

Gas pressure regulators for inlet pressures up to 100 bar

The European Standard EN 334:1999, with the incorporation of Amendment A1:2000, has the status of a British Standard

ICS 23.060.40

National foreword

This British Standard is the English language version of EN 334:1999, including amendment A1:2000.

The UK participation in its preparation was entrusted to Technical Committee GSE/32, Gas governors, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 59 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Sidelining in this document indicates the most recent changes by amendment.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 November 1999

© BSI 05-2001

Amendments issued since publication

Amd. No.	Date	Comments
13001	May 2001	Indicated by a sideline

ISBN 0 580 30423 X

English version

Gas pressure regulators for inlet pressures up to 100 bar

(includes amendment A1:2000)

Appareils de régulation de pression de gaz
(régulateurs) pour des pressions amont
jusqu'à 100 bar
(inclut l'amendement A1:2000)

Gas-Druckregelgeräte für Eingangsdrücke
bis 100 bar
(enthält Änderung A1:2000)

This European Standard was approved by CEN on 7 August 1998.
Amendment A1:2000 was approved by CEN on 2000-09-10.

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

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 235, Gas pressure regulators and associated safety shut-off devices for use in gas transmission and distribution, the Secretariat of which is held by UNI.

At the time of drafting, it has not been decided whether the pressure regulators within the scope of this European Standard will fall under the Pressure Equipment Directive 97/23/EC and also there was no network of Notified Bodies under the provisions of the directive itself. Therefore it was decided to establish the evaluation of conformity according to the CEN, Guidelines for Technical Committees — Requirements in European Standards concerning the evaluation of conformity 1993-01.

When it is confirmed that pressure regulators within the scope of this European Standard fall under the Pressure Equipment Directive, the Standard will be revised to ensure that its clauses conform with the essential requirements and conformity assessments of the Directive.

NOTE Referring to 4.2.2 of this European Standard it should be noted that at the discussion during its elaboration within WG 1, it was pointed out that in some member countries there is legislation limiting the application of some materials listed in Table 5.

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 1999, and conflicting national standards shall be withdrawn at the latest by November 1999.

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

Foreword to amendment A1

This amendment EN 334:1999/A1:2000 to the EN 334:1999 has been prepared by Technical Committee CEN/TC 235, Gas pressure regulators and associated safety shut-off devices for use in gas transmission and distribution, the Secretariat of which is held by UNI.

This amendment to the European Standard EN 334:1999 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2001, and conflicting national standards shall be withdrawn at the latest by March 2001.

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

Contents

	Page
Foreword	2
1 Scope	5
2 Normative references	5
3 Definitions and symbols	7
3.1 Terminology	7
3.1.1 Gas pressure regulator	7
3.1.2 Main components	9
3.1.3 Accessories	10
3.2 Control variables	10
3.2.1 Reference values	10
3.2.2 Variables in the controlling process	11
3.2.3 Possible values of all variables	12
3.2.4 Terms pertinent to the controlled variable	12
3.3 Operating features in stable conditions	12
3.3.1 Stable conditions	12
3.3.2 Performance curve	13
3.3.3 Hysteresis band	13
3.3.4 Family of performance curves	14
3.3.5 Features pertinent to accuracy	14
3.3.6 Features pertinent to lock-up behaviour	14
3.4 Further functional terminology	17
3.4.1 Pressures pertinent to design of gas pressure regulator	17
3.4.2 Nominal pressure	17
3.4.3 Operating temperature range	18
4 Construction requirements	18
4.1 General requirements	18
4.1.1 Operational requirements	18
4.1.2 Gas pressure regulators with built-in safety devices	18
4.1.3 End connections	18
4.1.4 Nominal pressures	18
4.1.5 Nominal sizes and face-to-face dimensions	19
4.2 Materials	20

	Page		Page
4.2.1 Chemical resistance requirements	20	7.2.2 Materials check	33
4.2.2 Requirements for metallic materials	21	7.2.3 Verification of the strength of the pressure containing parts	34
4.2.3 Requirements for elastomers (including vulcanized rubbers)	25	7.2.4 Shell strength test	34
4.2.4 Alternative materials	25	7.2.5 External tightness test	35
4.3 Strength of housings	25	7.2.6 Functional tests	36
4.3.1 Regulator body	25	7.2.7 Final inspection	43
4.3.2 Other pressure containing parts	25	8 Documentation	45
4.3.3 Minimum values of safety factors	25	8.1 Documentation related to the type test	45
5 Functional requirements	26	8.1.1 Documentation required prior to the type test	45
5.1 General	26	8.1.2 Test report	45
5.1.1 Mounting position	26	8.2 Documentation related to the manufacturer's tests	45
5.1.2 Sound emission	26	8.2.1 Documentation provided at the request of the customer	45
5.2 Shell strength, external tightness and internal sealing	27	8.2.2 Documentation provided with the regulator	45
5.2.1 Shell strength	27	8.3 Documentation related to surveillance	45
5.2.2 External tightness	27	8.3.1 Documentation to be available for surveillance	45
5.2.3 Internal sealing	27	8.3.2 Surveillance report	45
5.3 Control classifications	28	9 Marking	46
5.3.1 Accuracy under stable conditions	28	9.1 General requirements	46
5.3.2 Lock-up behaviour	28	9.2 Markings for the various connections	46
5.3.3 Stable conditions	29	9.3 Marking of built-in safety devices	46
6 Gas pressure regulator sizing	29	Annex A (informative) Use of allowable pressure p_{zul}	47
6.1 Flow behaviour	29	Annex B (informative) Alternative methods for the determination of the accuracy class, the lock-up pressure class, the maximum accuracy flow rate, the flow coefficients and the verification of the hysteresis band	47
6.2 Sizing equations for the calculation of volumetric flow rates of a gas pressure regulator with its control member in its mechanically fully open position	29	B.1 General	47
6.2.1 Normal calculations	29	B.2 Test methods	47
6.2.2 Practical calculations	30	B.2.1 Direct acting gas pressure regulator	47
6.2.3 Simplified calculations	30	B.2.2 Pilot controlled gas pressure regulators	48
6.3 Calculation of the maximum accuracy flow rate	30	B.3 Determination of flow coefficients for larger capacity regulators	49
6.4 Inherent flow characteristics	31	Annex C (informative) Inspection certificate	54
6.5 Calculation of volumetric flow rates for partially open gas pressure regulators	31	Annex D (informative) Acceptance test	56
7 Testing	31	Annex E (informative) Conformity evaluation	56
7.1 Types of tests	31	E.1 General	56
7.1.1 General	31	E.2 Manufacturer's conformity evaluation	56
7.1.2 Type test	32	E.3 Third party conformity evaluation	57
7.1.3 Selection of test samples	33	E.3.1 Introduction	57
7.1.4 Manufacturer's test	33	E.3.2 Procedure	57
7.1.5 Surveillance	33	E.4 Issue of the certificate of conformity	57
7.2 Test and verification methods	33		
7.2.1 Dimensional check and visual inspection	33		

	Page		Page
E.3.3 Selection of test samples	57	Figure B.2 — Graph of the outlet pressure plotted against different positions of the control member in a unbalanced direct acting regulator	50
Annex F (informative) Seat leakage	57	Figure B.3 — Functional diagram of a pilot controlled regulator	51
Annex G (informative) Order specification	58	Figure B.4 — Various graphs relating to the tests detailed in B.2 for a balanced pilot controlled regulator	52
G.1 Minimum specifications	58	Figure B.5 — Various graphs relating to the tests detailed in B.2 for an unbalanced pilot controlled regulator	53
G.1.1 Details of construction	58	Figure B.6 — Graph of C_g values plotted against different positions of the control member	54
G.1.2 Dimensions	58	Table 1 — Recommended face-to-face dimensions for flanged regulators	19
G.1.3 Performance	58	Table 2 — Alternative face-to-face dimensions for flanged regulators	19
G.2 Optional specifications	58	Table 3 — Face-to-face dimensions for flangeless regulators	20
Annex H (informative) A-deviations	59	Table 4 — Face-to-face dimensions for flangeless regulators	20
Annex J (informative) Bibliography	59	Table 5 — Materials for pressure containing parts	21
Figure 1 — Example of a direct acting regulator	7	Table 5a — Non-destructive testing	23
Figure 2 — Example of a pilot controlled regulator	8	Table 5b — Minimum inspection sample	24
Figure 3 — Performance curve (p_{as} constant, p_e constant)	13	Table 6 — Minimum values of safety factor	26
Figure 4 — Family of performance curves (p_{as} constant)	14	Table 7 — Accuracy classes	28
Figure 5 — Family of performance curves indicating maximum accuracy flow rates and minimum flow rates (p_{as} constant, stable conditions)	15	Table 8 — Lock-up pressure classes	28
Figure 6 — Performance curve indicating lock-up pressure zone (stable condition)	16	Table 9 — Lock-up pressure zone classes	28
Figure 7 — Points of measurement for sound pressure level	27	Table 10 — Summary of types of tests and relevant test methods and requirements	32
Figure 8 — Flow behaviour of a regulator with the control member in a fixed position	29	Table 11 — Pressure values for the shell strength test	35
Figure 9 — Three examples of inherent flow characteristics	31	Table 12 — Pressure values in the external leakage test	35
Figure 10 — Graphical representation of the tests detailed in 7.2.6.3	38	Table 13 — Maximum external and internal leakage rates	35
Figure 11 — Graphical representation of 7.2.6.4.3	40		
Figure 12 — Graphical example of 7.2.6.4.4	41		
Figure 13 — Recommended pressure tapping	43		
Figure 14 — Test rig requirements	44		
Figure B.1 — Graph of the outlet pressure plotted against different positions of the control member in a balanced direct acting regulator	49		

1 Scope

This European Standard specifies constructional and functional requirements, regulator sizing, testing, documentation and marking of gas pressure regulators:

- for inlet pressures up to 100 bar and nominal diameter up to DN 400;
- used at an operating temperature range from $-20\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$;

which operate with fuel gases of the 1st and of the 2nd family in accordance with EN 437 in transmission and distribution networks and also in industrial installations.

“Gas pressure regulators” hereafter will be called “regulators” except in the titles.

This European Standard considers the following classes of regulators:

- class 1: operating temperature range from $-10\text{ }^{\circ}\text{C}$ to $60\text{ }^{\circ}\text{C}$;
- class 2: operating temperature range from $-20\text{ }^{\circ}\text{C}$ to $60\text{ }^{\circ}\text{C}$.

For inlet pressure higher than 100 bar and/or operating temperatures outside the range from $-20\text{ }^{\circ}\text{C}$ to $60\text{ }^{\circ}\text{C}$ and/or nominal diameter $\text{DN} > 400$, this European Standard may be used as a “guideline”.

This European Standard applies to regulators which use the pipeline gas as a source of control energy unassisted by any external power source. These regulators have no continuous discharge of gas into the atmosphere but temporary discharges from safety devices can occur.

The regulators complying with the requirements of this European Standard may be declared as “in conformity with EN 334”.

This European Standard does not apply to:

- regulators upstream from/on/in domestic gas-consuming appliances which are installed downstream of domestic gas meters;
- regulators that comply with both of the following characteristics:
 - volumetric flow rate $\leq 100\text{ m}^3/\text{h}$ at standard conditions;
 - inlet pressure $\leq 5\text{ bar}$;
- regulators for which a specific European Standard exists (e.g. EN 88, etc.);
- industrial process control valves in accordance with prEN 1349.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

BS 437, *Test gases — Test pressures — Appliance categories*.

EN 287-1, *Approval testing of welders — Fusion welding — Part 1: Steels*.

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

EN 288-1, *Specification and qualification of welding procedures for metallic materials — Part 1: General rules for fusion welding*.

EN 288-2, *Specification and qualification of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding*.

EN 288-3, *Specification and qualification of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels*.

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

prEN 1349, *Industrial process control valves*.

EN 1418, *Welding personnel — Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*.

EN 10045-1, *Metallic materials — Charpy impact test — Part 1: Test method*.

EN 10204, *Metallic products — Types of inspection documents*.

EN 12732, *Gas supply systems — Welding steel pipework — Functional requirements.*

prEN 13787:2000, *Elastomers for gas pressure regulators and associated safety devices for inlet pressures up to 100 bar.*

EN 20898-1, *Mechanical properties of fasteners — Part 1: Bolts, screws and studs.*
(ISO 898-1:1988)

EN 45011, *General criteria for certification bodies operating product certification.*

EN 45014, *General criteria for supplier's declaration of conformity.*

EN 45020, *General terms and their definitions concerning standardization and related activities.*

EN 60534-1, *Industrial-process control valves — Part 1: Control valve terminology and general considerations.*
(IEC 534-1:1987)

EN 60534-2-2, *Industrial-process control valves — Part 2: Flow capacity — Section 2: Sizing equations for compressible fluid flow under installed conditions.*
(IEC 534-2-2:1980)

EN 60534-2-3, *Industrial-process control valves — Part 2: Flow capacity — Section 3: Test procedures.*
(IEC 534-2-3:1983)

EN 60651:1994, *Sound level meters.*
(IEC 651:1979)

EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs.*
(ISO 898-1:1999)

EN ISO 6708, *Pipework components — Definition and selection of DN (nominal size).*
(ISO 6708:1995)

EN ISO 9000-1, *Quality-management and quality assurance standards — Part 1: Guidelines for selection and use.*
(ISO 9000-1:1994)

EN ISO 9001, *Quality systems — Model for quality assurance in design/development, production, installation and servicing.*
(ISO 9001:1994)

EN ISO 9002, *Quality systems — Model for quality assurance in production, installation and servicing.*
(ISO 9002:1994)

EN ISO 9003, *Quality systems — Model for quality assurance in final inspection and test.*
(ISO 9003:1994)

EN ISO 9004-1, *Quality management and quality system elements — Part 1: Guidelines.*
(ISO 9004-1:1994)

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation.*

ISO 3419, *Non-alloy and alloy steel butt-welding fittings.*

ISO 5752, *Metal valves for use in flanged pipe systems — Face-to-face and centre-to-face dimensions.*

ISO 6761, *Steel tubes — Preparation of ends of tubes and fittings for welding.*

ISO 7005, *Metallic flanges.*

IEC 534-3:1976, *Industrial-process control valves — Part 3: Dimensions — Section 1: Face-to-face dimensions for flanged, two-way, globe-type control valves.*

IEC 534-3-2:1984, *Industrial-process control valves — Part 3: Dimensions — Section 2: Face-to-face dimensions for flangeless control valves except wafer butterfly valves.*

ASME B 16.34:1996, *Valves — Flanged, threaded and welding end.*

ASME VIII div. 1:1995, *Rules for construction of pressure vessels.*

MSS SP 55 — 1985, *Quality standard for steel castings for valves, flanges and fittings and other piping components (Visual method).*

3 Definitions and symbols

For the purposes of this European Standard, the definitions given in EN 60534-1 and the following specific definitions apply.

3.1 Terminology

3.1.1

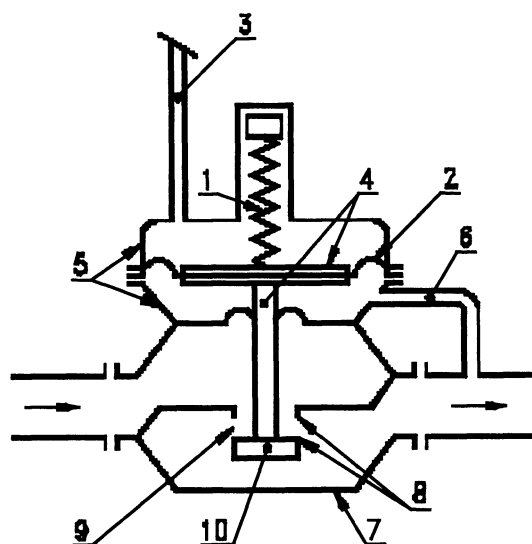
gas pressure regulator

device whose function is to maintain the value of the controlled variable (see 3.2.2.1) within its tolerance field irrespective of disturbance variables

3.1.1.1

direct acting gas pressure regulator

regulator in which the net force required to move the control member is supplied directly by the controlled variable (see example in Figure 1)



- | | |
|---|-----------------------|
| 1 | Setting element |
| 2 | Detector element |
| 3 | Breather/exhaust line |
| 4 | Actuator |
| 5 | Casing of actuator |

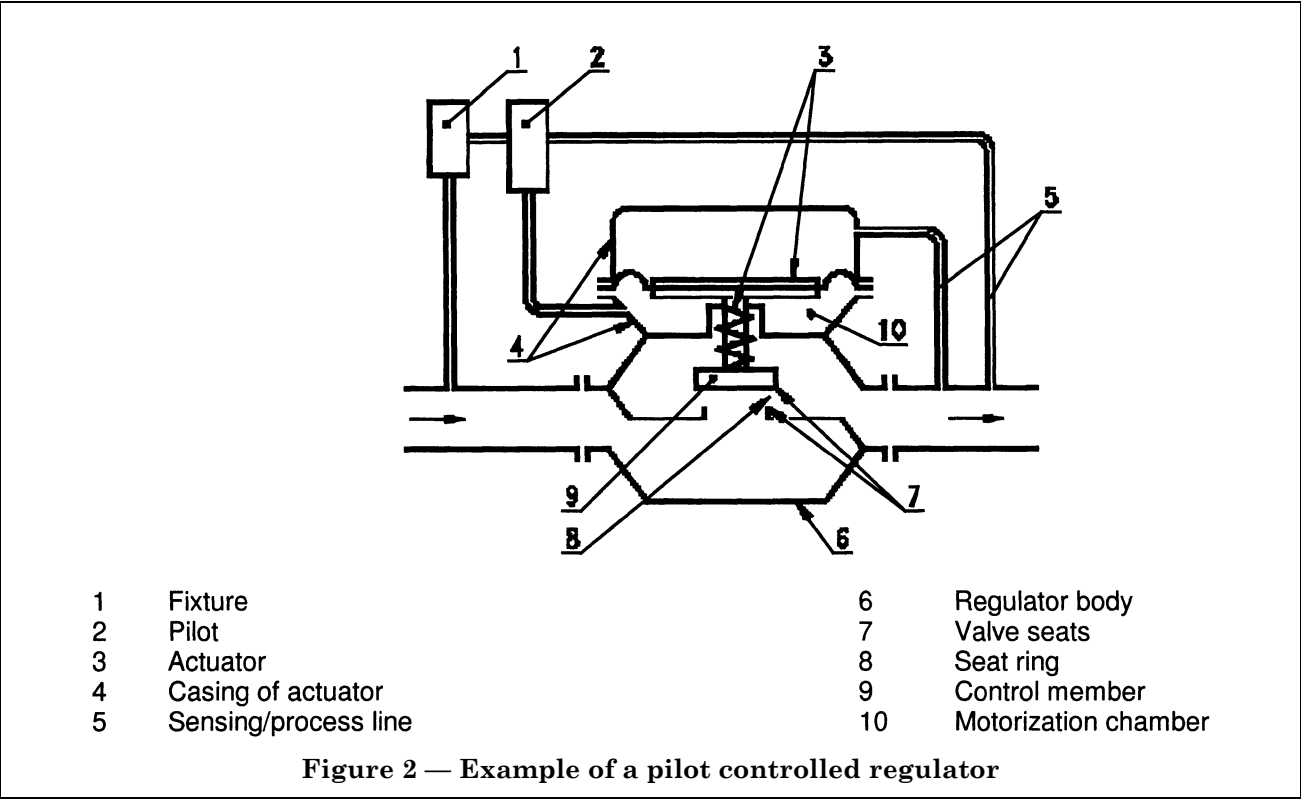
- | | |
|----|----------------|
| 6 | Sensing line |
| 7 | Regulator body |
| 8 | Valve seats |
| 9 | Seat ring |
| 10 | Control member |

1 + 2 = Controller

Figure 1 — Example of a direct acting regulator

3.1.1.2
pilot controlled gas pressure regulator (indirect acting)

regulator in which the net force required to move the control member is supplied by a pilot
(see example in Figure 2)



3.1.1.3
monitor

second regulator normally installed in series with an active regulator which has the task of maintaining the controlled variable within allowable limits in the event of the failure of the active regulator

3.1.1.4
series of regulators

regulators with the same design concept but differing only in size

3.1.1.5
fail open regulator

regulator whose control member automatically tends to open when the main diaphragm fails or when the energy required to move the control member fails

NOTE The definition in this clause covers typical main failure modes. There are other failure modes that may be considered.

3.1.1.6
fail close regulator

regulator whose control member automatically tends to close when the main diaphragm fails or when the energy required to move the control member fails

NOTE The definition in this clause covers typical main failure modes. There are other failure modes that may be considered.

3.1.1.7
integral strength regulator

regulator in which the pressure containing parts have a design pressure p_d not less than the allowable pressure p_{zul}

3.1.1.8**differential strength regulator**

regulator in which some of the pressure containing parts have a design pressure p_d less than the allowable pressure p_{zul}

3.1.1.9**regulator size; nominal inlet diameter**

nominal size DN of the inlet connection in accordance with EN ISO 6708

3.1.1.10**nominal outlet diameter**

nominal size DN of the outlet connection in accordance with EN ISO 6708

3.1.2**main components**

the main components of a gas pressure regulator normally include: control member, regulator body, actuator, casing of actuator, controller, pilot (only in pilot controlled regulators)

the regulator might include additional units such as: a shut-off device, a monitor, a relief valve and other fixtures

Figure 1 and Figure 2 serve as examples

3.1.2.1**control member**

movable part of the regulator which is positioned in the flow path to restrict the flow through the regulator
a control member may be a plug, ball, disk, vane, gate, diaphragm, etc.

3.1.2.2**regulator body**

part of the regulator which is the main pressure containing envelope
it provides the fluid flow passageway and the pipe end connections

3.1.2.3**valve seats**

corresponding sealing surfaces within a regulator which make full contact only when the regulator is in the closed position

3.1.2.4**seat ring**

part assembled in a component of the regulator to provide a removable seat

3.1.2.5**actuator**

device or mechanism which changes the signal from the controller into a corresponding movement controlling the position of the control member

3.1.2.6**casing of actuator**

housing of the actuator

there may be two chambers under pressure within it

when the pressure in each chamber is different from atmospheric pressure, the chamber at the higher pressure is termed the "motorization chamber"

3.1.2.7**controller**

device which normally includes:

- a setting element, normally a spring, to obtain the set value of the controlled variable;
- a detector element, normally a diaphragm, for the controlled variable.

3.1.2.8

pilot

device which included:

- a setting element to obtain the set value of the controlled variable;
- a detector element for the controlled variable;
- a unit which compares the set value of the controlled variable with its feedback value;
- a system which provides the motorization energy for the actuator.

3.1.2.9

main diaphragm

diaphragm, the function of which is to detect the feedback of the controlled variable and/or the diaphragm which provides the thrust to move the control member

3.1.2.10

pressure controlling parts

parts intended to control or regulate the movement of pressurized fuel gas, such as the control member, the actuator etc.

3.1.2.11

pressure containing parts

parts whose failure to function as intended would result in a release of the retained fuel gas to the atmosphere

these include bodies, bonnets, the casing of the actuator and blind flanges

3.1.3

accessories

parts or minor devices connected to the regulator

3.1.3.1

sensing and process lines

lines which connect impulse points to the regulator

sensing and process lines may be integrated into the regulator or external to the regulator

those lines with no internal flow are termed “sensing lines”; those with internal flow are termed “process lines”

3.1.3.2

breather line

connection line between the controller and/or pilot and atmosphere to equalize the pressure on the detector element when it changes its position in normal operating conditions

in the event of a fault in the detector element this line may become an exhaust line

3.1.3.3

exhaust line

connection line between the regulator or its fixtures and atmosphere for the safe exhausting of gas in the event of failure of any part

3.1.3.4

fixtures

functional devices connected to the main components of the regulator (see 3.1.2)

3.2 Control variables

3.2.1 Reference values

3.2.1.1

pressure

NOTE All pressures specified in this European Standard are static gauge pressures. They are measured in bar¹⁾.

¹⁾ 1 bar = 1 000 mbar = 10⁵ N/m² = 10⁵ Pa = 10⁻¹ MPa.

3.2.1.1.1**inlet pressure, p_e**

gas pressure at the inlet of the regulator

3.2.1.1.2**outlet pressure, p_a**

gas pressure at the outlet of the regulator

3.2.1.1.3**differential pressure, Δp**

difference between two values of pressure measured at two different points

3.2.1.1.4**motorization pressure, p_m**

gas pressure in the motorization chamber

3.2.1.1.5**pilot feeding pressure, p_{ep}**

gas pressure at the inlet of the pilot

3.2.1.2 Flow conditions**3.2.1.2.1****normal conditions**

absolute pressure of 1,013 25 bar and temperature of 0 °C (273,15 K)

NOTE For calculation purposes a value of 273 K is used in this European Standard.

3.2.1.2.2**gas volume**

volume of gas at normal conditions

it is expressed in m^3

3.2.1.2.3**volumetric flow rate, Q**

volume of gas which flows through the regulator in unit time

it is expressed in m^3/h at normal conditions

3.2.1.3**sound pressure level, L_{pA}**

sound pressure frequency weightings A in accordance with EN 60651:1994

3.2.2 Variables in the controlling process**3.2.2.1****controlled variable, X**

variable which is monitored by the controlling process

this controlled variable in regulators may be:

- inlet pressure, p_e ;
- outlet pressure, p_a ;
- differential pressure, Δp ;

in this European Standard, only the outlet pressure " p_a " is considered as the controlled variable.

3.2.2.2

disturbance variable, Z

variables acting from outside on the controlling process

in the case of regulators with the outlet pressure as the controlled variable, the disturbance variables are essentially:

- fluctuations in the inlet pressure, p_e ;
- changes in the volumetric flow rate, Q .

3.2.3 Possible values of all variables

3.2.3.1

actual value

instantaneous value of any variable at any instant

it is specified by the index “i” added to the symbol of the variable

3.2.3.2

maximum value

the highest value:

- to which any variable can be adjusted or to which it is limited;
- any variable may reach during a series of measurements or during a certain time period;

it is specified by the subscript “max” added to the symbol of the variable.

3.2.3.3

minimum value

the lowest value:

- to which any variable can be adjusted or to which it is limited;
- any variable may reach during a series of measurements or during a certain time period;

it is specified by the index “min” added to the symbol of the variable.

3.2.4 Terms pertinent to the controlled variable

3.2.4.1

set point, p_{as}

nominal value of the controlled variable

NOTE The set point is not directly measurable but determined as shown in Figure 5.

3.2.4.2

set range, W_h

whole range of set points which can be obtained from a regulator by adjustment and/or the replacement of some components (i.e. replacement of the valve seat or adjustment element e.g. spring)

3.2.4.3

specific set range, W_a

whole range of set points which can be obtained in a regulator by adjustment and with no replacement of its components

3.2.4.4

control deviation, X_w

difference between the actual value of the controlled variable and the set point

3.2.4.5

regulation change

control deviation, X_w expressed as a percentage of the set point

3.3 Operating features in stable conditions

3.3.1

stable conditions

conditions when the controlled variable settles to a stable value after a disturbance has occurred

3.3.2

performance curve

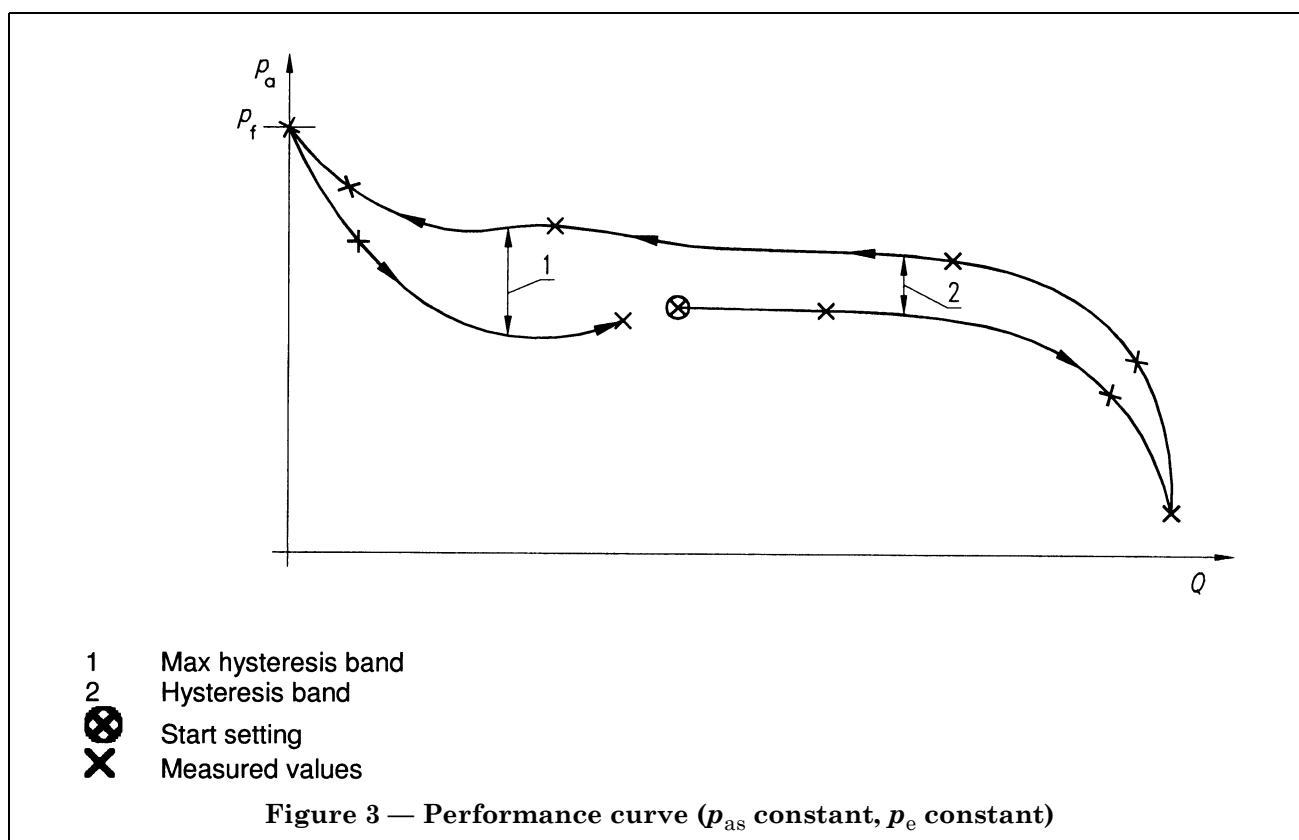
graphic representation of the controlled variable as a function of the volumetric flow rate

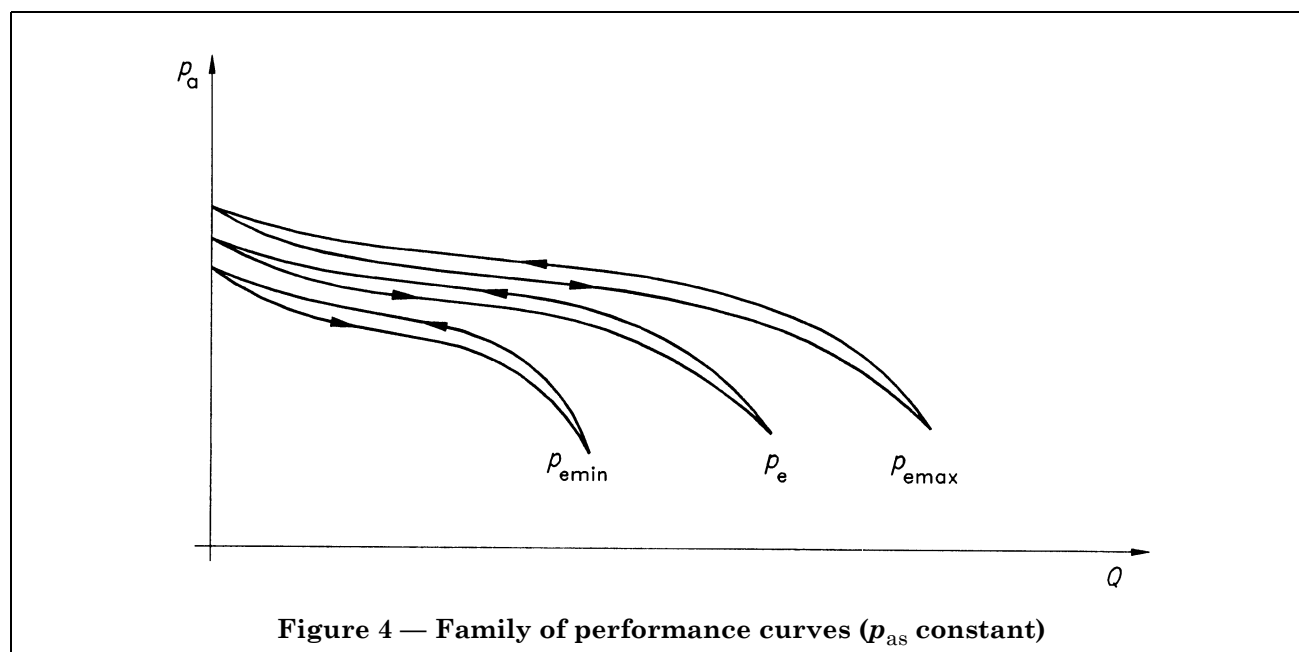
this curve is determined by increasing and then decreasing the volumetric flow rate with constant inlet pressure and set point (see Figure 3)

3.3.3

hysteresis band

difference between the two values of outlet pressure for a given volumetric flow rate (see Figure 3)





3.3.4 family of performance curves
set of the performance curves for each value of inlet pressure determined for a given set point (see Figure 4)

3.3.5 Features pertinent to accuracy

3.3.5.1 accuracy
average, expressed as a percentage of the set point, of the absolute maximum values of the positive and negative control deviation within the operating range

3.3.5.2 accuracy class, AC
maximum permissible value of the accuracy

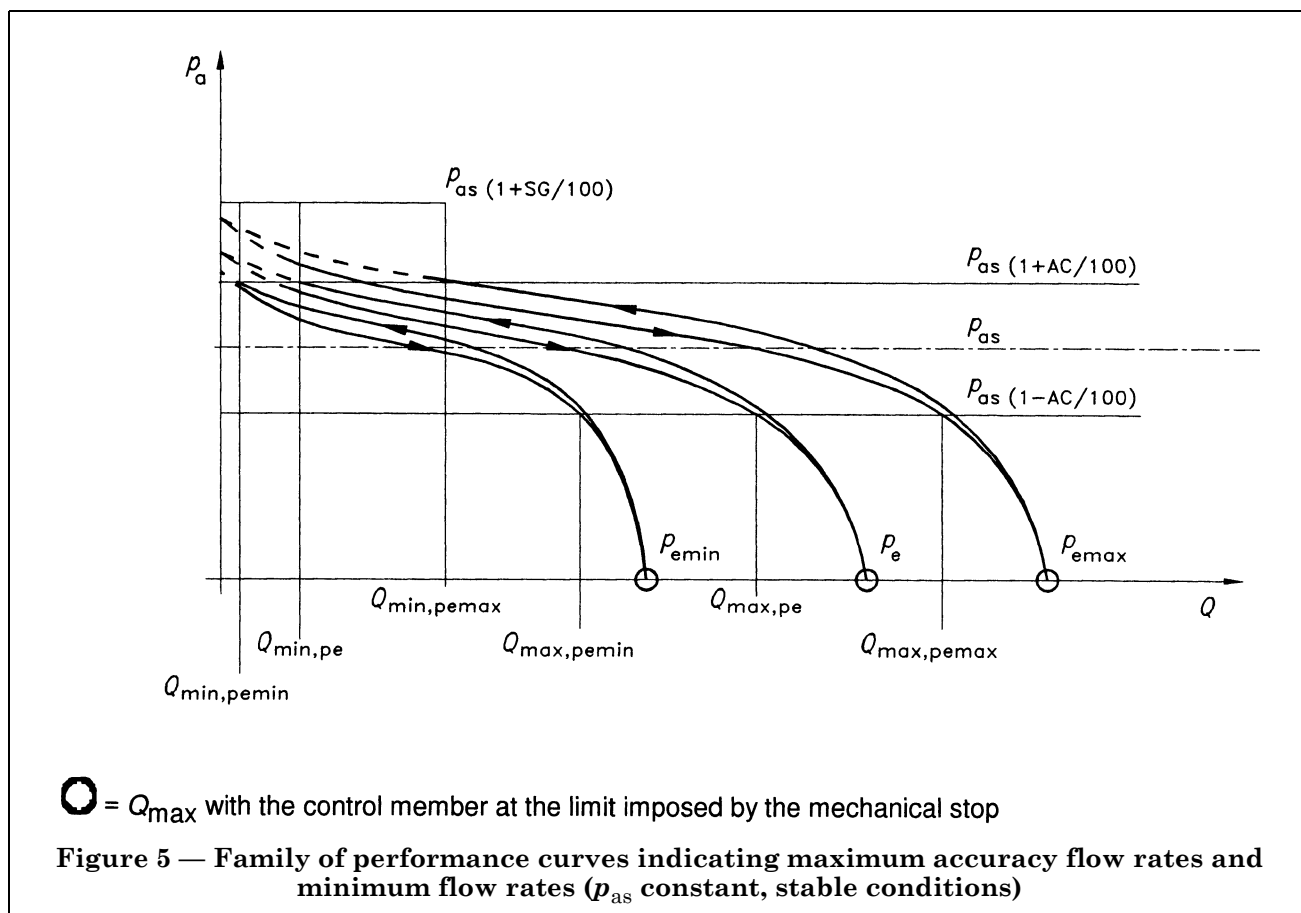
3.3.5.3 inlet pressure range, b_{pe}
range of the inlet pressure for which the regulator ensures a given accuracy class
the inlet pressure range is characterized by its limit values p_{emax} and p_{emin}

3.3.5.4 maximum accuracy flow rate
the lowest value of the maximum volumetric flow rate up to which, for a given set point and within the ambient temperature range specified, a given accuracy class is ensured:

- at the lowest inlet pressure (see Figure 5) $Q_{max,pemin}$
- at the highest inlet pressure (see Figure 5) $Q_{max,pemax}$
- at an intermediate inlet pressure between p_{emax} and p_{emin} (see Figure 5) $Q_{max,pe}$

3.3.6 Features pertinent to lock-up behaviour

3.3.6.1 lock-up time, t_f
time taken for the control member to move from an open position to the closed position



3.3.6.2

lock-up pressure, p_f

pressure that occurs at the measuring point of the controlled variable when the control member is in the closed position

the lock-up pressure corresponds to the outlet pressure at the volumetric flow rate $Q = 0$ in the performance curve (see Figure 3)

it results when the time taken for a change in volumetric flow rate from Q to zero is greater than the lock-up time of the regulator

3.3.6.3

lock-up pressure class, SG

maximum permissible positive difference between the actual lock-up pressure and the set point expressed as a percentage of the set point e.g:

$$SG = \frac{P_f - P_{as}}{P_{as}} \times 100 \quad (1)$$

3.3.6.4
minimum flow rate

the largest value of the minimum volumetric flow rate down to which, for a given set point and within the ambient temperature range specified, stable conditions as per 5.3.3 are obtained:

- at the lowest inlet pressure (see Figure 5)

$Q_{\min,\text{pemin}}$
- at the highest inlet pressure (see Figure 5)

$Q_{\min,\text{pemax}}$
- at an intermediate inlet pressure between p_{emax} and p_{emin} (see Figure 5)

$Q_{\min,\text{pe}}$

3.3.6.5
lock-up pressure zone

zone between the volumetric flow rate $Q = 0$ and the minimum flow rate $Q_{\min,\text{pe}}$ for each corresponding inlet pressure and set point (see Figure 6)

3.3.6.6
class of lock-up pressure zone, SZ

maximum permissible lock-up pressure zone for specified:

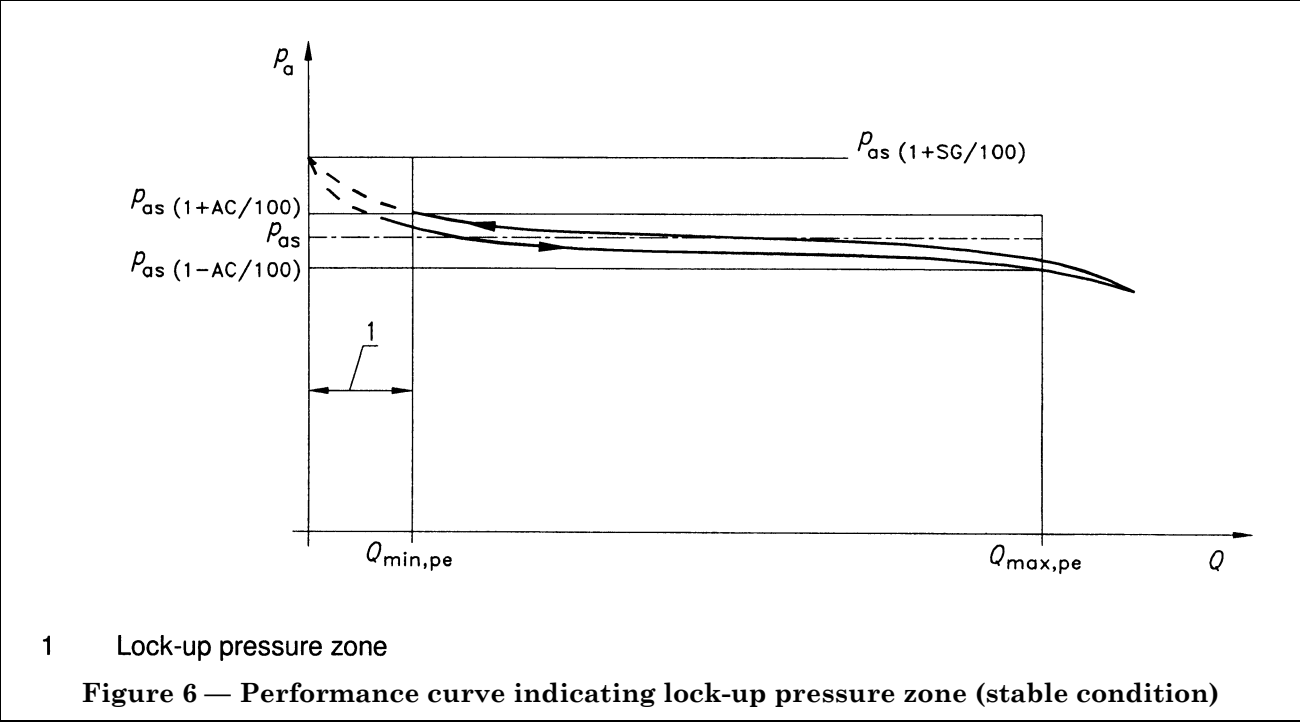
- inlet pressure p_e or inlet pressure range b_{pe} ;
- set point p_{as} or specific set range W_a or set range W_h ;

it is expressed as the percentage of $Q_{\min,\text{pe}}$ to $Q_{\max,\text{pe}}$, i.e:

$$\text{SZ} = \frac{Q_{\min,\text{pe}}}{Q_{\max,\text{pe}}} \times 100$$

(2)

NOTE The values of p_e referred to in $Q_{\min}$ and $Q_{\max}$ are not necessarily the same.



3.4 Further functional terminology

3.4.1 Pressures pertinent to design of gas pressure regulator

3.4.1.1

component operating pressure, p

gas pressure occurring in any part of a regulator during operation

3.4.1.2

maximum component operating pressure, $p_{\max}$

the highest operating pressure at which any component of a regulator will continuously operate within specified conditions

3.4.1.3

allowable pressure, p_{zul}

pressure the regulator body will withstand in accordance with the specified strength and external tightness requirements²⁾

NOTE At this pressure functional performance is not necessarily required.

3.4.1.4

test pressure, p_t

pressure applied to a section of the regulator for a limited period of time in order to prove certain characteristics

3.4.1.5

design pressure, p_d

pressure used in the strength calculations for the body and other parts of the housing taking into account the safety factors required by this European Standard

3.4.1.6

limit pressure, p_l

pressure at which yielding or failure becomes apparent in any component of the regulator or its fixtures

3.4.1.7

safety factor

ratio of the value of the limit pressure p_l to the value of the design pressure p_d applied to:

- the regulator body: S_b ;
- the other pressure containing parts of the regulator: S .

3.4.1.8

permissible inlet pressure, p_{emax}

the highest inlet pressure at which the regulator can continuously operate within specified conditions

3.4.1.9

permissible outlet pressure, p_{amax}

the highest outlet pressure at which the regulator can continuously operate within specified conditions

3.4.1.10

minimum operating differential pressure, $\Delta p_{\min}$

minimum operating differential pressure between the inlet and outlet pressures below which the regulator will no longer function correctly within specified conditions

3.4.2

nominal pressure, PN

numerical designation relating to pressure that is a convenient round number for reference purposes for the specific purpose of this European Standard it applies to flanges

²⁾ For additional explanation see Annex A.