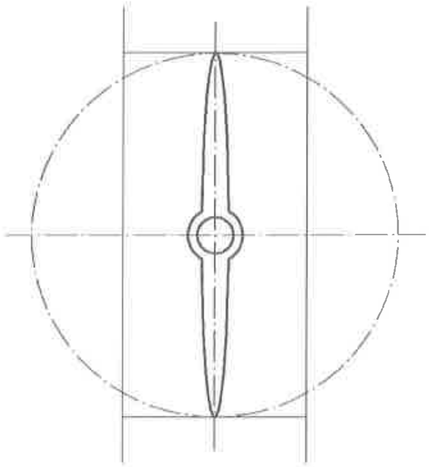
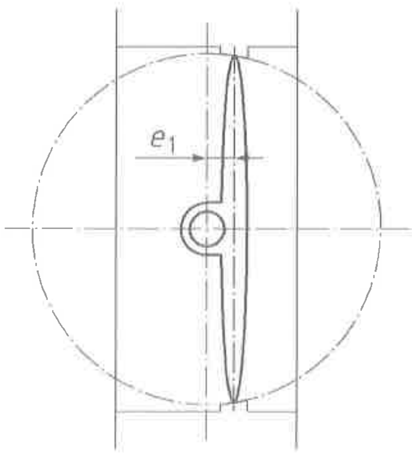


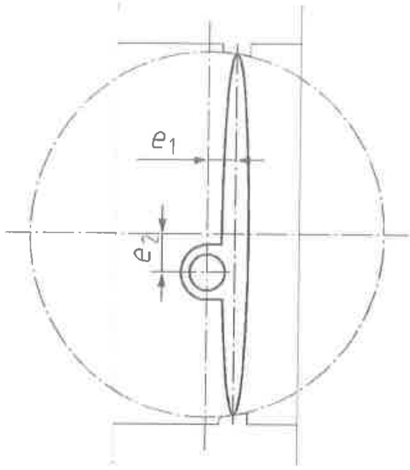
Figure 1 — Concentric design



Key

e_1 eccentricity 1

Figure 2 — Single eccentric design (single offset)

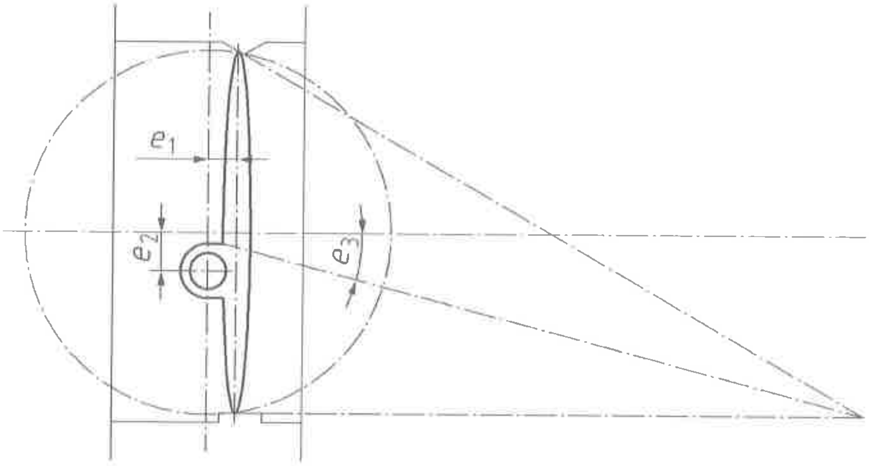


Key

e_1 eccentricity 1

e_2 eccentricity 2

Figure 3 — Double eccentric design (double offset)



Key

e_1 eccentricity 1

e_2 eccentricity 2

e_3 eccentricity 3

Figure 4 — Triple eccentric design (triple offset)

The design details are the responsibility of the manufacturer.

The butterfly valve may be:

— soft sealing; or

— metallic sealing.

NOTE The choice of design and material depends on the design working temperature and the physical and chemical characteristics of the fluid.

4.2 Shell

The shell is the combination of all pressure retaining part:

— the body,

— the retaining elements of the shaft seal ring or the stuffing box;

— the cover and the cover bolting if any,

— if used as end of line, the obturator and the shaft.

4.3 Body

4.3.1 General

Flanges of double flanged valves and single flange wafer valves shall have bolt holes in accordance with the relevant standard as specified in 4.11.2. Threaded holes can be provided where the design of the valve precludes through flange bolting.

Flangeless wafer valves (see Figure 6) are intended for clamping between pipe flanges using through bolting. The shape of wafer valve bodies shall be such that centring of the valves within the appropriate flange bolt circle is ensured. Where through bolting is not practicable due to the valve design, e.g. close to shaft passages, threaded holes can be provided for individual bolting.

Lugged or single flange wafer valves (see Figure 7) are supplied with threaded or through holes for installation between two flanged components or at the end of a pipeline (i.e. end of line service or downstream dismantling).

Threaded holes shall allow full thread engagement to a depth at least equal to the nominal bolt diameter and at least 0,67 of the bolt diameter when the bolt hole is adjacent to the valve shaft.

For Class designed valves threaded body flange holes for bolts 1 inch or less in diameter shall be drilled and tapped in accordance with ASME B1.1, UNC coarse thread series, Class 2B. For bolts 1 1/8 inches or more in diameter, such holes shall be drilled and tapped in accordance with ASME B1.1, UN 8 eight thread series, Class 2B. Threads according to other standards shall be specified.

The manufacturer's literature shall be consulted to determine if through bolting or/and end of line assembly is possible. Any limitation regarding end of line service condition shall be indicated.

Elastomeric or plastic linings and liners can be extended over the flange faces of the body to form a gasket for the flange.

4.3.2 End connections

End connections shall be either one of the following.

a) Double flanged butterfly valve: butterfly valve having double flanged body ends for connection to flanges of adjacent components by individual bolting (see Figure 5).

b) Wafer butterfly valve: butterfly valve intended for clamping between flanges of adjacent components.

NOTE Different body shapes are possible: see Figures 6 and 7 a) to g).

c) Butt welding end butterfly valve: butterfly valve intended for butt welding into a pipeline (see Figure 8).

d) Mechanical connection for loose flange connection: butterfly valve with one or both loose flanges for compensation of piping alignment (see Figure 9). The loose flange shall be pullout proof.

e) Mechanical connection: butterfly valve with one or two interfaces for connection of piping (see Figures 10 and 11). The connection shall be spigot end or socket end. Requirements and test methods of mechanical joints are described in EN 545. The connection may be pullout proof.

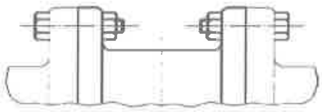


Figure 5 — Double flanged body

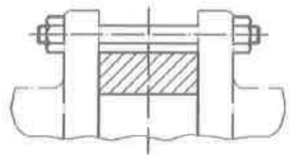
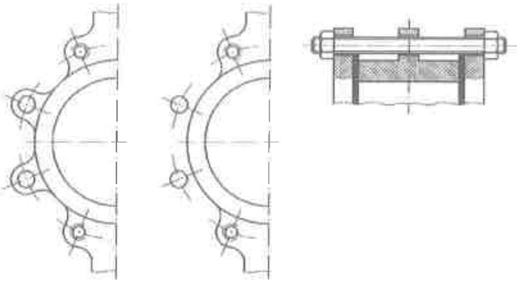
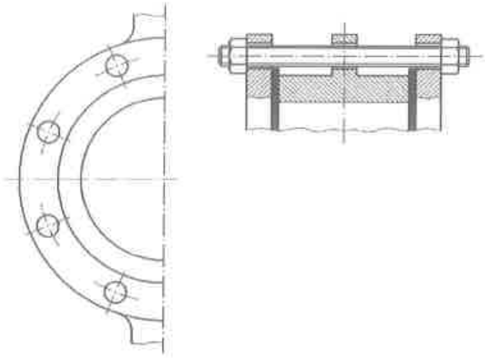


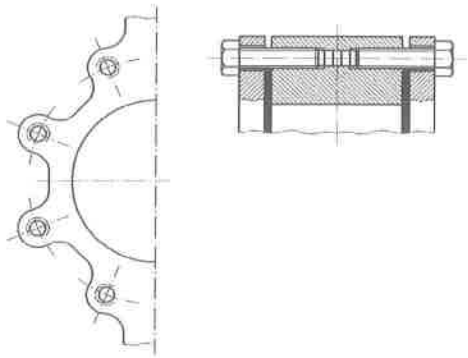
Figure 6 — Flangeless wafer body



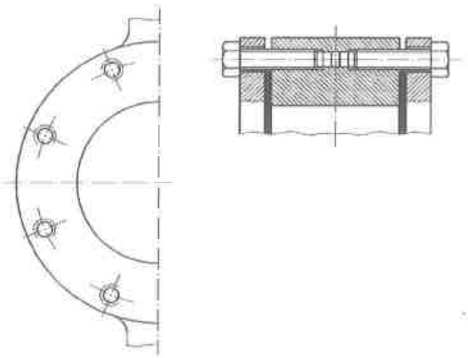
a) Valve with central lugs



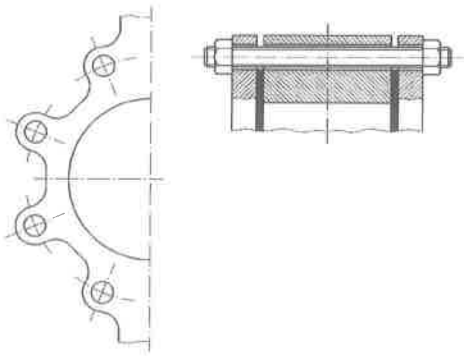
b) Central single flange valve



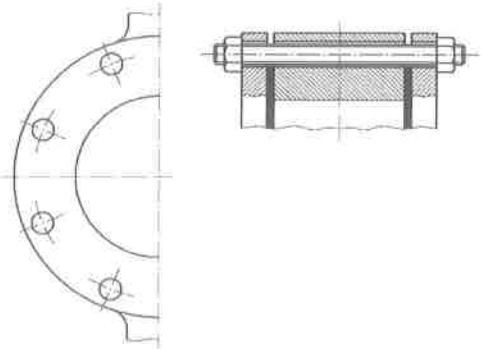
c) Valve with lugs with internally threaded holes



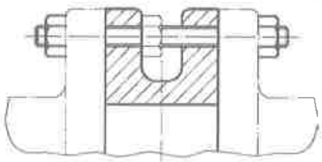
d) Single-flange valve with internally threaded holes



e) Valve with lugs with drilled holes



f) Single-flange valve with drilled holes



g) Valve with U-section

Figure 7 — Wafer valve bodies bolting configurations

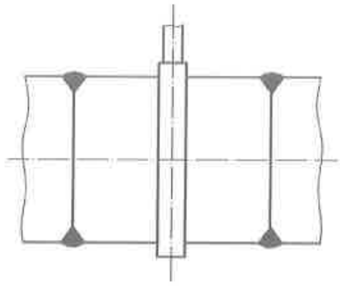


Figure 8 — Butt welding end body

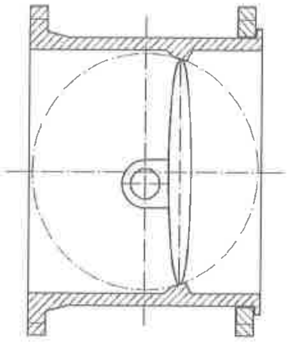


Figure 9 — Loose-flange design

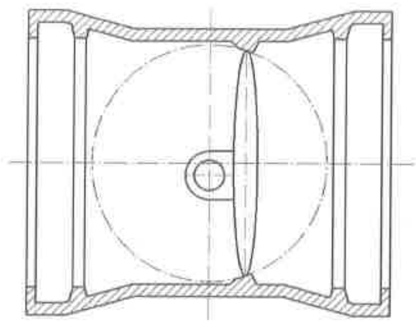


Figure 10 — Socket-socket design

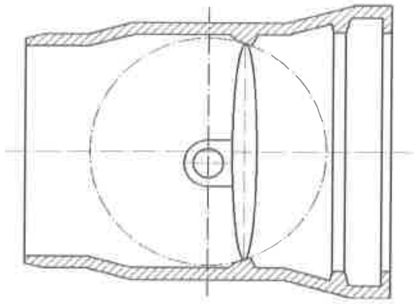


Figure 11 — Spigot-socket design

4.4 Obturator (disc)

The obturator (often named disc) can be with or without seal.

The valve manufacturer's technical documentation shall specify all necessary dimensions showing the protrusion of the obturator in the open position beyond the faces of the valve.

4.5 Seat seal

In its technical documentation, the valve manufacturer shall specify whether the seat seal

— is a body liner by design, or

— is located in the body or on the obturator.

The liner/lining may have additional functions, including sealing the driving shaft and flange.

The valve documentation shall specify the seat materials and if the sealing element is replaceable or not.

4.6 Driving shaft

The external end of the driving shaft shall indicate the orientation of the obturator.

The choice of the shaft material depends on the design working temperature and the physical and chemical characteristics of the fluid.

Valve shafts shall be sized for the maximum design torque at seating operation and at obturator position of highest combined dynamic and bearing torques with a safety factor. The value of this safety factor depends on the calculation method of the driving shaft. An example of calculation method is given in Annex E.

The connection between the shaft and the obturator shall be designed to transmit the shaft torque with the same safety factor. Higher flow velocities than defined in Table 1 may cause higher dynamic torques (see examples in Annex E).

The outside end of the shaft shall indicate by design or marking the position of the obturator. Where required by the design of valve, the manufacturer's operating instructions shall specify the method to preserve the indication of the obturator position, during and after re-assembly of the obturator to the shaft, e.g. for routine maintenance.

The sealing of the shaft shall remain leak tight to atmosphere when the operating device is removed.

The shaft shall be retained in the valve, so it cannot be ejected out of the body when external parts are removed. It shall be in accordance with EN 736-3.

External parts as stated in EN 736-3:2008, 3.3.7, are parts which are not included in the bare shaft valve e.g. bracket, lever, actuator.

4.7 Shaft seal

The shaft seal tightness shall remain unchanged when the actuating device is removed.

The shaft seal is not part of the shell.

4.8 Optional design features

a) Fire type tested design: valves designated as fire type tested design shall be tested in accordance with EN ISO 10497.

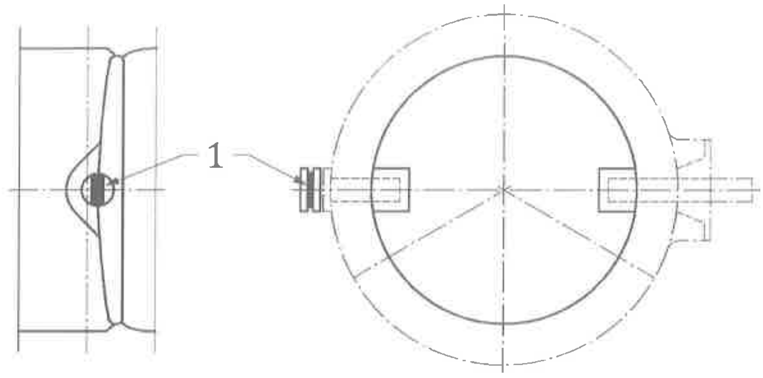
   If valves are required to be a fire type tested design, this requirement shall be specified (see Annex A).

b) Anti-static design: valves with anti-static design shall have electrical continuity between shaft, obturator and body in accordance with EN 12266-2.

   If valves are required to be an anti-static design, this requirement shall be specified (see Annex A).

c) Valves may be designed with a blocking device of the shaft which fixes the open or close position for maintenance purposes of the gearbox by an external blocking device. See Figure 12.

d) Valves may be designed with a blocking device which fixes the obturator in closed and tight position independently of the function of the actuator. The blocking device acts as a safety device. See Figure 13.



Key

1 external blocking device

Figure 12 — Blocking device of the shaft

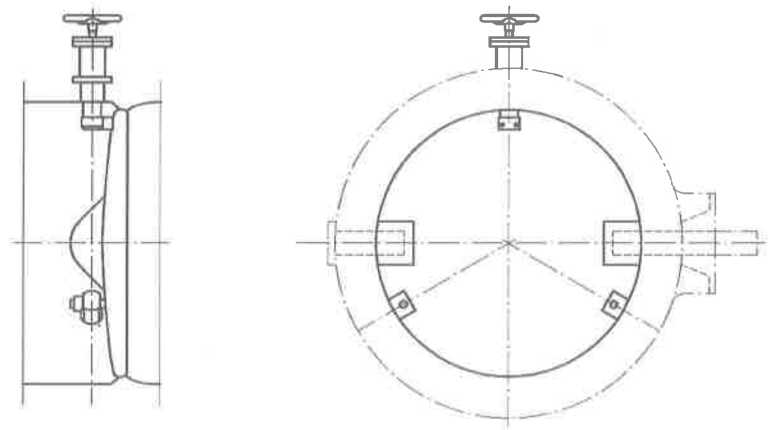


Figure 13 — Blocking device of the obturator

4.9 Materials

4.9.1 Shell

Materials for the shell shall be selected from those described in EN 12516-1, EN 12516-3 and EN 12516-4.

Bolting material shall be selected from EN 10269.

4.9.2 Trim

The trim comprises the following:

a) body or obturator seats;

b) shaft and seat seals;

c) shafts;

d) bushes;

e) shaft/obturator connecting parts;

f) seat/obturator seal clamping rings;

g) clamping ring bolting;

h) body lining/coating;

i) obturator linings/coatings.

The technical documentation of the valve manufacturer shall specify the relevant materials for the trim parts (see Annex B).

The materials of seat and seal can be elastomeric, plastic, composite, graphite, metallic or a combination of these materials.

The valve manufacturer's technical documentation shall specify the material type of the seat or liner or seal.

4.9.3 Corrosion protection

The choice of materials and/or surface protection methods used shall be included in the manufacturer's technical documentation and may be subject to agreement with the customer.

a) External corrosion protection: valve shells shall be protected against corrosion by proper material selection or surface treatment.

   Surface treatment system may be chosen according to classification category given by Annex C or agreed between customer and manufacturer.

   Test assessment and test procedures are the responsibility of the manufacturer.

b) Internal corrosion protection: all surfaces in contact with the fluid shall be protected against corrosion by suitable material selection or surface treatment (see Annex B) or agreed between customer and manufacturer.

4.10 Pressure/temperature ratings

The pressure/temperature rating shall be as specified in:

a) steel materials: EN 12516-1:2014 for the particular body/bonnet material group;

b) cast iron materials: EN 1092-2:1997;

c) copper alloy materials: EN 1092-3:2003 for PN-designated valves; EN 1759-3:2003 for Class-designated flanged valves;

d) aluminium alloys: EN 1092-4:2002 for PN-designated valves; EN 1759-4:2003 for Class-designated flanged valves.

Where restrictions on pressure and/or temperature are necessary on valves by reason of valve type, trim materials or other factors, the maximum allowable pressure and/or temperature shall be marked on the valve (in accordance with 7.1.2) and shall be considered with the designation of the valve [in accordance with Clause 6 i)].

It is recommended that the service conditions under which a butterfly valve is to be used should be specified by the customer (see Annex A).

4.11 Dimensions and tolerances

4.11.1 Face-to-face and end-to-end dimensions

The face-to-face dimensions and tolerances for flanged and wafer type butterfly valves shall be selected from EN 558 for PN- and Class-designated valves.

The end-to-end dimensions and tolerances for butt welding end butterfly valves shall be selected from EN 12982.

The face-to-face or end-to-end dimension for DN lower or larger than those defined in EN 558 or EN 12982 shall be specified by the manufacturer.

For spigot and mechanical joint, the end-to-end dimensions may be according to the manufacturer's technical documentation.

For loose flange connection, the end-to-end dimensions may be according to EN 558, series 14, but with a higher length tolerance for pipe assembling.

4.11.2 Flange body ends

Flanged ends shall be in accordance with:

a) EN 1092-1, EN 1092-2, EN 1092-3 and EN 1092-4 for PN designated butterfly valves;

b) EN 1759-1, EN 1759-3 and EN 1759-4 for Class designated butterfly valves.

4.11.3 Wafer bodies

Flangeless, lugged or single flanged bodies shall be such that they can be clamped between flanges in accordance with:

a) EN 1092-1, EN 1092-2, EN 1092-3 and EN 1092-4 for PN designated butterfly valves;

b) EN 1759-1, EN 1759-3 and EN 1759-4 for Class designated butterfly valves.

4.11.4 Butt welding ends

Butt welding end profiles shall be in accordance with EN 12627.

4.12 Operation

4.12.1 Operational capability

All butterfly valves shall be capable of being operated from fully closed to fully open, and vice-versa, at a differential pressure across the obturator equal to the maximum allowable pressure, PS at 20 °C or as marked on the valve, taking into account the limits in flow velocity (see Table 1).

4.12.2 Operating device

4.12.2.1 Direct manual actuation

Direct manual actuation may be lever, handwheel or T-wrench.

Where a lever is used, the valve shall be open when the lever is parallel to the pipe.

When intermediate position is specified, means of securing the valve obturator in intermediate positions shall be provided.

4.12.2.2 Direct actuation by power actuator

The design of the valve shall allow, with or without an intermediate part, mounting of a pneumatic, hydraulic or electric part-turn actuator complying with EN ISO 5211.

4.12.2.3 Gear actuation

The manual gear actuator shall be of self-locking movement design (in any position) and shall be provided with stops in the two extreme travel positions.

Adjustable stop(s) shall be set and secured in a reliable way.

The gear actuator shall be fitted with a position indicator.

On request, the manufacturer shall supply the number of turns that are necessary to complete a full opening or closing operation.

The design of the valve shall allow, with or without an intermediate part, mounting of a gear actuator with a plate complying with EN ISO 5211.

4.12.2.4 Sizing the operating element

For any manual operation of valves, the minimum size of the operating element shall be in accordance with EN 12570. The size of the operating element shall be selected such that the valve can be operated:

a) when the allowable differential pressure is equal to the maximum allowable pressure, and

b) taking into account the effect of hydrodynamic torque due to flow velocity.

When specified by the customer, it is allowed to size an actuator based on a reduced differential pressure taking into account the effect of the hydraulic torque.

According to 7.1, the actual differential pressure shall be marked on the valve.

4.12.2.5 Direction of operation

Manually operated valves and bare shaft valves shall normally be closed by turning the handwheel or lever or the shaft in a clockwise direction when facing the handwheel or lever or the shaft end.

If anti-clockwise closing is required, this shall be specified and marked on the operating element.

4.12.2.6 Valve supplied bare shaft

When, on request, a butterfly valve without an operating device is supplied, the manufacturer shall provide:

a) the necessary torque value, based on the maximum flow velocities as specified in Table 1;

b) maximum allowable pressure, PS at 20 °C;

c) the maximum differential pressure marked on the valve;

d) direction of operation to close the valve;

e) shaft end dimensions according to EN ISO 5211 or other as required.

4.13 Permanent joining

4.13.1 Welding

Welding as part of the valve shell shall be carried out to approved welding procedures to EN ISO 15607 or other appropriate standard. Welders shall be approved to EN ISO 9606-1 and welding operators shall be approved to EN ISO 14732 or other appropriate standard.

4.13.2 Non-destructive tests

If non-destructive test of welded joints, which are part of the valve shell, is required, it shall be detailed in the approved welding procedure.

4.13.3 Heat treatment

Heat treatment requirements of welded joints, which are part of the valve shell, shall be detailed in the approved welding procedure.

4.14 Functional characteristics and performances

4.14.1 Application

Butterfly valves intended for isolating applications require being seat tight in the closed position of the obturator.

NOTE For appropriate seat leakage rate, see 5.2.2.

Butterfly valves intended for regulating or control applications may have a clearance between obturator and body seat in the closed position.

The suitability of valves for end of line service shall be specified by the manufacturer either in the technical documentation or on the valve (seat tightness and pressure).

4.14.2 Design strength

The shell strength resistance shall be

a) for steel valves designed by the tabulation method, according to EN 12516-1:2014,

b) for steel valves designed by calculation, according to EN 12516-2:2014,

c) for valves in metallic materials other than steel, according to EN 12516-4:2014,

d) if the shell strength resistance is validated by an experimental method, according to EN 12516-3:2002.

Other dimensioning methods (i.e. finite elements) are the responsibility of the valve manufacturer.

The dimensioning procedures of parts using materials other than those specified in EN 12516-1, EN 12516-2, EN 12516-3 or EN 12516-4 are the responsibility of the manufacturer.

Flange dimension for PN-designated valves according to EN 1092-1, EN 1092-2, EN 1092-3 and EN 1092-4 shall not be recalculated.

Flange dimension for Class-designated valves according to EN 1759-1, EN 1759-3 and EN 1759-4 shall not be recalculated.

The design of the other parts is determined for a differential pressure defined by the pressure/temperature rating or for a differential pressure which shall be indicated on the valve.

4.14.3 Flow characteristics

4.14.3.1 Flow velocity

Butterfly valves shall be designed such that they are suitable for the maximum flow velocities specified in Table 1 for the applicable PS of the valve design.

NOTE 1 Flow velocity is a design parameter to be considered for butterfly valves: see Annex E for examples.

NOTE 2 The flow velocity is the quotient of the volumetric flow rate (expressed in m^3/s) and the area calculated using the diameter (expressed in m) having a value equal to the number of the DN divided by 1 000.

Table 1 — Flow velocity

PS bar	**Maximum flow velocity** m/s	
	Liquids with a density of 1 000 kg/m³ [a]	**Gas (at density 1,293 kg/m³ at 273 °K and 1 bara) [a]**
Up to 6	2,5	25
6 < PS ≤ 10	3	30
10 < PS ≤ 16	4	35
PS > 16	5	40

[a] In case of other physical properties of fluids, the values are adapted to the specific weight of the fluid.

4.14.3.2 Flow coefficient K_v

The manufacturer shall provide the flow coefficient (K_v) in the fully open position and the butterfly valve characteristic curve shall define the variation of the flow coefficient depending on the valve opening.

Measurement of the flow resistance ζ of butterfly valves intended for isolating purpose shall be in accordance with the procedure specified in EN 1267.

For valves intended for flow control only, the test of the flow resistance shall be in accordance with EN 60534-2-3.

5 Final assessment

5.1 General

Final assessment (testing, documentation, declaration of compliance) shall be carried out according to EN 16668:2016, 5.5.

For water supply application, EN 1074-2:2000, Clause 6, shall apply.

Additional tests shall be carried out according to 5.2.

5.2 Additional tests

5.2.1 Shell tightness

There shall be no external leakage from the shell according to test P11 of EN 12266-1.

5.2.2 Seat tightness

For all valves designed to be seat tight in the closed position of the obturator, the manufacturer shall indicate in the valve documentation the maximum allowable seat leakage rate selected from EN 12266-1:2012,Table A.5.

For valves with a preferential tightness direction, the manufacturer shall give guidance for installation in the documentation.

For valves with a preferential tightness direction, the leakage rate may be different in the two directions.

5.2.3 Optional tests

Optional tests of finished valves may also be carried out, if applicable, according to the requirements of EN 12266-2. The customer shall specify which optional tests are required.

6 Designation

Butterfly valves manufactured in accordance with the requirements of this European Standard shall be designated by the following elements in the same order as follows:

a) butterfly valve;

b) EN 593;

c) valve type: concentric or single eccentric or double eccentric or triple eccentric (see 4.1);

d) type of body end connection (see 4.3.2);

e) DN symbol and number;

f) PN or Class-designation;

g) body material;

h) trim or seat seal material;

i) if applicable: limitation of the maximum allowable pressure or the maximum allowable temperature (or maximum differential pressure);

j) for flanged or wafer type valves or welded end valves, the face-to-face or end-to-end dimension basic series number in accordance with EN 558 or EN 12982.

7 Marking and preparation for storage and transportation

7.1 Marking

7.1.1 Mandatory marking

All valves shall be marked in accordance with EN 19:2016.

7.1.2 Supplementary marking

Appropriate to the design, items 6, 7 and 9 of EN 19:2016 shall be marked on the valve.

Marking of the allowable differential pressure Δp is mandatory when it is less than the maximum allowable pressure PS of the valve (item 20 of EN 19:2016).

NOTE Δp is the allowable differential pressure. This pressure can be limited by internal components or the operating device.

Seat material shall be indicated by marking. For rubber and plastic seats, marking shall be in accordance with EN ISO 1043-1:2011 and ISO 1629:2013.

Valves designed with a preferred direction of flow shall be marked in accordance with item 5 of EN 19:2016.

When fitted, the levers or handwheels of valves supplied for anti-clockwise closing shall be marked to show the direction of operation.

When required by the application, items 10, 12, 18 of EN 19:2016 shall be marked.

If a valve is suitable for end of line service, it may be marked by the manufacturer.

7.2 Preparation for storage and transportation

Each valve shall be drained of any liquid.

The obturator of a soft seated valve may remain slightly open with the seat material not in compression.

Flange covers – when provided – shall extend over the entire gasket face. Body end surfaces to be welded shall be suitably protected to prevent mechanical damage during normal conditions of transportation and storage.

The valve packaging or the body end protection shall prevent the introduction of foreign matter.

Annex A
(informative)

Information to be supplied by the customer

It is recommended that the customer provides the information as indicated in Table A.1.

Table A.1 — Valve data sheet

Data for butterfly valves to EN 593
Feuille de données pour robinet à papillon selon l'EN 593
Technische Daten für Klappen nach EN 593

Butterfly type valve	**Type de robinet à papillon**	**Typ der Klappe**

DN ☐ PN/Class ☐

☐ Double flanged/A brides/mit Flanschen	☐ Concentric design/Conception concentrique/Zentrische Auslegung
☐ Wafer/A insérer/Zum Einklemmen	☐ Single eccentric design/Conception à simple excentration/Einfach exzentrierte Auslegung
☐ Downstream dismantling/Démontage aval/abströmseitige Demontage	☐ Double eccentric design/Conception à double excentration/Doppelt exzentrierte Auslegung
☐ End of line service/Service bout de ligne/Endarmatur	☐ Triple eccentric design/Conception à triple excentration/Dreifach exzentrierte Auslegung

Working conditions	**Conditions de service**	**Betriebsbedingungen**
Type of fluid	Type de fluide	Art des Mediums
Maximum working pressure	Pression de service	Betriebsdruck
Fluid temperature	Temperature du fluide	Temperatur des Mediums
Flow velocity	Vitesse du fluide	Strömungsgeschwindigkeit
Differential pressure (valve closed)	Pression différentielle (robinet fermé)	Differenzdruck(Klappe geschlossen)
Frequency of operation	Fréquence des manœuvres	Betätigungsfrequenz
Opening time	Temps d'ouverture	Öffnungszeit
Closing time	Temps de fermeture	Schließzeit
Operating Δp (valve closing or opening)	Δp de manœuvre (robinet s'ouvrant ou se fermant)	Δp bei Betätigung (sich öffnende oder schließende Klappe)

Materials	**Matériaux**	**Werkstoff**
Body	Corps	Gehäuse
Shaft	Arbre	Welle
Obturator	Obturateur	Abschlusskörper
Seal/seat/liner	Joint/siège/manchette	Dichtung/Sitz/Manschette

Operation	**Manœuvre**	**Betätigung**

☐ Manual/Manuel/Handantrieb	☐ Automatic/Automatique/Automatisch
|— ☐ Lever/Levier/Handhebel	☐ Electric/Electrique/Elektrisch
|— ☐ Gearbox/Démultiplicateur/Getriebe	☐ Pneumatic/Pneumatique/Pneumatisch
|— ☐ Others/Autres/Sonstige	☐ Hydraulic/Hydraulique/Hydraulisch

☐ Failsafe/Position de sécurité/Sicherheitsstellung
|— ☐ Single acting open/Simple effet ouverture/einfach wirkend auf
|— ☐ Single acting closed/Simple effet fermeture/einfach wirkend zu

Option

☐ Fire type tested design/Conception tenue au feu/Feuersichere Ausführung (see EN ISO 10497)
☐ Anti-static design/Conception antistatique/Antistatische Ausführung (see EN 12266-2)
☐ Limit switch signalling/Signalisation de fin de course/Endschalteranzeige
☐ Emergency hand control/Commande manuelle de secours/Notbetätigung
Others (specify)/Autres (à préciser)/Andere (genau angeben):

Complementary information/Informations complémentaires/Zusätzliche Angaben:

Annex B
(informative)

Trim material list

Table B.1 gives a list of materials from which the manufacturer may select the materials for all trim parts.

Table B.1 — Butterfly valve trim materials

Parts of the trim	Material and designation of trim						
	Trim A soft seated valves	**Trim B** metallic seated valves	**Trim C** other coatings	**Trim D** epoxy coated	**Trim E** enamel coated	**Trim F** rubber lined	**Trim G** fluored plastic lined
Body or obturator seats	Manufacturer's standard		Metallic, corrosion resistant alloy		Enamel coated	Rubber lined	PTFE, PVDF, PFA or ECTFE
Shaft and seat seals	To be specified by the manufacturer						
Shaft(s)	Minimum 12 % Cr or Cu-alloy					Rubber lined or CrNi- or Cu-alloy	Manufacturer's standard
Bushes	Manufacturer's standard						
Shaft /obturator connecting parts	Manufacturer's standard		Minimum 12 % Cr or Cu-alloy				Manufacturer's standard
Clamping ring for seat/ obturator seal	Manufacturer's standard			Minimum 12 % Cr or epoxy coated or Cu-alloy	Minimum 12 % Cr or enamel coated or Cu-alloy	Rubber lined or corrosion resistant alloy	—
Bolting for the clamping ring	Manufacturer's standard suitable for the process application						
Body liner/lining/coating	Manufacturer's standard			Epoxy coated	Enamel coated	Rubber lined	PTFE, PVDF, PFA or ECTFE
Obturator liner/lining/coating	Manufacturer's standard			Epoxy coated or obturator stainless	Enamel coated or obturator stainless	Rubber lined or obturator CrNi- or Cu-alloy	PTFE, PVDF, PFA or ECTFE

Annex C
(informative)

Environmental corrosion protection

Table C.1 can be used to define the corrosion category and to help the valve manufacturers to define the surface treatment for corrosion protection.

NOTE Table C.1 is taken from EN ISO 12944-2:1998.

Table C.1 — Environmental corrosion protection

Corrosion category	Typical environments	
	Exterior	Interior
C2 (low)	Atmospheres with low level of pollution. Mostly rural areas.	Unheated buildings where condensation may occur, e.g. depots, sport halls.
C3 (medium)	Urban and industrial atmospheres, moderate sulfur dioxide pollution. Coastal areas with low salinity.	Production rooms with high humidity and some air pollution, e.g. food-processing plants, laundries, breweries.
C4 (high)	Industrial areas and coastal areas with moderate salinity.	Chemical plants, swimming pools, coastal shipyards.
C5-I (very high – industrial)	Industrial areas with high humidity and aggressive atmosphere.	Buildings or areas with almost permanent condensation and with high pollution.
C5-M (very high-marine)	Coastal and offshore areas with high salinity.	Buildings or areas with almost permanent condensation and with high pollution.
Immersed in water or buried in soil:		
Im 1 (Immersed in fresh water)	River installations, hydro-electric power plants.	
Im 2 (immersed in sea or brackish water)	Harbour areas and offshore structures.	
Im 3 (buried in soil)	Buried pipelines.	

Annex D
(informative)

Correspondence between DN and NPS

Table D.1 gives the correspondence between DN (nominal size) and NPS (nominal pipe size) for the most usual sizes.

NOTE 1 Table D.1 is a combination of some main International Standards (EN 1092 series, ISO 7005 series, ASME B16.47, AWWA C207).

NOTE 2 For NPS greater than 3, the related DN = 25 x NPS number.

Table D.1

DN mm	**NPS** inch	**DN** mm	**NPS** inch
20	3/4	1 200	48
25	1	—	50
32	1 1/4	—	52
40	1 1/2	—	54
50	2	1 400	56
65	2 1/2	—	58
80	3	*1 500* [a]	*60*
100	4	1 600	—
125	5	—	66
150	6	1 800	72
200	8	—	78
250	10	2 000	—
300	12	—	84
350	14	2 200	—
400	16	—	90
450	18	2 400	96
500	20	—	102
—	22	2 600	104
600	24	—	108
—	26	2 800	—
700	28	—	114
750 [a]	*30*	3 000	120
800	32	—	126
—	34	3 200	—
900	36	—	132
—	38	3 400	—
1 000	40	—	138
1 050	42	3 600	144
1 100 [a]	*44*	3 800	—
—	46	4 000	—

[a] The sizes in italics are given in addition to the DN listed in the EN 1092 series.

Annex E
(informative)

Example for valve shaft calculation

E.1 General

This Annex is only given as informative guidance for calculation. Other calculation methods may be used at manufacturer's choice.

The valve shafts are designed for the maximum design torque at seating and at the valve position of highest combined dynamic and bearing torques.

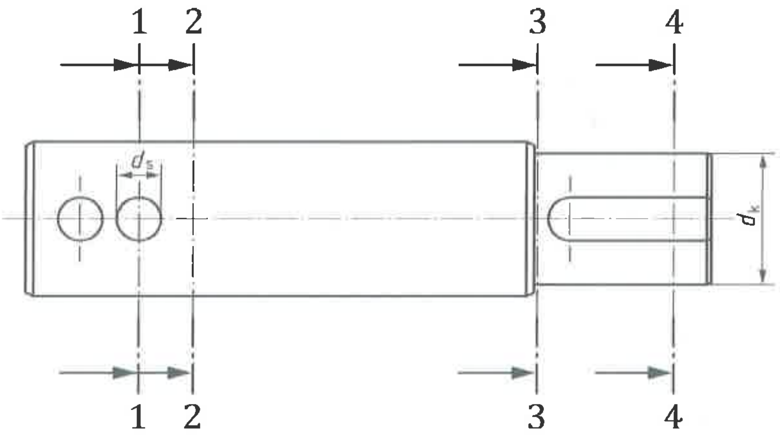


Figure E.1 — Sketch of a butterfly valve shaft

The calculation is done at the following sections (see Figure E.1).

— Section 1-1: the connection between shaft and obturator is designed to transmit the maximum shaft torque.

The connection between shaft and obturator should be recalculated.

— Section 2-2: calculation of combined tensile stress at seating due to torsion at bending

The combined shear stress due to torsion is calculated.

The bending at seating or operating positions has a safety factor of 1,5 against the yield strength of the shaft material.

— Section 3-3: reduced shaft diameter at valve shaft connection

If the valve shaft diameter is reduced to fit connections to the valve operating mechanism the smallest shaft diameter is capable of transmitting the maximum operating torque.

— Section 4-4: calculation of keyed/square connection to the actuator/gearbox

The reduced shaft diameter due to the connections is capable of transmitting the maximum operating torque.

E.2 Calculation

E.2.1 Shear stress

This calculation scheme applies solely for torsion loaded zones (intermediate sections 2-2 and 3-3).

The shear stress is calculated using Formula (E.1):

$$\tau_1 = \frac{16 \times T}{\pi\ d^3} \tag{E.1}$$

where

τ_1 is the torsional shear stress, in kPa;

T is the maximum design torque at seated or operating position, in Nm;

d is the shaft diameter, in mm.

The maximum allowable shear stress depends on material properties.

E.2.2 Combined shear stress (at valve bearing) (section 2-2)

The combined shear stress is calculated using Formula (E.2):

$$\tau_2 = \frac{16 \times T}{\pi\ d^3} + \frac{2}{3} \times \left(\frac{D}{d}\right)^2 \times P_1 \tag{E.2}$$

where

τ_2 is the combined shear stress, in kPa;

T is the maximum design torque at seated or operating position, in Nm;

d is the shaft diameter, in mm;

D is the obturator diameter, in mm;

P_1 is the design pressure rating or differential pressure at operating position, in kPa.

The maximum allowable shear stress depends on material properties.

E.2.3 Combined tensile stress at seating due to torsion and bending (section 2-2)

The combined tensile stress caused by torsion and bending is calculated using Formula (E.3):

$$\sigma_1 = \frac{\dfrac{32 \times M}{\pi\ d^3} + \sqrt{\left(\dfrac{32 \times M}{\pi\ d^3}\right)^2 + 4 \times \left(\dfrac{16 \times T_S}{\pi\ d^3}\right)^2}}{2} \tag{E.3}$$

where

σ_1 is the combined tensile stress, in kPa;

d is the shaft diameter, in mm;

T_S is the maximum design torque at seated position, in Nm;

M is the bending moment of guided cantilever, in Nm, calculated using Formula (E.4):

$$M = \pi \times D^2 \times P \times \frac{L}{16} \tag{E.4}$$

where

P is the design pressure rating, in kPa;

L is the unsupported shaft length, in mm.

The maximum allowable shear stress depends on material properties.

E.2.4 Shear stress at reduced area (sections 1-1, 3-3, 4-4)

The maximum torsional shear stress is calculated using Formula (E.5):

$$\tau = K \times \frac{16 \times T_m}{\pi \, d^3} \tag{E.5}$$

where

τ is the maximum torsional shear stress, in kPa;

K is the stress intensity/factor;

T_m is the maximum operating torque, in Nm.

d is the shaft diameter, in mm.

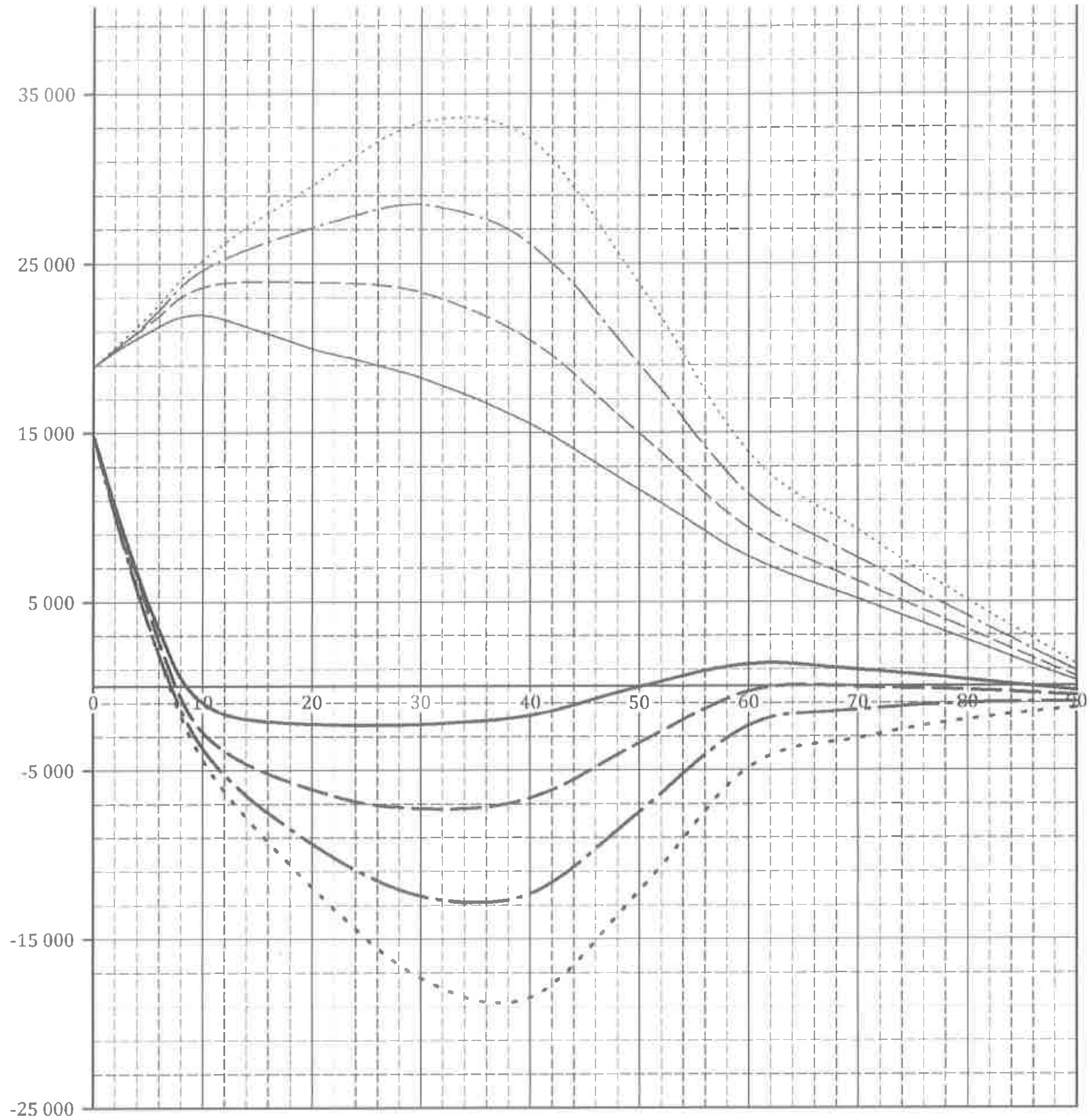
E.3 Examples of influence of flow velocity/hydrodynamic torques for shaft sizing

The flow velocity has an influence on the hydrodynamic torque of the valve by adding additional load on the shaft.

Figures E.2 and E.3 are given for information only. They show the influence of flow velocity on the valve torque.

The characteristics of the example given in Figure E.2 are:

- size: DN 1 200;
- pressure rate: PN 10;
- design: double-offset.



Key

x-axis degree of opening, in °

y-axis total torque, in Nm

closing 3 m/s

closing 4 m/s

closing 5 m/s

closing 6 m/s

opening 3 m/s

opening 4 m/s

opening 5 m/s

opening 6 m/s

Figure E.2 — Example of valve shaft torques at different flow velocities from upstream side

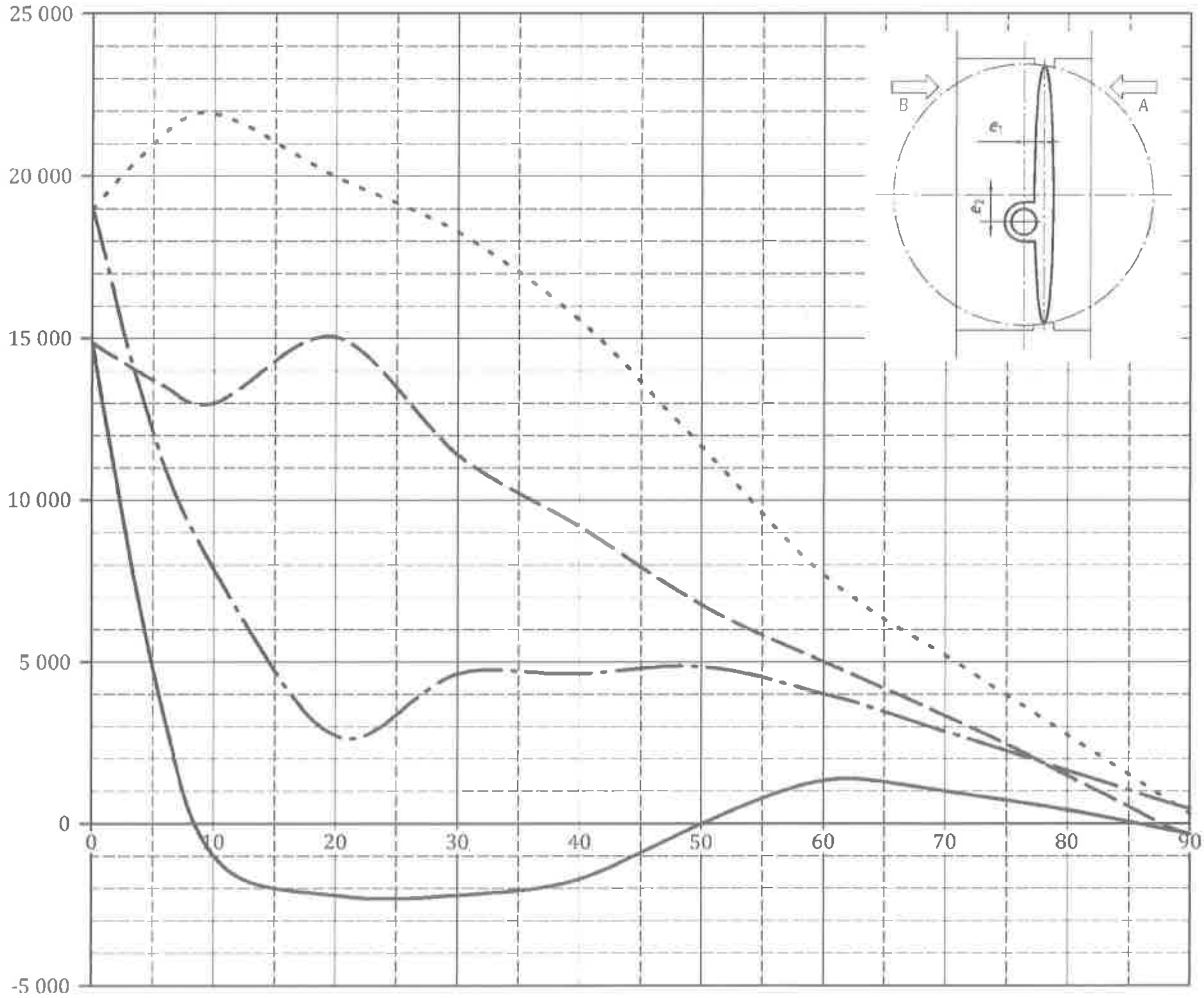
The characteristics of the example given in Figure E.3 are:

— size: DN 1 200;

— pressure rate: PN 10;

— design: double-offset;

— flow velocity: 3 m/s.



Key

x-axis	degree of opening, in °
y-axis	torque, in Nm
(dotted line)	B closing
(solid line)	B opening
(dash-dot line)	A closing
(dashed line)	A opening

Figure E.3 — Example of valve shaft torques opening/closing with pressure from downstream side A or upstream side B

Annex ZA
(informative)

Relationship between this European Standard and the essential requirements of Directive 2014/68/EU (Pressure Equipment Directive) aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/071 to provide one voluntary means of conforming to essential requirements of Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonization of the laws of the Member States relating to the making available on the market of pressure equipment.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU

Essential Requirements of Directive 2014/68/EU	Clause(s)/subclause(s) of this EN	Remarks/Notes
2.1	4.10, 4.14.2 a), 4.14.2 b)	General design
2.2.1	4.14.2 a), 4.14.2 c)	Design loading factors due to pressure
2.2.2	4.14.2 b), 4.14.2 c), 4.14.2 d)	Design for adequate strength
2.2.3	4.14.2 a), 4.14.2 b), 4.14.2 c)	Design calculation method
2.2.4	4.14.2 d)	Experimental design method
2.6	4.9.3	Corrosion protection
3.2.1	5.1	Final inspection
3.2.2	5.1	Proof test
3.3	7.1.1	Marking and labelling

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

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[2] EN 764-1:2015+A1:2016, *Pressure equipment — Part 1: Vocabulary*

[3] EN 1074-1, *Valves for water supply — Fitness for purpose requirements and appropriate verification tests — Part 1: General requirements*

[4] EN 1349, *Industrial process control valves*

[5] EN 60534-2-1, *Industrial-process control valves — Part 2-1: Flow capacity —Sizing equations for fluid flow under installed conditions (IEC 60534 2 1)*

[6] EN ISO 3506-1, *Mechanical properties of corrosion-resistant stainless steel fasteners — Part 1: Bolts, screws and studs (ISO 3506-1)*

[7] EN ISO 3506-2, *Mechanical properties of corrosion-resistant stainless steel fasteners — Part 2: Nuts (ISO 3506-2)*

[8] EN ISO 12944-2:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments (ISO 12944-2:1998)*

[9] ISO 7005-1, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

[10] ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges*

[11] ISO 7005-3, *Metallic flanges — Part 3: Copper alloy and composite flanges*

[12] ASME B16.47, *Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard*

[13] AWWA C207, *Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)*

[14] AWWA C516-14, *Large-Diameter Rubber-Seated Butterfly Valves, Sizes 78 In. (2,000 mm) and Larger*

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