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Second edition
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Gas welding equipment — Pressure regulators for gas cylinders used in welding, cutting and allied processes up to 300 bar

Matériel de soudage au gaz — Détendeurs pour bouteilles de gaz utilisés pour le soudage, le coupage et les techniques connexes jusqu'à 300 bar

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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 2503, was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 8, *Equipment for gas welding, cutting and allied processing*.

This second edition cancels and replaces the first edition (ISO 2503:1983), which has been technically revised.

Gas welding equipment — Pressure regulators for gas cylinders used in welding, cutting and allied processes up to 300 bar

1 Scope

This International Standard specifies requirements for single or two-stage pressure regulators for connections to gas cylinders normally used for compressed gases up to 300 bar[1)] (30 MPa), for dissolved acetylene, for liquefied petroleum gases (LPG), methylacetylene-propadiene-mixtures (MPS) and carbon dioxide (CO_2) used in welding, cutting and allied processes.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All Standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*.

ISO 3253:1998, *Gas welding equipment — Hose connections for equipment for welding, cutting and related processes.*

ISO 5171:1995, *Pressure gauges used in welding, cutting and allied processes*.

ISO/TR 7470:1988, *Valve outlets for gas cylinders — List of provisions which are either standardized or in use*.

ISO 9090:1989, *Gas tightness of equipment for gas welding and allied processes*.

ISO 9539:1988, *Materials for equipment used in gas welding, cutting and allied processes*.

3 Definition

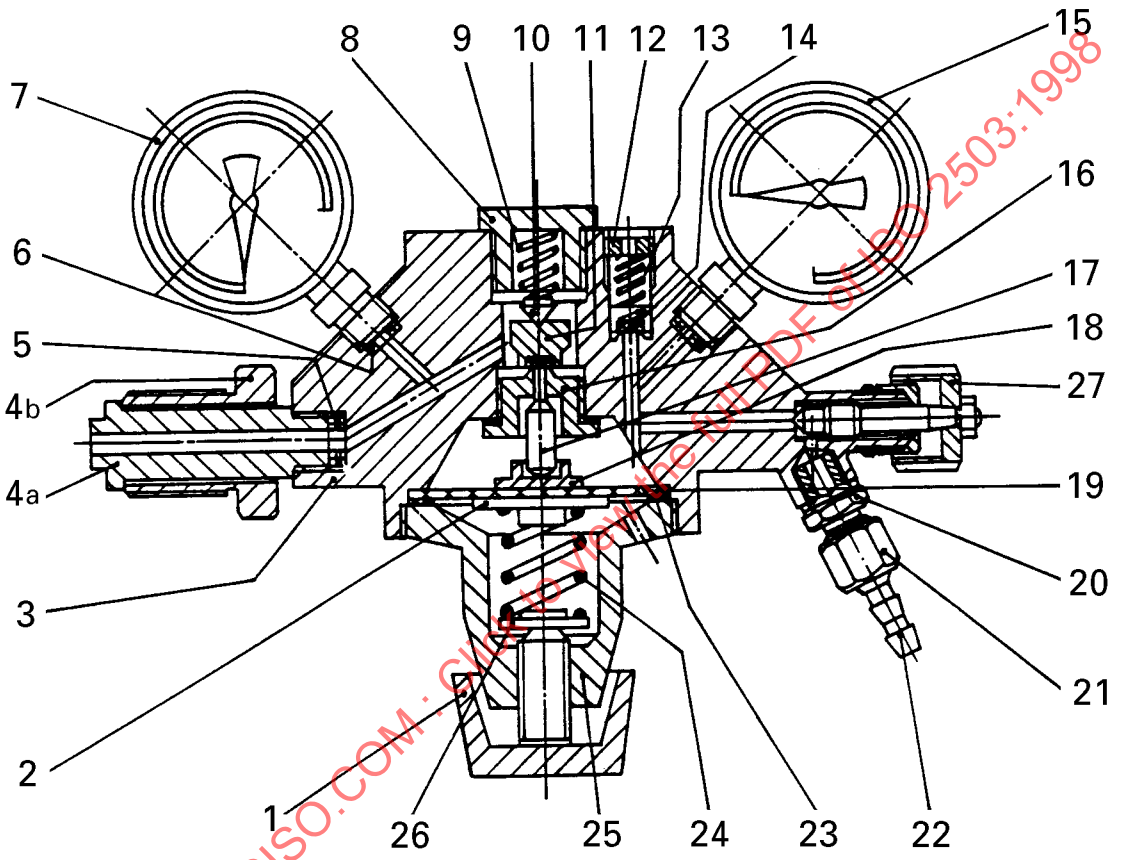
For the purposes of this International Standard, the following definition applies.

3.1 pressure regulator: Device for regulating a generally variable inlet pressure to an as constant as possible outlet pressure.

1) 300 bar relates to maximum cylinder charging pressure at 15 °C.

4 Terminology

The terms relating to pressure regulators are given in the key to figure 1 given in table 1. The diagram of the pressure regulator is an example only.



NOTES

1 Parts 12, 13 and 14 are components of the relief valve

2 Part 27 is an outlet valve and its installation is optional, see 6.2.4.

3 Parts 4a and 4b of the drawing are examples and are not specified. Other types of inlet connection pieces are also in use.

Figure 1 — Diagram of a pressure regulator and designation of its components

Table 1 — List of terms

No.	English	French	German
1	pressure adjusting screw	vis de réglage	Einstellschraube
2	spring plate	plateau de membrane	Federteller
3	body	corps	Körper
4a	inlet stem	raccord d'entrée	Eingangsstutzen
4b	inlet nut	écrou flottant raccord d'entrée	Schraubverbindung
5	inlet filter	filtre d'entrée	Eintrittsfilter
6	seating washer	joint de manomètre	Manometeranschluß-Dichtungsring
7	high-pressure gauge	manomètre haute pression (amont)	Hochdruckmanometer
8	pressure regulator valve cap	bouchon de clapet	Regelventilkappe
9	pressure regulator valve spring	ressort de clapet	Regelventilfeder
10	spring centre	appui mobile de centrage du ressort de clapet	Regelventil-Federteller
11	pressure regulator valve	clapet	Regelventil
12	relief valve cap	vis de réglage de la soupape de sécurité	Einstellschraube des Abblaseventils
13	relief valve spring	ressort de soupape de sécurité	Feder für Abblaseventil
14	relief valve seat	clapet de soupape de sécurité	Abblaseventilsitz
15	low-pressure gauge	manomètre basse pression (aval)	Niederdruckmanometer
16	pressure regulator valve seat	siège	Regelventilsitz
17	pressure regulator valve pin	poussoir	Regelventilstift
18	diaphragm plate	plateau d'appui du poussoir	Membranteller
19	diaphragm	membrane	Membran
20	outlet connection piece	raccord de sortie (mamelon fileté)	Abgangsstutzen
21	union nut	écrou de douille	Überwurfmutter
22	hose tail	douille porte-tuyau	Schlauchtülle
23	diaphragm seal	joint de membrane	Membrangleitring
24	pressure regulator spring	ressort de détente	Stellfeder
25	pressure regulator cover	couvercle	Federdeckel
26	pressure regulator spring plate	appui mobile de centrage du ressort de détente	Stellfederteller
27	outlet valve	robinet de sortie	Absperrventil

5 Units

5.1 Pressure

The pressures measured are gauge pressures[2] and are expressed in bar.

5.2 Flow

Flow rates are measured in cubic metres per hour (m^3/h) at normal conditions[3] taking into account the relevant conversion coefficient for the gas used (see table 2).

Table 2 — Conversion coefficient, *U*

Test gas	Conversion coefficient								
	air	**oxygen**	**nitrogen**	**argon**	**hydro-gen**	**helium**	**acety-lene**	**LPG,** e.g. propane	**CO_2**
air	1	0,950	1,02	0,851	3,81	2,695	1,05	0,800	0,808
nitrogen	0,983	0,930	1	0,837	3,75	2,65	1,03	0,784	0,792

Conversion coefficient, *U*, is based on the formula:

$$U = \sqrt{\frac{\gamma_0}{\gamma_1}}$$

where

γ_0 is the specific weight of test gas;

γ_1 is the specific weight of gas used.

5.3 Temperature

Temperatures are measured in degrees Celsius.

6 Manufacturing requirements

6.1 Materials

Materials for pressure regulators shall conform to the requirements of ISO 9539.

6.2 Design, machining and assembly

6.2.1 Oxygen regulators

Regulators for oxygen shall be designed, machined and manufactured such that internal ignition does not occur (see 11.5.3). All components and accessories shall be thoroughly cleaned and degreased before assembly.

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2) Pressure exceeding atmospheric pressure.
3) Normal conditions are given in ISO 554.

6.2.2 Acetylene regulators

Regulators for acetylene shall be designed and manufactured so that the outlet pressure shall not exceed 1,5 bar.

6.2.3 Filter

A dust filter, having an effective cross-section compatible with the discharge, shall be mounted within the pressure regulator upstream of the pressure regulator valve. The filter shall not be removable without the use of a tool. The filter shall retain particles greater than or equal to 0,1 mm.

6.2.4 Outlet valve

Pressure regulators can be fitted with an outlet valve. When fitted, the spindle shall be captive.

6.2.5 Pressure adjusting device

This device shall be designed in such a way that it is not possible for the pressure regulator valve to be held in the open position, for example, as a consequence of the spring being compressed fully (to its solid length).

If the dimensions of the pressure adjusting screw are such as to prevent the spring becoming fully compressed, then the pressure adjusting screw shall be not removable.

Using the adjusting device, it shall not be possible to set a pressure at which the relief valve vents.

6.2.6 Relief valve

6.2.6.1 General

The fitting of a relief valve is obligatory for all compressed gases and carbon dioxide and optional for LPG, MPS and acetylene.

The minimum discharge Q_{RV} of the relief valve, if fitted, shall be equal to or greater than the standard discharge Q_1 (see tables 3 and 4) for a pressure p_{RV} defined by the expression $p_{RV} = 2p_2$, except in the case of acetylene regulators, where p_{RV} shall be equal to 3 bar for all classes.

With decreasing pressure the relief valve shall close at a pressure greater than p_2. The relief valve shall be non-adjustable by the user.

6.2.6.2 Relief valve for compressed gases and carbon dioxide

The relief valve shall remain gas tight to a pressure above the maximum outlet pressure achieved when the flow is shut off for the initial pressure p_3. The relief valve shall be fitted in such a way that the gas discharges safely.

6.2.6.3 Relief valve for acetylene

The relief valve, if fitted, shall remain gas tight to a pressure above 1,5 bar. It shall be fitted in such a way that the gas is not discharged towards to the operator.

6.2.6.4 Relief valve for LPG and MPS

The relief valve, if fitted, shall conform to 6.2.6.2.

6.2.7 Pressure gauges

When fitted externally, pressure gauges shall conform to ISO 5171. If pressure gauges are integral with the regulator, the relevant operational and safety requirements stipulated in ISO 5171 shall apply.

6.2.8 Gas tightness

Pressure regulators shall be gas tight to the atmosphere and shall conform to the requirements of ISO 9090.

Pressure regulators shall be internally gas tight, i.e. between the high pressure and low pressure parts for all normal pressures for relevant gases. The maximal internal leakage shall not exceed 0,2 mbar l/min (12 cm^3/h).

6.2.9 Mechanical resistance

6.2.9.1 Fitness for service

Pressure regulators shall be designed and constructed in such a way that the application of pressures given in table 6 in the high pressure and low pressure chambers does not lead to permanent deformation.

6.2.9.2 Safety

Pressure regulators shall be designed and constructed so that if the low pressure chamber of the regulator, or intermediate chamber in the case of two-stage regulators, is in direct communication with a full cylinder of gas, for instance if the regulator valve is held in the open position and the outlet connection is closed (by an attached stop valve or a blind plug) the high-pressure gas shall either be safely retained or vented (see 11.5.1.2).

7 Types of connections

7.1 Inlet connections

Pressure regulators shall be made in such a way that the inlet connection is compatible with the cylinder valve outlet designed for the gas contained (see ISO/TR 7470). The inlet pressure p_1 specified by the manufacturer, shall be not less than the maximum charging pressure (at 15 °C) permitted for the cylinder connection.

7.2 Outlet connections

Threaded outlet connections shall conform to ISO 3253 and comply with the following conditions:

– the outlet connection orientation should preferably point downwards and away from the cylinder;

– curved hose tails shall not be used.

8 Physical characteristics

The symbols used are given in table 3.

Table 3 — Symbols used

Symbol	Explanation
p_1	rated (maximum) inlet pressure
p_2	rated (maximum) outlet pressure
p_{2R}	acetylene outlet pressure used for calculation of R (see 11.4.4)
p_{2i}	acetylene outlet pressure used for calculation of i (see 11.4.5)
p_3	upstream pressure for type testing: $p_3 = 2p_2 + 1$ bar (0,1 MPa)
p_4	stabilized outlet pressure (stabilization after flow ceases)
p_5	the highest or lowest outlet pressure during a test of determination of irregularity coefficient according to 11.4.5
Q_1	standard discharge
Q_{max}	maximum discharge
Q_{RV}	discharge of the relief valve
R	coefficient of pressure increase upon closure
i	irregularity coefficient

8.1 Pressures

8.1.1 Rated (maximum) inlet pressure, p_1

Rated (maximum) inlet pressure for which the pressure regulator is designed.

8.1.2 Rated (maximum) outlet pressure, p_2

Rated (maximum) downstream pressure for the standard discharge specified in the table of equipment classes (see table 4).

NOTE — This maximum pressure is defined for testing, and is above the normal operating pressure of the pressure regulator.

In the case of acetylene regulators class 2, the standard discharge will be measured at p_{2R}.

8.1.3 Stabilized outlet pressure, p_4, for acetylene regulators class 2

For acetylene regulators class 2 the stabilized outlet pressure p_4 shall not exceed 1,5 bar for all inlet pressures.

8.2 Flow rates

8.2.1 Maximum discharge, Q_{max}

The maximum discharge of the gas concerned, expressed in (m^3/h), which the pressure regulator can provide for an upstream pressure p_3 is defined by the expression:

$p_3 = 2p_2 + 1$ bar.

This discharge Q_{max} shall be not less than Q_1 (see 11.4.1).

8.2.2 Standard discharge, Q_1

The standard discharge is given in table 4.

8.3 Equipment classes

Performance is measured at a standard discharge Q_1 related to p_2, shown in table 4.

A pressure regulator is considered to belong to one of the classes specified in table 4 if its maximum discharge, Q_{max}, is not less than the standard discharge Q_1 of the class concerned.

The values of p_2 and Q_1 given in table 4 are preferred values, but other values are allowed.

Table 4 — Equipment classes

Gas	Class	Rated (max.) inlet pressure p_1 bar (10^{-1} MPa)	Rated (max.) outlet pressure p_2 bar (10^{-1} MPa)	Standard discharge Q_1 m^3/h
oxygen and other compressed gases up to 300 bar (30 MPa)	0 1 2 3 4 5	0 to 300 [1]	2 4 6 10 12,5 20	1,5 5 15 30 40 50
dissolved acetylene	1 2	25	0,8 < 1,5	1 5 [2]
MPS	0 1	25 [3]	1,5 4	1 5
LPG	0 1	25 [4]	1,5 4	1 [5] 5 [5]
CO_2	0 1	200 [6]	2 4	2 [5] 2 [5]

1) Pressure relating to maximum cylinder charging pressure at 15 °C.

2) General recommendations: flow rates greater than 1 m^3/h should be avoided.

3) Vapour pressure for MPS at 65 °C. This value may change depending on components of the gas mixture.

4) Vapour pressure for propane at 70 °C.

5) Depending upon ambient conditions, the use of a heater may be necessary to achieve standard discharge with LPG and CO_2 gases.

6) Pressure for CO_2 at 70 °C at the filling ratio of 0,667.

8.4 Operating characteristics

8.4.1 Coefficient of pressure increase upon closure, R

This coefficient is defined by:

$$R = \frac{p_4 - p_2}{p_2}$$

For acetylene regulators class 2, $p_2 = p_{2R}$, (see table 3).

where p_4 is the stabilized outlet pressure (stabilization pressure) noted 1 min after discharge ceases where the acetylene regulators class 2 have been set to the initial conditions Q_1, p_{2R} for inlet p_3.

For standard discharge Q_1, the coefficient R of pressure increase upon closure shall be less than 0,3.

8.4.2 Irregularity coefficient, i

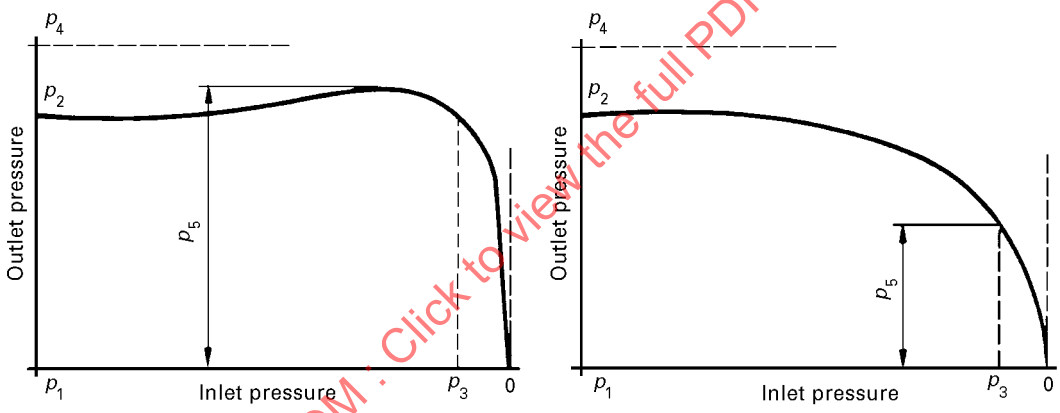
This coefficient is defined by:

$$i = \frac{p_5 - p_2}{p_2}$$

For acetylene regulators class 2, $p_2 = p_{2i}$, (see table 3)

where p_5 is the highest or lowest value of the outlet pressure (see figure 2) during a test in which the inlet pressure varies from p_1 to p_3 for a flow equal to the standard discharge Q_1 in accordance with table 4.

The limits shall be: $-0{,}3 < i < +0{,}3$.



a) With rising characteristic **b) With falling characteristic**

Figure 2 — Typical dynamic expansion curves

8.4.3 Operating temperature range

The pressure regulators shall be capable of operating normally in the temperature range – 20 °C to + 60 °C.

9 Marking

The following information shall be clearly and permanently marked in accordance with 11.6 on the pressure regulator body or cover or on a label permanently fixed to the pressure regulator:

– the number of this International Standard;

– the name or trade mark of the manufacturer and/or distributor;

– pressure regulator class or p_2, Q_1 in accordance with 8.3;

– rated inlet pressure, p_1, nominated by the manufacturer (only for oxygen and other compressed gases);

– gas intended for use (when the full name of the gas cannot be imprinted the symbols shown in table 5 shall be used).

Table 5 — Code letters for gases to be used for marking of pressure regulators

Type of gas	Code letter
acetylene	A
oxygen	O
hydrogen	H
compressed air	D
LPG	P
MPS	Y
natural gas	M
CO_2, nitrogen, inert gas	N

10 Instructions for use

The manufacturer, supplier or distributor shall supply instructions for use with each pressure regulator, covering at least:

a) the field of application of the pressure regulator;

b) a description of the pressure regulator and the meaning of the marking;

c) the safe and correct installation of the pressure regulator;

d) the commissioning tests that are necessary to guarantee safe and correct installation prior to service;

e) the use and maintenance of the pressure regulator (intended for the operator), including hazards and safety precautions in the case of oxygen.

11 Type test procedure

11.1 General

Checking conformity to this International Standard, of a regulator of a given type consists of:

– tests;

– checking of documents.

Conformity to the requirements of this International Standard can be confirmed by an independent body.

The oxygen ignition test (see 11.5.3) shall be carried out after the functional tests (see 11.4) and before the fitness test (see 11.5.1.1).

NOTE — These tests are applicable only to regulators submitted for conformity to this International Standard, i. e. type tests, and are not intended as the programme for production testing of all regulators.

11.2 Test samples and necessary documents

For the tests the following samples and documents shall be available:

– 3 samples of the pressure regulator (five in the case of oxygen);

– 1 set of general arrangement drawings with material lists;

– 2 sets of detailed drawings;

– if necessary a declaration from the manufacturer giving the material specifications and fitness for purpose.

The tests shall be carried out with pressure regulators which are in accordance with the drawings.

11.3 Test conditions

11.3.1 General characteristics of the test installation

All the pipelines of the testing installation together with the valve which controls the flow shall have a passage greater than that of the regulator to be tested.

11.3.2 Type of gas

Tests shall be carried out with air or nitrogen free from oil and grease in accordance with ISO 554.

Only the ignition test according to 11.5.3 shall be carried out with oxygen.

In all cases, tests shall be carried out with a gas of maximum moisture content of 0,005 % corresponding to a dew point of – 48 °C.

11.3.3 Units of measurement and rating test

Flow measurement data shall be expressed in accordance with the specifications contained in ISO 554.

The tolerance of the measuring apparatus shall not exceed ± 3 % of the measuring range.

11.3.4 Pressure measurement

The test bench shall be constructed in such a way that upstream and downstream pressures can be regulated. The equipment may be operated by remote control.

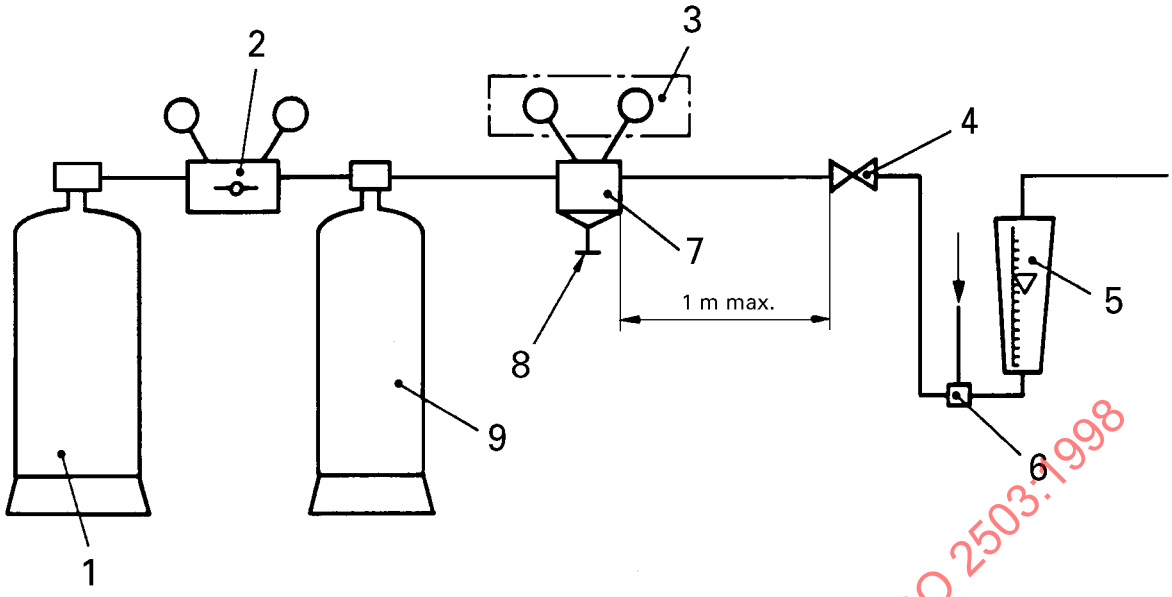
The gas supply for the rated (maximum) inlet pressure p_1 and for pressure p_3 shall have sufficient capacity for the duration of the test.

Gauges of class 1 or better shall be used for the pressure measurement. In such cases, the pressure gauges on the regulators can be included in the testing.

11.4 Functional tests

11.4.1 General

An example of the test apparatus used for the measurement of the maximum discharge, Q_{max}, is shown in figure 3. The pressure regulator may be supplied via a buffer cylinder. The upstream pressure p_3 (see 8.2.1) is held constant by means of an auxiliary regulator or any equivalent device.



Key

1	Gas supply	6	Thermometer for measurement of the gas temperature
2	Auxiliary regulator	7	Regulator (sample)
3	Calibrated gauges	8	Adjusting screw
4	Valve for regulation	9	Buffer cylinder
5	Flowmeter		

Figure 3 — Example for the measurement of the maximum discharge, Q_{max}

11.4.2 Maximum discharge, Q_{max}

The maximum discharge, Q_{max}, shall be measured as follows.

11.4.2.1 Maximum discharge, Q_{max}, excluding acetylene regulators class 2

The adjusting screw of the regulator sample under test shall be fully screwed in, and the valve for regulation shall be fully opened so that:

– the downstream pressure gauge indicates the rated (maximum) outlet pressure p_2;

– flowmeter indicates the maximum discharge, Q_{max}, taking into account the corrections in 11.3.3 and table 2 and the temperature measured by the thermometer.

11.4.2.2 Maximum discharge, Q_{max}, for acetylene regulators class 2

The adjusting screw of the regulator sample under test shall be fully screwed in, and the valve for regulation shall be fully opened. The flowmeter indicates the maximum discharge, Q_{max}, taking into account the corrections in 11.3.3 and table 2 and the temperature measured by the thermometer.

NOTE — Q_{max} defined in 8.2.1 is a conventional value. It may be lower than the real flow, which the regulator may permit under different conditions.

11.4.3 Standard discharge, Q_1

A standard discharge, Q_1, shall be obtained using the following settings.

11.4.3.1 Standard discharge, Q_1, excluding acetylene regulators class 2

The adjusting screw of the regulator sample under test and the valve for regulation shall be set to achieve p_2, Q_1 at p_3 inlet.

11.4.3.2 Standard discharge, Q_1, for acetylene regulators class 2

The adjusting screw of the regulator sample under test shall be fully screwed in, and the valve for regulation shall be opened to achieve Q_1 at p_3 and the corresponding outlet pressure measured. This pressure shall be referred to as p_{2R}.

11.4.4 Coefficient of pressure increase upon closure, R

With the regulator set to standard discharge conditions (see 11.4.3) proceed as follows:

– stop the flow by using the valve for regulation;

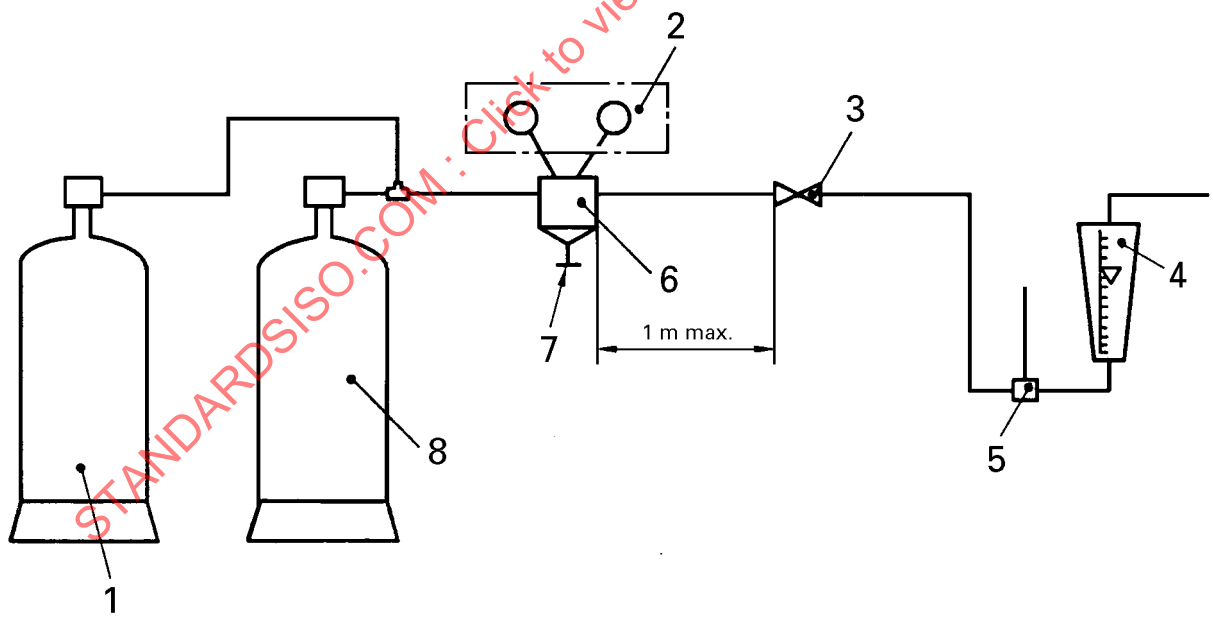
– after 1 min record the stabilization pressure p_4;

– determine the value of R (see 8.4.1).

11.4.5 Irregularity coefficient, i

For the determination of the irregularity coefficient, i, (see 8.4.2) a dynamic expansion curve is plotted. This curve indicates the downstream pressure as a function of the upstream pressure. During this test the upstream pressure varies from the rated (maximum) inlet pressure p_1 to pressure p_3.

An example of the test apparatus is shown in figure 4.



Key

1 Auxiliary gas cylinder
2 Calibrated gauges or recording equipment
3 Valve for regulation
4 Flowmeter
5 Thermometer for measurement of the gas temperature
6 Regulator (sample)
7 Adjusting screw
8 Primary gas cylinder

Figure 4 — Example for the measurement of the dynamic expansion curves