BS EN ISO 7291:2010+A1:2015

BSI Standards Publication

Gas welding equipment — Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar)

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National foreword

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The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by [A1] ⟨A1⟩.

The UK participation in its preparation was entrusted to Technical Committee WEE/18, Gas welding and cutting appliances.

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English Version

Gas welding equipment - Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar) (ISO 7291:2010)

Matériel de soudage aux gaz - Détendeurs de centrale de bouteilles pour le soudage, le coupage et les techniques connexes jusqu'à 30 MPa (300 bar) (ISO 7291:2010)

Gasschweißgeräte - Hauptstellendruckregler für Schweißen, Schneiden und verwandte Prozesse bis 30 MPa (300 bar) (ISO 7291:2010)

This European Standard was approved by CEN on 23 October 2010.

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Foreword

This document (EN ISO 7291:2010) has been prepared by Technical Committee ISO/TC 44 "Welding and allied processes" in collaboration with Technical Committee CEN/TC 121 “Welding” the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by May 2011, and conflicting national standards shall be withdrawn at the latest by May 2011.

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Endorsement notice

The text of ISO 7291:2010 has been approved by CEN as a EN ISO 7291:2010 without any modification.

Foreword to amendment A1

This document (EN ISO 7291:2010/A1:2015) has been prepared by Technical Committee ISO/TC 44 “Welding and allied processes” in collaboration with Technical Committee CEN/TC 121 “Welding and allied processes” the secretariat of which is held by DIN.

This Amendment to the European Standard EN ISO 7291:2010 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2015, and conflicting national standards shall be withdrawn at the latest by October 2015.

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Endorsement notice

The text of ISO 7291:2010/Amd 1:2015 has been approved by CEN as EN ISO 7291:2010/A1:2015 without any modification.

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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ISO 7291 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 8, *Equipment for gas welding, cutting and allied processes*.

This third edition cancels and replaces the second edition (ISO 7291:1999), which has been technically revised.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 8 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Gas welding equipment — Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar)

1 Scope

This International Standard specifies requirements and test methods for pressure regulators in manifold systems used in welding, cutting, and allied processes for:

a) compressed gases up to 30 MPa[1)] (300 bar);

b) dissolved acetylene;

c) liquefied petroleum gases (LPG);

d) methylacetylene-propadiene-mixtures (MPS);

e) carbon dioxide (CO_2).

It is not applicable to pressure regulators fitted directly to the gas cylinders, as defined in ISO 2503[2].

2 Normative references

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

ISO 5171, *Gas welding equipment — Pressure gauges used in welding, cutting and allied processes*

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

ISO 9539, *Gas welding equipment — Materials for equipment used in gas welding, cutting and allied processes*

ISO 15296, *Gas welding equipment — Vocabulary — Terms used for gas welding equipment*

〉A1〈 ISO 10225, *Gas welding equipment — Marking for equipment used for gas welding, cutting and allied processes* 〉A1〈

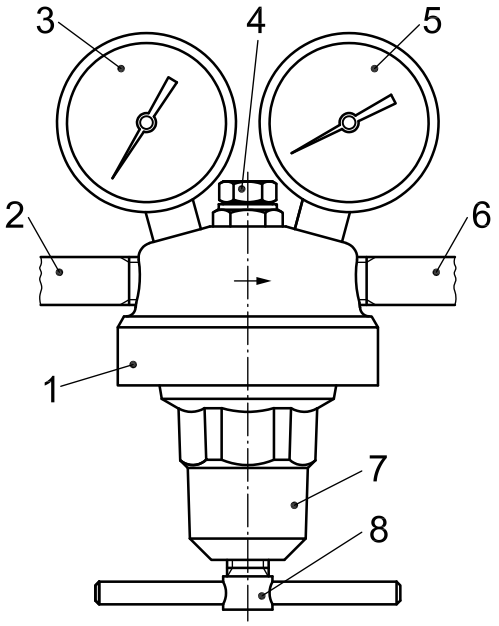
1) The value 30 MPa relates to maximum cylinder filling pressure at 15 °C.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15296 and the following apply.

3.1
pressure regulator for manifold systems
device for regulating a generally variable inlet pressure to as constant as possible an outlet pressure when controlling the output of a manifold of cylinders

NOTE The diagram of the pressure regulator is an example only. Optional design characteristics are to be compatible with the safety requirements specified in this International Standard. See Figure 1.



Key

1 pressure regulator body
2 inlet connector
3 upstream pressure gauge
4 relief valve
5 downstream pressure gauge
6 outlet connector
7 pressure regulator cover
8 pressure adjusting screw

Figure 1 — Example of pressure regulators and designation of its components

3.2
manifold
assembly of devices generally linking two or more gas sources coupled to a user pipeline system, delivering a regulated pressure under specified safe conditions

NOTE A manifold can include components like collectors, safety devices, and pressure regulators.

4 Units

4.1 Pressure

The pressures measured are gauge pressures[2)] and are expressed in megapascals or bars.

4.2 Flow

Flow rates are measured in cubic metres per hour corrected to a standard atmosphere[3)], taking into account the relevant conversion coefficient for the gas used (see Table 1).

Table 1 — Conversion coefficient, U

Test gas	Conversion coefficient								
	air	oxygen	nitrogen	argon	hydrogen	helium	acetylene	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

The conversion coefficient, U, is given by Equation (1):

$$U = \sqrt{\frac{\gamma_0}{\gamma_1}} \tag{1}$$

where

γ_0 is the density of test gas;

γ_1 is the density of gas used.

4.3 Temperature

Temperatures are measured in degrees Celsius.

5 Manufacturing requirements

5.1 Materials

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

2) Pressure exceeding atmospheric pressure.

3) A standard atmosphere at 23 °C and 0,101 3 MPa (1,013 bar), ISO 554[1].

5.2 Design, machining and assembly

5.2.1 Oxygen pressure regulators

Pressure regulators for oxygen shall be designed and manufactured giving consideration to the possibility of internal ignition. Pressure regulators for oxygen shall not ignite or show evidence of burning when submitted to the ignition test in 9.4.4.

All components and accessories shall be thoroughly cleaned and degreased before assembly.

5.2.2 Acetylene pressure regulators

Pressure regulators shall be designed and constructed in such a way that they withstand acetylene decomposition. The test shall be carried out in accordance with 9.4.6.

5.2.3 Connections

5.2.3.1 Inlet connections

Choice of inlet connections is left to the manufacturer's discretion.

5.2.3.2 Outlet connections

Choice of outlet connection is left to the manufacturer's discretion.

5.2.4 Filter

A particle filter, having an effective cross-section compatible with the discharge, shall be mounted within or directly fitted to 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 of size greater than or equal to 0,1 mm.

5.2.5 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 not be removable.

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

5.2.6 Pressure gauges

The pressure regulator shall be supplied with upstream and downstream pressure gauges complying with the functions and safety requirements specified in ISO 5171.

Inlet connection threads shall conform to international, regional or national standards for pressure gauges.

Pressure gauges shall be designed and constructed in such a way that they withstand acetylene decomposition. The test shall be carried out in accordance with 9.4.7.

5.2.7 Gas leakage

5.2.7.1 General

The pressure regulator shall be gastight to the exterior, e.g. to the atmosphere, and internally, i.e. between the high-pressure and low-pressure parts. At all normal pressures for relevant gases, the leakage shall not exceed the limits specified in 5.2.7.2 and 5.2.7.3.

5.2.7.2 External leakage

Pressure regulators shall be gastight to the atmosphere and shall conform to the requirements of ISO 9090. The total leakage shall be less than 10 cm^3/h.

5.2.7.3 Internal leakage, q_f

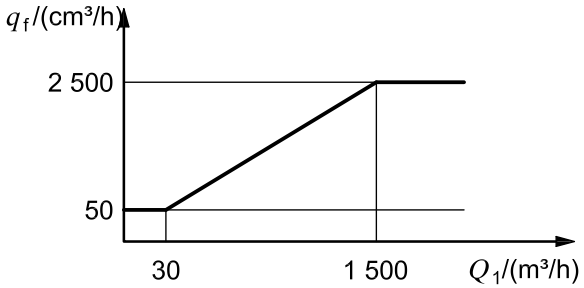
Maximum allowable internal leakage, q_f, in cubic centimetres per hour, of the pressure regulator is a function of its standard discharge, Q_1, in cubic metres per hour (see Figure 2).

For $Q_1 < 30$ m^3/h, $q_f < 50$ cm^3/h and

for $Q_1 > 1\,500$ m^3/h, $q_f < 2\,500$ cm^3/h.

Between these two pairs of values the allowable leakage rate shall satisfy Condition (2):

$$q_f \leqslant \frac{5}{3} Q_1 \tag{2}$$



Key

q_f internal leakage

Q_1 standard discharge

Figure 2 — Allowable internal leakage rates

5.2.8 Mechanical resistance

5.2.8.1 Resistance to internal pressure

Pressure regulators shall be designed and constructed in such a way that the application of pressures given in Table 2 in the high-pressure and low-pressure chambers does not lead to permanent deformation (see 9.4.2.1).

Table 2 — Test pressures

Gas	High-pressure chambers	Low-pressure chambers
Oxygen and other compressed gases, $p_2 \leqslant 1$ MPa (10 bar)	$1{,}2 \times 1{,}5 \times p_1$	3 MPa (30 bar)
Acetylene		
MPS		
Oxygen and other compressed gases, 1 MPa (10 bar) $< p_2 \leqslant 2$ MPa (20 bar)		6 MPa (60 bar)
Oxygen and other compressed gases, $p_2 > 2$ MPa (20 bar)		$3p_2$

5.2.8.2 Pressure retention of the low-pressure side

Pressure regulators shall be designed and constructed so that if the low-pressure chamber of the pressure regulator, or intermediate chamber in the case of two-stage pressure regulators, is in direct communication with a full cylinder of gas, for example, the pressure 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 9.4.2.2).

A pressure relief device may be fitted to the manifold pressure regulator to fulfil this requirement. For flammable gases, a means of safely venting shall be provided.

6 Physical characteristics

6.1 General

The symbols used are given in Table 3.

Table 3 — Symbols used

Symbol	Explanation
i	irregularity coefficient
p	pressure
p_1	nominal inlet pressure
p_2	nominal outlet pressure
p_{2R}	acetylene outlet pressure used for calculation of R (see 9.3.3.3)
p_{2i}	acetylene outlet pressure used for calculation of i (see 9.3.5.3)
p_3	upstream pressure for type testing: $p_3 = 2\,p_2 + 1$ (0,100 MPa)
p_4	stabilized outlet pressure (stabilization after flow ceases)
p_5	highest or lowest outlet pressure during a test of determination of irregularity coefficient according to 6.4.2
p_i	inlet pressure
p_o	outlet pressure
Q_1	standard (nominal) discharge
Q_max	maximum discharge
q_f	internal leakage
R	coefficient of pressure increase upon closure
t	time

6.2 Pressures

6.2.1 Nominal inlet pressure, p_1

Nominal inlet pressure specified by the manufacturer.

6.2.2 Nominal outlet pressure, p_2

Nominal outlet pressure for the standard discharge, Q_1, specified by the manufacturer.

NOTE This nominal pressure is defined for testing, and can be above the normal operating pressure of the pressure regulator.

For acetylene pressure regulators, the standard discharge is measured at p_{2R}.

6.2.3 Outlet pressure for acetylene pressure regulators

For acetylene pressure regulators the outlet pressures p_2, p_4, and p_5 shall not exceed 0,150 MPa (1,5 bar) in any case, but lower values may be applicable depending on the intended maximum pipeline diameter.

NOTE The nominal outlet pressure, p_2, is a function of the nominal diameter of the distribution line. It is possible that maximum values for the outlet pressures are specified in national standards and regulations.

6.3 Flow rates

6.3.1 Maximum discharge, Q_{max}

The maximum discharge which the pressure regulator can provide for an upstream pressure, p_3, in megapascals, which is given by the expression:

$$p_3 = 2\,p_2 + 1 \tag{3}$$

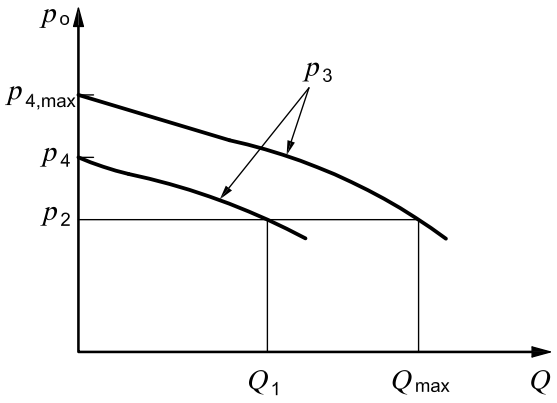
NOTE It is possible that Q_{max} is lower than the actual flow, which the pressure regulator can allow under different conditions.

6.3.2 Standard discharge, Q_1

The standard discharge for the pressure regulator is defined by the manufacturer for a particular gas (see Figure 3) at the rated outlet pressure p_2 (see Table 4).

The following condition shall be satisfied: $Q_1 \geqslant 0{,}5\,Q_{max}$.

For acetylene pressure regulators, the standard discharge is measured at p_{2R}.



Key

p_o	outlet pressure	$p_{4,max}$	maximum stabilized outlet pressure
p_2	nominal outlet pressure	Q	flow rate
p_3	upstream pressure for type testing	Q_1	standard discharge
p_4	stabilized outlet pressure	Q_{max}	maximum discharge

Figure 3 — Flow rate characteristics

Table 4 — Pressures[a]

Gas	Nominal inlet pressure p_1 MPa (bar)	Nominal outlet pressure p_2[b] MPa (bar)
Oxygen and other compressed gases up to 30 MPa (300 bar)	0 to 30 (0 to 300)[e]	0,2 (2) 0,4 (4) 0,6 (6) 1,0 (10) 1,25 (12,5) 2,0 (20)
Dissolved acetylene	2,5 (25)	$\leqslant$ 0,15 ($\leqslant$ 1,5)
MPS	2,5 (25)[c]	0,15 (1,5) 0,4 (4)
CO_2	20 (200)[d]	0,2 (2) 0,4 (4) 1,0 (10)

[a] For acetylene, p_2, p_4 and p_5 shall be less than or equal to 0,150 MPa (1,5 bar).

[b] If other values for the application of pressure are required, they should be selected preferably from the R20 series containing the values given.

[c] Vapour pressure for MPS at 65 °C. This value shall change depending on components of the gas mixture.

[d] Pressure for CO_2 at 53 °C.

[e] Pressure relating to maximum cylinder charging pressure at 15 °C.

6.4 Operating characteristics

6.4.1 Coefficient of pressure increase upon closure, R

This coefficient is defined by:

$$R = \frac{p_4 - p_2}{p_2} \tag{4}$$

where

p_2 is the nominal outlet pressure (for acetylene pressure regulators, $p_2 = p_{2R}$, see Table 3);

p_4 is the stabilized outlet pressure (stabilization pressure) noted 1 min after discharge ceases — for acetylene pressure regulators, set to 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 0,5.

6.4.2 Irregularity coefficient, i

This coefficient is defined by:

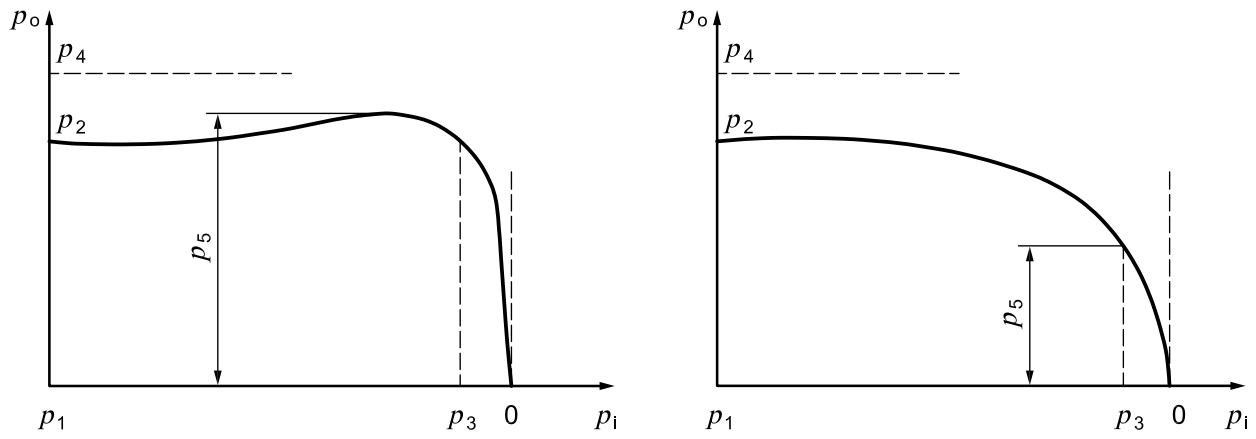
$$i = \frac{p_5 - p_2}{p_2} \tag{5}$$

where

p_2 is the nominal outlet pressure (for acetylene pressure regulators, $p_2 = p_{2i}$, see Table 3);

p_5 is the highest or lowest value of the outlet pressure (see Figure 4) 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.

The limits shall be: $-0{,}3 < i < +0{,}5$.



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

Key

p_o outlet pressure
p_i inlet pressure
p_1 nominal inlet pressure
p_2 nominal outlet pressure
p_3 upstream pressure
p_4 stabilized outlet pressure
p_5 extreme pressure during i determination

Figure 4 — Typical dynamic expansion curves

6.4.3 Operating temperature range

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

7 Marking

7.1 Pressure regulator

The following information shall be clearly and permanently marked in accordance with 9.5 on the pressure regulator body or cover or on a label permanently fixed to the pressure regulator:

a) number of this International Standard (ISO 7291:2010);

b) name or trade mark of the manufacturer or distributor;

c) the standard discharge, Q_1, and nominal outlet pressure, p_2;

d) nominal inlet pressure, p_1;

〚A1〛 e) the name of gas intended for use;

When the full name or the chemical symbol of the gas cannot be marked, the gas letter codes according to ISO 10225 shall be used for marking of equipment. 〚A1〛

f) the designation of the pressure regulator model, if necessary;

g) identification number, if the pressure relief device is supplied as a separate unit;

h) an indication of inlet or an arrow showing the direction of flow.

〚A1〛 *text deleted* 〚A1〛

7.2 Pressure relief devices

Pressure relief devices that are supplied as a separate unit shall be clearly and permanently marked with the same identification number as the pressure regulator.

8 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, including the safe venting of pressure relief devices, if fitted;

d) the commissioning tests that are necessary to prove 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.

9 Type test procedure

9.1 General

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

a) tests;

b) checking of documents.

The oxygen ignition test (see 9.4.4) shall be carried out after the functional tests (see 9.3) and before the internal pressure tests (see 9.4.2).

NOTE These are type tests applicable to pressure regulators only for verifying conformity to this International Standard and are not intended as the programme for production testing of all pressure regulators.

In general, samples and documents shall be submitted as required by the testing organization.

9.2 Test conditions

9.2.1 General characteristics of the test installation

All the pipelines of the testing installation together with the valve controlling the flow shall have gas passages greater than that of the pressure regulator to be tested.

9.2.2 Type of gas

Tests shall be carried out with air or nitrogen free from oil and grease.

The ignition test according to 9.4.4 shall be carried out with oxygen.

In all cases, tests shall be carried out with a gas with a maximum moisture content of 50 µg/g (50 ppm) corresponding to a dew point of −48 °C.

9.2.3 Accuracy of the flow measuring apparatus

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

9.2.4 Pressure measurement and accuracy of the pressure measuring apparatus

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

The source of gas for the nominal inlet pressure p_1 and p_3 shall have gas available for the duration of the test.

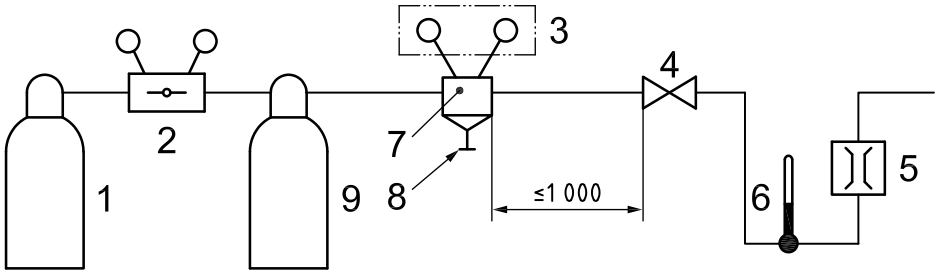
Pressure gauges shall not exceed 1 % error of its indication.

9.3 Functional tests

9.3.1 General

An example of the test apparatus used for the measurement of the discharge is shown in Figure 5. The pressure regulator may for example be supplied by a buffer cylinder. The upstream pressure p_3 (see 6.3.1) is held constant by means of an auxiliary pressure regulator or any equivalent device.

Dimensions in millimetres



Key

1 gas supply
2 auxiliary regulator
3 calibrated gauges
4 control valve for regulation
5 flow meter
6 thermometer for measurement of the gas temperature
7 pressure regulator (sample)
8 adjusting screw
9 buffer cylinder

Figure 5 — Example for the measurement of the maximum discharge, Q_{max}

9.3.2 Maximum discharge, Q_{max}

9.3.2.1 General

The maximum discharge, Q_{max}, shall be measured at an inlet pressure, p_3, as specified in 9.3.2.2 or 9.3.2.3.

9.3.2.2 Maximum discharge, Q_{max}, excluding acetylene pressure regulators

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

a) the downstream pressure gauge indicates the nominal (maximum) outlet pressure, p_2;

b) the flow meter indicates the maximum discharge, Q_{max}, taking into account the corrections in 4.2 and Table 1 and the temperature measured by the thermometer.

9.3.2.3 Maximum discharge, Q_{max}, for acetylene pressure regulators

The adjusting screw of the pressure regulator sample under test shall be fully screwed in, and the valve for regulation shall be fully opened. The flow meter indicates the maximum discharge, Q_{max}, taking into account the corrections in 4.2 and Table 1 and the temperature measured by the thermometer.

9.3.3 Standard discharge, Q_1

9.3.3.1 General

The condition $Q_1 \geqslant 0{,}5\ Q_{max}$ defined by the manufacturer (see 6.3.2) shall be fulfilled.

The standard discharge, Q_1, shall be obtained using the settings specified in 9.3.3.2 or 9.3.3.3.

9.3.3.2 Standard discharge, Q_1, excluding acetylene pressure regulators

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

9.3.3.3 Standard discharge, Q_1, for acetylene pressure regulators

The adjusting screw of the pressure 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}.

9.3.4 Coefficient of pressure increase upon closure, R

With the pressure regulator set to standard discharge conditions (see 9.3.3) proceed as follows:

a) stop the flow by using the valve for flow regulation;

b) after 1 min, record the stabilization pressure, p_4;

c) determine the value of R (see 6.4.1).

9.3.5 Irregularity coefficient, i

9.3.5.1 General

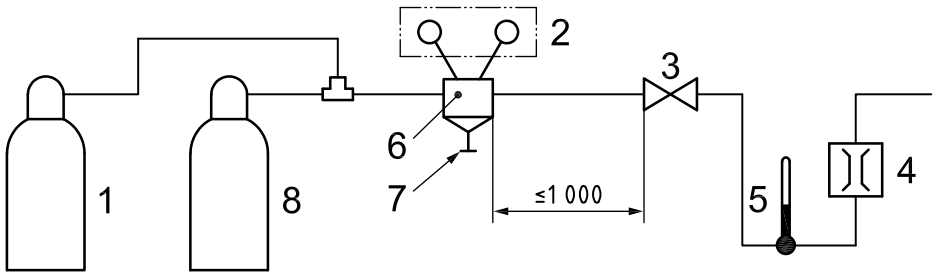
For the determination of the irregularity coefficient, i (see 6.4.2), plot a dynamic expansion curve. This curve indicates the downstream pressure as a function of the upstream pressure. During this test, the upstream pressure varies from the rated inlet pressure p_1 to pressure p_3.

An example of the test apparatus is shown in Figure 6.

The pressure regulator is equipped with two calibrated pressure gauges, preferably recording gauges according to class 1 or any other recording device, which produces the dynamic expansion curve directly. The pressure regulator is supplied from a source of gas capable of being adjusted in a smooth and continuous way at an approximately constant rate, e.g. by one or more gas cylinders. The source of gas shall be capable of supplying the test gas at the nominal inlet pressure p_1. The pressure regulator discharge is controlled by a flow meter.

9.3.5.2 Pre-test settings excluding acetylene pressure regulators

The adjusting screw of the pressure regulator sample under test and the valve for regulation shall be set to achieve p_2, Q_1 at p_1.



Key

1 auxiliary gas cylinder
2 gauges of class 1
3 valve for flow regulation
4 flow meter
5 thermometer for measurement of the gas temperature
6 pressure regulator (sample)
7 adjusting screw
8 primary gas cylinder

Figure 6 — Example for the measurement of the dynamic expansion curves

9.3.5.3 Pre-test settings for acetylene pressure regulators

The adjusting screw of the pressure regulator sample under test shall be fully screwed in and the valve for regulation shall be adjusted to achieve Q_1 at p_1. The resulting outlet pressure shall be measured and referred to as p_{2i}.

9.3.5.4 Tests

Without changing the preceding setting, the cylinder valve of the auxiliary cylinder shall be closed and that of the primary cylinder shall be opened. At this time, record the values of the upstream and downstream pressures. The capacity of the primary cylinder shall be sufficient for a test period of at least 15 min.

However, if the pre-test settings can be achieved in less than 30 s and the auxiliary cylinder has sufficient capacity, the test can be carried out without switching to the primary cylinder.

9.3.5.5 Results

During this test, there shall be no evidence of oscillation or sticking of the pressure regulator valve and there shall be a smooth pressure regulator dynamic expansion curve, which either rises to a maximum or falls (see Figure 4).

The pressure, p_5, for the irregularity coefficient, i, is the highest or lowest value of the outlet pressure during this test in which the inlet pressure varies from p_1 to p_3.

Determine the value of i (see 6.4.2).

9.4 Tests for mechanical resistance of pressure regulators

9.4.1 General

WARNING — Precautions shall be taken to protect test personnel.

9.4.2 Internal pressure tests

9.4.2.1 Test of resistance to internal pressure

For this test (see 5.2.8.1) the pressure relief device, diaphragm and pressure gauges shall be replaced by blind plugs. The low and high-pressure chambers shall be hydraulically pressurized for 5 min. After the test, check that there is no permanent deformation (e.g. measured by comparison).

The test pressures are given in Table 2.

9.4.2.2 Pressure retention test of the low-pressure side

For this test (see 5.2.8.2), the pressure regulator valve shall be held permanently open or removed. The pressure gauges shall be replaced by blind plugs and the outlet blanked off.

The pressure relief device supplied with the pressure regulator shall be in operation.

A pneumatic pressure of p_1 shall be applied to the pressure regulator inlet, through a valve which is manually opened quickly.

If no rupture occurs, the test is satisfactory.

If rupture occurs, no pieces shall be ejected. Venting of gas through pressure relief devices, if fitted, is allowed.

9.4.3 Leakage tests

9.4.3.1 External leakage

Gas tightness to the atmosphere shall be tested according to ISO 9090.

9.4.3.2 Internal leakage

The gas tightness of the pressure regulator valve seat is tested at the inlet pressure, p_1, for 5 min. The pressure regulator valve shall be closed (pressure adjusting screw completely unscrewed) and the outlet open. A leakage rate, q_f, shall satisfy the requirements of 5.2.7.3.

The test shall be repeated with the upstream pressure for type testing, p_3.

9.4.4 Ignition test for pressure regulators for oxygen

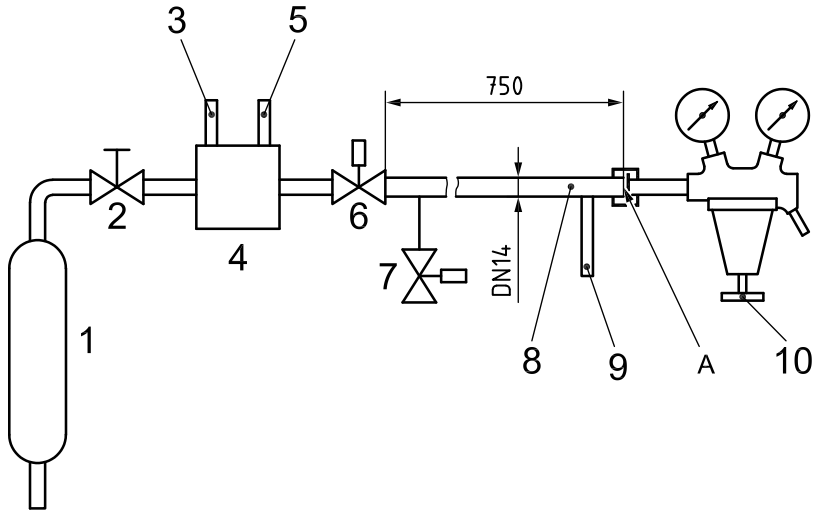
Three samples of the oxygen pressure regulator shall be exposed, through their inlets, to pressure shocks from industrial oxygen [minimum 99,5 % (by mass) purity; hydrocarbon content less than or equal to 40 µg/g (40 ppm)]. The test system (see Figure 7) shall be provided with equipment for preheating the oxygen, an oxygen vessel and a quick opening valve. Figure 7 gives an example of a test bench.

The time required to increase the pressure from atmospheric up to the test pressure shall be 20^{0}_{-5} ms, measured at point A prior to the test (see Figure 7).

The pressure shall also be measured at a distance of 30 mm to 40 mm from the sealing face of the sample (see Figure 7, label 9). At least every second pressure shock shall be recorded. The connection tube between the quick opening valve and the pressure regulator under test shall be 750 mm in length and 14 mm in internal diameter, made from oxygen-resistant metallic material, e.g. copper, stainless steel or brass. The specified dimensions of the tube are essential in order to ensure that a well-defined energy input into the pressure regulator to be tested is achieved. Before starting the test, the test samples shall be at room temperature. The test pressure shall in all cases be $1{,}2p_1$ at a temperature of (60 $\pm$ 3) °C.

Each test series shall consist of 20 pressure shocks at intervals of 30 s (see Figure 8).

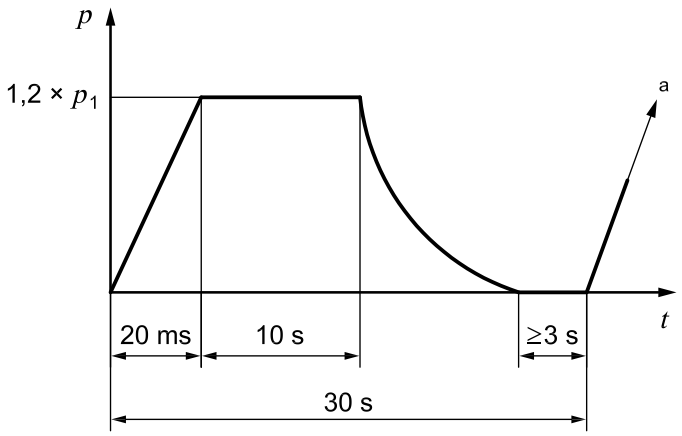
Dimensions in millimetres



Key

1 oxygen supply
2 inlet valve
3 pressure transducer on the oxygen vessel
4 high-pressure oxygen vessel with preheating device (e.g. water bath, electric heating)
5 thermo element
6 quick opening valve
7 valve to decrease the outlet pressure after every shock
8 connection tube
9 pressure transducer on the outlet valve
10 pressure regulator (test sample)
A measuring point

Figure 7 — Test bench for ignition test



Key

p pressure
p_1 nominal inlet pressure
t time
a Next pressure shock.

Figure 8 — Test interval

Each pressure shock is applied for 10 s. After each pressure shock, the pressure regulator is brought back to atmospheric pressure. This shall not be done by adjusting the pressure regulator, but by operating an upstream outlet valve. Between each pressure shock, atmospheric pressure shall be held for at least 3 s.

During a test series, the inlet pressure shall not decrease by more than 3 %.

The tests shall be carried out with the pressure regulator valve in the:

a) fully opened position and outlet closed;

b) fully closed position.

The pressure regulator shall not burn out during the test. After the tests have been completed, the three test samples shall be dismantled and all internal parts and surfaces inspected. Internal damage and evidence of burning are not acceptable.

9.4.5 Pressure adjusting

Check, if necessary, that the pressure-adjusting screw is not removable. For acetylene pressure regulators, after the gas outlet has been plugged, it shall be not possible to set a pressure greater than 0,150 MPa (1,5 bar).

9.4.6 Decomposition test for pressure regulators for acetylene

Three samples of pressure regulators shall be tested under acetylene decomposition conditions. The test system (see Figure 9) shall be constructed in a way to resist consequences of the test. The inlet tube (label 3) of the pressure regulator (label 4) shall be 5 m long. The outlet tube (label 6) of the pressure regulator shall be 1 m long. The internal diameter of both tubes shall be 12 mm, if the maximum inlet diameter of the pressure regulator is not greater than 12 mm.

If the maximum inlet diameter is larger than 12 mm, the tubing shall be 25 mm.

The temperature of the test system, the gas and the pressure regulator shall be greater than 5 °C.

The test shall be carried out as in the following.

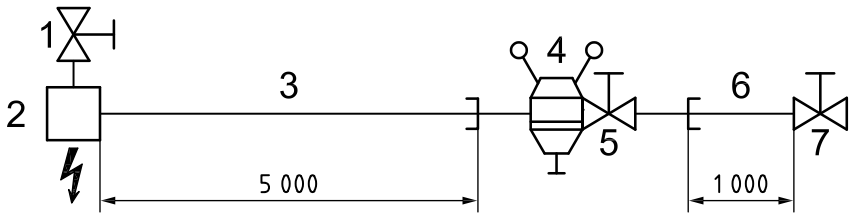
The pressure adjusting screw shall be set to deliver maximum outlet pressure.

The inlet tube system of the pressure regulator shall be filled with acetylene with a pressure equal to (2,5 ± 0,1) MPa [(25 ± 1) bar]. If the pressure regulator has an outlet valve (label 5) it shall be opened completely. The outlet valve (label 7) of the test system is closed, followed by the closing of the inlet valve (label 1).

The gas is ignited at a pressure of (2,5 ± 0,1) MPa [(25 ± 1) bar].

The pressure regulator shall not burst when tested. No part shall be ejected. A destruction of inner parts of the pressure regulator is permitted.

Dimensions in millimetres



Key

1 inlet valve
2 location of ignition source
3 inlet tube/upstream tube
4 pressure regulator or pressure gauge mounted on a T-adapter (test sample)
5 outlet valve of pressure regulator (option)
6 outlet tube/downstream tube
7 outlet valve

Figure 9 — Test bench for decomposition test

9.4.7 Decomposition test for pressure gauges for acetylene

If the test according to 9.4.6 has been performed without pressure gauges, three samples of pressure gauges shall be tested under the conditions of a decomposition of acetylene. The test system (See Figure 9) shall be constructed in a way to resist consequences of the test. The upstream tube (label 3) of the T-adapter of the mounted pressure gauge (label 4) shall be 5 m long. The downstream tube (label 6) of the T-adapter of the mounted pressure gauge (label 4) shall be 1 m long. The internal diameter of both tubes shall be 12 mm. The connector for the gauge on the T-adapter shall not have internal diameter less than DN 4.

The temperature of the test system, the gas and the pressure gauges shall be greater than 5 °C.

The test shall be carried out as in the following.

The tube system shall be filled with acetylene with a pressure equal to (2,5 ± 0,1) MPa [(25 ± 1) bar]. The outlet valve (label 7) of the test system is closed, followed by the closing of the inlet valve (label 1).

The gas is ignited at a pressure of (2,5 ± 0,1) MPa [(25 ± 1) bar].

If the bourdon tube ruptures, the gas shall be vented in a direction away from the face of the gauge. No parts shall be thrown from the gauge.

9.5 Test for durability of markings

Markings shall be rubbed by hand, without undue pressure, first for 15 s with a cloth soaked with distilled water, then for 15 s with a cloth soaked with petroleum spirit. Labels, if used as markings, shall be adhesive over the whole attachment surface.

After the test, the marking shall remain legible.

Bibliography

[1] ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

[2] ISO 2503, *Gas welding equipment — Pressure regulators and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (30 MPa)*

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