INTERNATIONAL STANDARD

ISO 2503

Third edition
2009-07-15

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)

Matériel de soudage aux gaz — Détendeurs et détendeurs débitmètres intégrés pour bouteilles de gaz utilisés pour le soudage, le coupage et les techniques connexes jusqu'à 300 bar (30 MPa)

Reference number
ISO 2503:2009(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

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

ISO 2503 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 2503:1998), and also ISO 7292:1997, which have 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 and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (30 MPa)

1 Scope

This International Standard specifies requirements for single or two-stage pressure regulators without flow-metering devices for connection to gas cylinders used for

— compressed gases up to 300 bar [1] (30 MPa),

— dissolved acetylene,

— liquefied petroleum gases (LPG),

— methylacetylene-propadiene mixtures (MPS), and

— carbon dioxide (CO_2),

for use in welding, cutting and allied processes. It does not cover pressure regulators having a nominal outlet pressure $p_2 > 20$ bar.

This International Standard also specifies requirements for single or two-stage pressure regulators with flow-metering devices for connection to gas cylinders used for

— compressed gases or mixtures up to 300 bar (30 MPa), and

— carbon dioxide (CO_2),

for use in welding, cutting and allied processes. Typical processes using this equipment are: tungsten inert-gas arc welding (TIG), metal-arc inert-gas welding (MIG), metal-arc active-gas welding (MAG), plasma arc welding, tubular-cored-wiretubular-cored-wire welding and plasma cutting. Annex B gives examples of flow-control systems and their flow-measuring devices.

This International Standard does not cover pressure regulators intended for direct use on cylinder bundles. Such regulators comply with the safety requirements of ISO 7291, in particular with the adiabatic compression test for oxygen regulators.

NOTE In addition to terms used in English and French, two of the three official ISO languages (English, French and Russian), this document gives the equivalent terms in German; these are published under the responsibility of the member body for Germany (DIN), and are given for information only. Only the terms and definitions given in the official languages can be considered as ISO terms and definitions.

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

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 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 5145, *Cylinder valve outlets for gases and gas mixtures — Selection and dimensioning*

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

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

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

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

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

3 Terms and definitions

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

3.1
accuracy of a flow-metering device
classification based on the permissible error of the flow indication of the device

3.2
adjustable pressure regulators
pressure regulator that is provided with a means of operator adjustment at the outlet pressure

NOTE See A.1.

3.3
fixed orifice
device, which delivers but does not indicate, a known flow when supplied with a constant upstream pressure and facing no significant back pressure

3.4
flow gauge
device which measures pressure and which is calibrated in units of flow

NOTE The flow gauge does not measure flow. It indicates flow by measuring the pressure upstream of a fixed orifice.

3.5
flow meter
device that measures and indicates the flow of a specific gas or gas mixture

3.6
indicated flow(s)
flow(s) indicated on the measuring device of a pressure regulator with a flow-metering device

3.7
maximum intermediate pressure
p_{2m}
for pressure regulators with flow-metering devices, maximum pressure specified by the manufacturer and measured in the intermediate pressure chamber, downstream of the pressure-regulator valve and upstream of the flow-adjusting and measuring device

NOTE This maximum pressure is defined for the pressure-regulator tests, and is above the normal operating pressure of the flow meter.

3.8
nominal discharge
Q_n
for pressure regulators with flow-metering devices, discharge specified by the manufacturer (measured downstream of the flow-adjusting and measuring devices)

3.9
permissible error of the flow indication
difference between the indicated flow and the true flow, as a percentage of the indicated flow

3.10
preset pressure regulator
pressure regulator that is not provided with a means of operator adjustment at the outlet pressure

NOTE See A.2.

3.11
pressure gauge
device that measures and indicates pressure

3.12
pressure regulator
device for regulating a generally variable inlet pressure to an outlet pressure that is as constant as possible

NOTE See A.1.

3.13
pressure regulator with flow-metering devices
device for regulating a generally variable inlet gas pressure to an outlet pressure that is as constant as possible, ensuring in addition a selected gas flow

NOTE 1 See A.2.

NOTE 2 It is generally a pressure regulator equipped with flow-adjusting and measuring devices which are not intended to be separated from the regulating device by the operator.

3.14
stability of the flow-metering device
ability of a flow-metering device, when at a given flow setting, to deliver flows at any inlet pressure close to the true value of the flow delivered at the nominal pressure p_1

3.15
true flow
flow measured with a calibrated measuring device

4 Symbols and abbreviated terms

The symbols used in this International Standard are given in Table 1.

Table 1 — Symbols and definitions

Symbol	Definition
p_1	nominal inlet pressure specified by the manufacturer, see Table 3 for preferred values
p_2	nominal outlet pressure specified by the manufacturer, see Table 3 for preferred values
p_{2R}	acetylene outlet pressure used for calculation of R (see 9.5.3.3)
p_{2i}	acetylene outlet pressure used for calculation of i (see 9.5.5.3)
p_{2m}	maximum intermediate pressure
p_3	upstream pressure for type testing: $p_3 = 2_{p2} + 1$ bar (0,1 MPa)
p_4	closing pressure after stopping the standard discharge
p_5	highest or lowest outlet pressure during a test for determination of irregularity coefficient in accordance with 6.6.1.2
p_{RV}	pressure for the pressure-relief valve during discharge test, see 6.4.1
Q_1	standard discharge (equipment classes), see Table 3
Q_n	nominal discharge (of a pressure regulator with a flow-metering device), specified by the manufacturer
Q_{max}	maximum discharge
Q_{RV}	discharge of the pressure-relief valve
R	coefficient of pressure increase upon closure
i	irregularity coefficient

5 Design requirements

5.1 Materials

Materials for pressure regulators and pressure regulators with flow-metering devices shall conform to the requirements of ISO 9539.

5.2 Design and construction

5.2.1 Oxygen pressure regulators

Pressure regulators for oxygen shall be designed and manufactured while giving consideration to the possibility for internal ignition. Pressure regulators for oxygen shall not ignite or show evidence of burning when submitted to the ignition test in 9.7.4.

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

5.2.2 Acetylene pressure regulators

Pressure regulators for acetylene shall be designed and manufactured so that the stabilized outlet pressure shall not exceed 1,5 bar for all inlet pressures.

5.2.3 Connections

5.2.3.1 Inlet connections

Pressure regulators and pressure regulators with flow-metering devices shall be made in such a way that the inlet connection is compatible with the cylinder valve outlet and designated for the intended gas service in accordance with ISO 5145, regional and national standards [2]. The inlet pressure p_1 specified by the manufacturer, shall not be less than the maximum filling pressure (at 15 °C) allowed for the gas-cylinder connection.

5.2.3.2 Outlet connections

Threaded outlet connections shall comply with the national standard or regulatory requirements of the country where they are used. If no national standard is enforced, it is recommended that the connection comply with ISO/TR 28821. The connections will comply with the following conditions:

— the outlet-connection orientation should preferably point downwards and away from the gas cylinder;

— curved hose tails shall not be used.

5.2.4 Filter

A particle 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 or equal to 0,1 mm.

5.2.5 Outlet shut-off valve

Pressure regulators may be fitted with an outlet shut-off valve. When fitted, the spindle shall be captive.

5.2.6 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 prevention of the spring becoming fully compressed depends on the dimensions of the pressure-adjusting screw, then the screw shall be not removable.

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

5.2.7 Flow-control valve

A pressure regulator with a flow-metering device may be fitted with a flow-control valve. The flow-control knob and the valve spindle shall be captive such that they cannot be dismantled without the use of a tool.

5.2.8 Pressure-relief device

All pressure regulators, except those for acetylene or LPG, shall be supplied with a pressure-relief device (e.g. pressure-relief valve or burst disc) designed to vent excess outlet pressure in the case of partial regulator-seat malfunction. It shall be demonstrated that a sufficient level of safety is ensured in accordance with 5.2.11.2. A safety-risk analysis or special safety precautions shall be considered.

---

2) See ISO/TR 7470.

5.2.9 Pressure gauges

If pressure gauges or flow gauges are used, they shall conform to ISO 5171. If pressure gauges or flow gauges are integral with the pressure regulator or the pressure regulator with a flow-metering device, the relevant operational and safety requirements shall be specified.

5.2.10 Leakage

5.2.10.1 General

Pressure regulators and pressure regulators with flow-metering devices shall be gas tight to the atmosphere.

5.2.10.2 External leakage

Pressure regulators and pressure regulators with flow-metering devices shall be externally gas tight for all normal pressures for relevant gases. Regulators shall not have a leakage rate greater than 0,17 mbar l/min (10 cm^3/h).

This requirement is given in ISO 9090, together with suitable test methods.

5.2.10.3 Internal Leakage

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

5.2.11 Mechanical resistance

5.2.11.1 Resistance to internal pressure

Pressure regulators and pressure regulators with flow-metering devices 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-regulator chambers does not lead to permanent deformation.

Table 2 — Test pressures

Gas	High-pressure chambers	Low-pressure chambers
Oxygen and other compressed gases, including classes 0, 1, 2, 3, 4 and 5	$1{,}5 \times p_1$	60 bar (6 MPa)
Acetylene, including classes 1 and 2	300 bar (30 MPa)	30 bar (3 MPa)
LPG and MPS, including classes 0 and 1		
CO_2, including classes 0 and 1		60 bar (6 MPa)

Pressure regulators and pressure regulators with flow-metering devices shall comply with the test in 9.7.2.1.

5.2.11.2 Pressure retention of the low-pressure side of the pressure regulator

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, if the regulator pressure 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.

Pressure regulators and pressure regulators with flow-metering devices shall comply with the test in 9.7.2.2.

6 Physical performance and operating characteristics

6.1 Pressures

6.1.1 Nominal inlet pressure p_1

The nominal inlet pressure shall be specified by the manufacturer in accordance with Table 3.

NOTE p_1 is related to the cylinder filling pressure at 15 °C.

6.1.2 Nominal outlet pressure p_2, for pressure regulators without flow-metering devices

The nominal outlet pressure p_2 for the standard discharge Q_1 shall be specified by the manufacturer (see Table 3 for preferred values).

6.1.3 Outlet pressures for acetylene pressure regulators of class 2 without flow-metering devices

For acetylene pressure regulators of class 2, the outlet pressures p_2, p_4 and p_5 shall not exceed 1,5 bar.

6.2 Flow rates for pressure regulators without flow-metering devices

6.2.1 Standard discharge Q_1

Performance shall be measured at a standard discharge Q_1, expressed in m^3/h, and related to the outlet pressure p_2, from the preferred values in Table 3 or nominated by the manufacturer, which the pressure regulator can provide at the outlet pressure p_2 and an upstream pressure p_3 given by the expression

$$p_3 = 2p_2 + 1\,\text{bar} \quad (1)$$

For acetylene pressure regulators of class 2, the standard discharge Q_1 shall be measured at p_{2R}.

6.2.2 Maximum discharge Q_{max}

The maximum discharge Q_{max} of the gas intended for use, expressed in m^3/h, which the pressure regulator can provide, at the outlet pressure p_2 [excluding acetylene regulators of class 2, see Figure 1a)], for the upstream pressure p_3 (see 6.2.1).

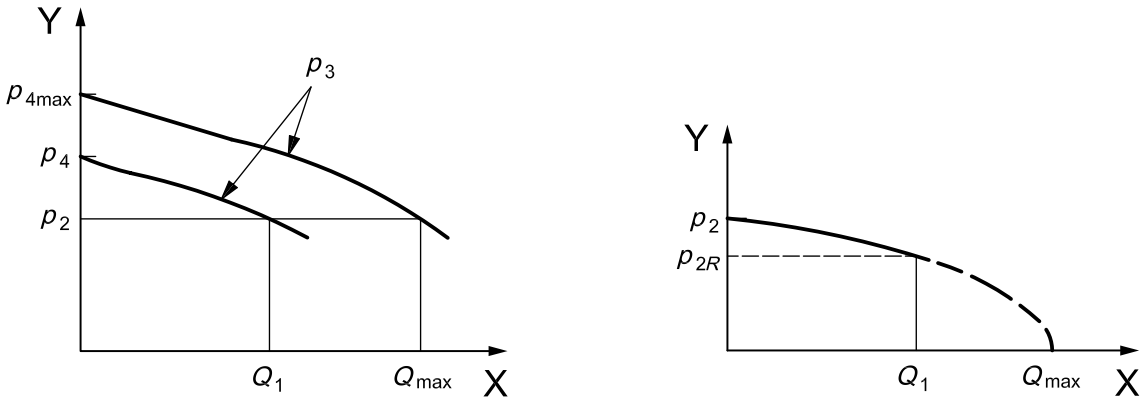
For acetylene pressure regulators of class 2, the maximum discharge Q_{max} shall be measured at the lowest outlet pressure, see Figure 1b).

The maximum discharge Q_{max} shall be not less than the standard discharge Q_1 (see 6.2.1).

6.3 Equipment classes for pressure regulators without flow-metering devices

Performance is measured at the standard discharge Q_1 and nominated outlet pressure specified by the manufacturer.

Preferred values of p_2 and Q_1 are given in Table 3, but other values may be specified by the manufacturer.



a) For all gases except acetylene

b) For acetylene

Key

X flow rate

Y outlet pressure

Figure 1 — Flow rate characteristics

Table 3 — Equipment classes

Gas	Class	Nominal inlet pressure p_1 bar (10^{-1} MPa)	Nominal 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	0 to 300 [a]	2	1,5
	1		4	5
	2		6	15
	3		10	30
	4		12,5	40
	5		20	50
dissolved acetylene	1	25	0,8	1
	2		< 1,5	5 [b]
MPS	0	25 [c]	1,5	1
	1		4	5
LPG	0	25 [d]	1,5	1 [e]
	1		4	5 [e]
CO_2	0	200 [f]	2	2 [e]
	1		4	2 [e]

[a] Pressure relating to maximum cylinder filling pressure at 15 °C.

[b] General recommendation: Flow rates more than 0,8 m^3/h should be avoided due to limitations in the allowable average gas withdrawal rate from one acetylene cylinder.

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

[d] Vapour pressure for propane at 70 °C.

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

[f] Pressure for CO_2 at 70 °C at the filling ratio of 0,667.