INTERNATIONAL STANDARD

ISO 7291

First edition
1990-11-01

Welding, cutting and allied processes — Manifold regulators

Soudage, coupage et techniques connexes — Détendeurs des centrales de bouteilles (de gaz industriels)

Reference number
ISO 7291 : 1990 (E)

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 7291 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Sub-Committee SC 8, *Gas welding equipment*.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

Welding, cutting and allied processes — Manifold regulators

1 Scope

This International Standard specifies requirements and test methods for manifold regulators for welding, cutting and allied processes.

It is applicable to regulators used to regulate the pressure at the outlet of high-pressure lines from manifold gas cylinders to provide a feed with compressed gases or dissolved acetylene.

It is not applicable to regulators fitted directly to the gas cylinders, as defined in ISO 2503, or to regulators for liquefied gases.

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 2503 : 1983, *Pressure regulators for gas cylinders used in welding, cutting and allied processes.*

ISO 5171 : 1980, *Pressure gauges used for welding, cutting and allied processes.*

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 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 manifold regulator: Device for regulating a generally variable inlet pressure to as constant as possible an outlet pressure, and intended to equip a manifold of cylinders.

3.2 Pressures

3.2.1 nominal (maximum) inlet pressure, p_1: Nominal (maximum) upstream pressure for which the manifold regulator is designed.

3.2.2 nominal (maximum) outlet pressure, p_2: Nominal (maximum) downstream pressure corresponding to the nominal discharge, Q_1, indicated by the manufacturer.

3.2.3 upstream pressure for type testing, p_3: The pressure, in bars[1], given by the equation

$$p_3 = 2 p_2 + 1 \text{ bar } (0{,}1 \text{ MPa})$$

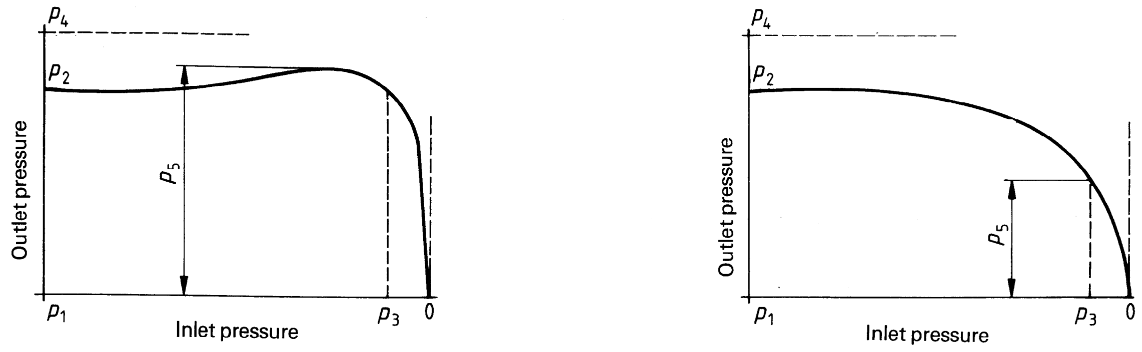
3.2.4 stabilized outlet pressure; stabilization pressure, p_4: The pressure recorded 1 min after discharge ceases, with the pressure regulator set to the standard initial conditions p_2, p_3, Q_1.

3.2.5 highest or lowest outlet pressure, p_5: The highest or lowest value of the outlet pressure during a test in which the inlet pressure varies from p_1 to p_3 for a flow equal to the nominal discharge Q_1 indicated by the manufacturer (see figure 1).

3.3 Flow rates (see figures 1 and 2)

3.3.1 maximum discharge, Q_{max}: The maximum flow rate obtained at pressures p_3 and p_2. At these conditions the stabilized outlet pressure p_4 shall not exceed the allowable value given in 3.4.1.

1) 1 bar = 10^5 Pa



a) **with rising characteristic**

b) **with falling characteristic**

Figure 1 — Typical dynamic expansion curves

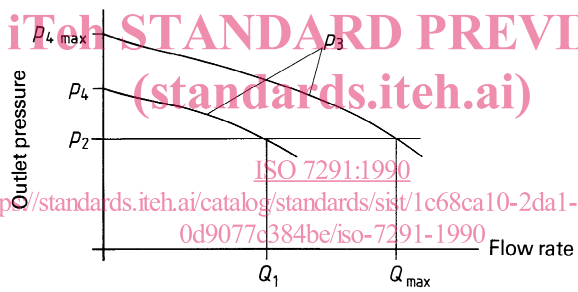


Figure 2 — Flow rate characteristics

3.3.2 nominal discharge, Q_1: The maximum flow rate for the manifold regulator defined by the manufacturer for a particular gas.

Q_1 cannot be less than 0,5 Q_{max}.

3.4 Coefficients

3.4.1 coefficient of pressure increase upon closure, R: The coefficient given by the equation

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

The resulting value shall be in conformity with

$R \leqslant 0{,}5$

3.4.2 irregularity coefficient, i: The coefficient given by the equation

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

The resulting value shall be in conformity with

$-0{,}3 \leqslant i \leqslant +0{,}5$

3.4.3 combined coefficient, $i + R$: The combined coefficient $i + R$ is given by:

$i + R \leqslant 0{,}7$

The combined coefficient shall be considered when the regulator does not include a relief valve (see 5.1.2.6).

4 Units

Pressures specified in this International Standard are gauge pressures, i.e. pressures exceeding atmospheric pressure. They are expressed in bars (or in pascals or multiples thereof).

Flow rates are measured in cubic metres per hour, at reference conditions 23 °C and 1,013 bar (0,101 3 MPa).

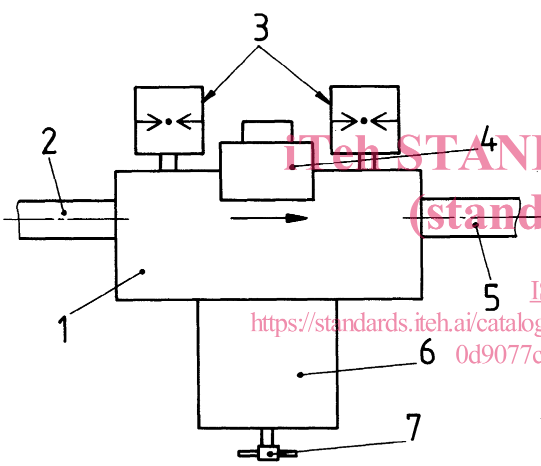
Temperatures are measured in degrees Celsius.

5 Design and safety requirements

NOTE — In some countries there may be a legal obligation for rules, directives and mandatory tests concerning oxygen or acetylene manifold regulators.

Figure 3 shows a manifold regulator as an illustration only.

Optional design characteristics shall not be incompatible with the safety requirements specified in this International Standard.



Key

1 Regulator housing
2 Inlet connection
3 Pressure gauges
4 Relief valve
5 Outlet connection
6 Pressure regulator cover
7 Pressure-adjusting screw

Figure 3 — Manifold regulator

5.1 Design requirements

5.1.1 Materials

Materials used for the construction of regulators shaii comply with the requirements specified in ISO 9539.

5.1.2 Design and manufacture

5.1.2.1 Oxygen manifold regulators

Oxygen manifold regulators shall be so designed, machined and assembled as to minimize the risk of internal burning and shall comply with the requirements specified in 6.5. All components and accessories shall be thoroughly cleaned and degreased before assembly.

5.1.2.2 Acetylene manifold regulators

The nominal (maximum) outlet pressure, p_2, of acetylene manifold regulators is a function of the nominal diameter of the distribution line. These values are specified in the standards and regulations applicable in each country.

In any event, the requirements specified in 5.1.2.8 and 6.3.2 shall be met.

5.1.2.3 Filters

Irrespective of its position, a filter shall be placed upstream of the pressure regulator valve. The useful cross-section shall be compatible with the average flow rate. The filter shall retain particles $\geqslant$ 0,1 mm.

5.1.2.4 Inlet connections

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

If cylinder valve connections are used, they shall conform to the relevant national standard.

5.1.2.5 Pressure regulator cover

The manifold regulator shall be designed and assembled in such a way that, if the low pressure chamber or the intermediate chamber (in the case of a two-stage regulator) is subjected to direct full cylinder pressure, for example if the regulator valve is jammed in the open position or if the outlet union is closed (for example by a valve or a seal) high pressure gas is either contained or is vented safely without ejecting component parts.

Pneumatically controlled regulators, in which the diaphragm is held by the pressure of the control gas, shall comply with the safety requirements.

5.1.2.6 Relief valve

5.1.2.6.1 Location

Manifold regulators may be fitted with a relief valve. It may be located on the regulator or on the distribution line downstream of the regulator valve.

The relief valve shall be designed to vent the gas safely vertically up or through a special pipe, fixed to the outlet orifice of the relief valve, leading outside.

5.1.2.6.2 Operation

The relief valve, if fitted, shall be tight against a pressure greater than the maximum pressure attained when the flow rate is set for the initial pressure, p_2, plus an overpressure corresponding to the real coefficients i and R.

When the gas to be vented is at a pressure of 2 p_2, the flow rate of the relief valve shall be equal to at least half the nominal discharge, Q_1 ($\geqslant$ 0,5 Q_1), of the manifold regulator.

During its response, when the pressure falls, the relief valve shall seal when the downstream pressure is again equal or slightly superior to the maximum value, p_2.

5.1.2.7 Pressure gauges

Manifold regulators shall be fitted with pressure measuring devices complying with the functions and safety requirements specified in ISO 5171. Upstream pressure gauges may form an integral part of the regulator or they may be fitted to the manifold.

Downstream pressure gauges shall be fitted directly to the regulator or close to the latter without a possibility of shut-off.

Gauges fitted downstream shall satisfy the requirements resulting from a possible pressure rise due to the coefficients i and R.

5.1.2.8 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 going solid.

If the dimensions of the pressure-adjusting screw are important for the safe operation of the manifold regulator, then the pressure-adjusting screw shall not be removable.

The threaded part of the pressure-adjusting screw of acetylene manifold regulators shall be restricted, in order to obtain a maximum permissible nominal outlet pressure, p_2 (see table 1).

Table 1 — Pressures[1)]

Gas type	Nominal (maximum) outlet pressure, p_2 bar
Compressed gases, p_1 = 150 to 200 bar	3,5[2)] 8 10 20

1) In the special case of acetylene, p_2, p_4 and p_5 shall not exceed 1,5 bar.

2) If other values for the application pressure are required, they should be selected preferably from the R 20 series containing the values given.

5.1.2.9 Outlet connections

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

5.2 Functional characteristics

5.2.1 Mechanical resistance

The pressure chambers of compressed gas and dissolved acetylene manifold regulators shall withstand at least 1,5 times the supply pressure or the nominal (maximum) outlet pressure, with a minimum of 300 bar for the upstream section and a minimum of 30 bar for the downstream section.

5.2.2 Gas tightness

Manifold regulators shall be gas-tight to the exterior, for example to the atmosphere, and to the interior, i.e. between the high-pressure and low-pressure parts, at all normal pressures for relevant gases but shall not exceed the following requirements.

5.2.2.1 Internal leakage, T_f

Maximum allowable internal leakage, T_f, of a manifold regulator is a function of its nominal discharge, Q_1 (see figure 4).

For $Q_1 \leqslant 30$ m³/h, $T_f \leqslant 50$ cm³/h

$Q_1 \geqslant 1\ 500$ m³/h, $T_f \leqslant 2\ 500$ cm³/h

Between these two pairs of values the allowable leakage rate shall satisfy the condition

$$T_f\ (\text{cm}^3/\text{h}) \geqslant \frac{5}{3} Q_1\ (\text{m}^3/\text{h})$$

5.2.2.2 External leakage

The requirements for external leakage shall be in accordance with ISO 9090. The total leakage shall be less than 10 cm³/h.

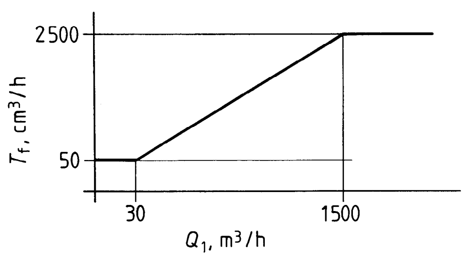


Figure 4 — Allowable leakage rates

6 Type tests

6.1 General test conditions

6.1.1 General characteristics of the test installation

All the piping of the testing installation together with the valve controlling the flow, shall have a bore greater than that of the regulator under test.

6.1.2 Type of gas

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

In all cases, tests shall be carried out with dry gas with a maximum moisture content of 50 ppm corresponding to a dew point of −48 °C. Oxygen manifold regulators may be tested with oxygen.

6.1.3 Unit of measurement and rating test

Flow- and pressure-measuring data shall be established in accordance with ISO 554, i.e. at 23 °C and 1,013 bar (0,101 3 MPa).

The flow measuring apparatus shall have an accuracy of ± 3 % or better.

6.1.4 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 p_3, shall be of adequate and sufficient capacity.

Gauges of a standard class 1,0 or better shall be used for the pressure measurement. In such a case, the pressure gauges of the manifold regulator can be included in the testing.

6.2 Performance and functional tests

6.2.1 Measurement of maximum flow rate, Q_{max}

6.2.1.1 Test set-up (see figure 5)

The regulator under test is connected to a buffer receiver (1), where the upstream pressure, p_3, is maintained by an auxiliary regulator or a similar device. The flow rate of the regulator is adjusted by means of a valve (4) and measured by means of a flowmeter (5). A thermometer (6) measures the gas temperature.

6.2.1.2 Test procedure

Adjust the pressure-adjusting screw (3) of the regulator under test and open the setting valve (4) until

— the pressure gauge for the expanded gas shows pressure p_2 corresponding to the class of the regulator under test; and

— the flowmeter (5) shows the highest flow rate obtainable under the conditions specified in 6.1.3 and at that gas temperature.

Verify that $Q_1 \geqslant 0,5\ Q_{max}$.

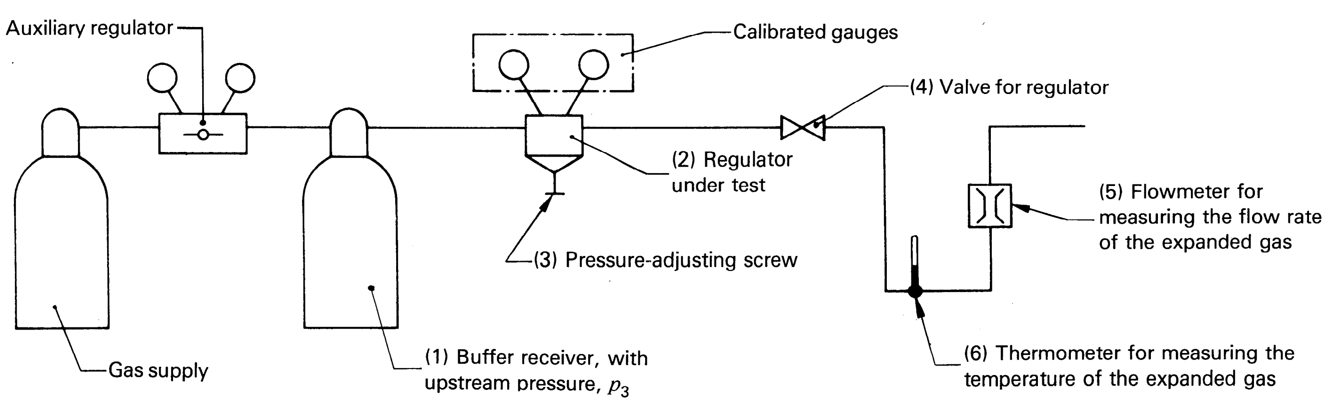


Figure 5 — Example of test set-up for the measurement of the maximum flow rate, Q_{max}

6.2.2 Dynamic expansion curve, irregularity coefficient, verification of specifications

6.2.2.1 Test set-up (see figure 6)

The regulator under test (2) is fitted with two calibrated pressure gauges, preferably recording gauges. A device plotting directly the dynamic expansion curve may also be used.

The regulator is connected to two receivers (0 and 1), one of the two being used, and both being initially at the nominal (maximum) inlet pressure p_1. The capacity of the cylinders shall be sufficient for a test duration of at least 15 min.

The flow rate of the regulators is adjusted by means of a valve (4) and measured by means of a flowmeter (5). A thermometer (6) measures the gas temperature.

6.2.2.2 Initial setting

With the regulator being fed by the cylinder (0), adjust the pressure-adjusting screw of the regulator (3) and the valve (4) to obtain the typical flow rate, Q_1, at the nominal outlet pressure, p_2, considering the corrections given in 6.1.3 and the gas temperature.

6.2.2.3 Testing

Without modifying the initial setting, close the valve of receiver (0) and open the valve of receiver (1). From this instant onwards, record the upstream and downstream pressures until the cylinder is empty.

NOTE — If the setting took less than 30 s and if the capacity of cylinder (0) is sufficient, the test may be performed without interchanging the cylinders.

6.2.2.4 Results

If there is no mechanical fault, the dynamic expansion curve is similar to one of those given in figure 1. The outlet pressure, p_5, is a function of the shape of the dynamic expansion curve. It corresponds to

— the maximum of the curve; or

— the expansion pressure that corresponds to an upstream pressure, p_3.

The irregularity coefficient, i, is given as follows:

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

Verify that $-0,3 \leqslant i \leqslant +0,5$.

6.2.3 Verification of the coefficient of pressure increase upon closure, R

Set up the regulator as given 6.2.1 and set it for a flow rate of Q_1.

Interrupt the gas flow downstream and after 1 min, record the stabilized outlet pressure, p_4, on the low pressure gauge.

Calculate the coefficient for pressure increase upon closure, R, as follows:

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

Verify that $R \leqslant 0,5$.

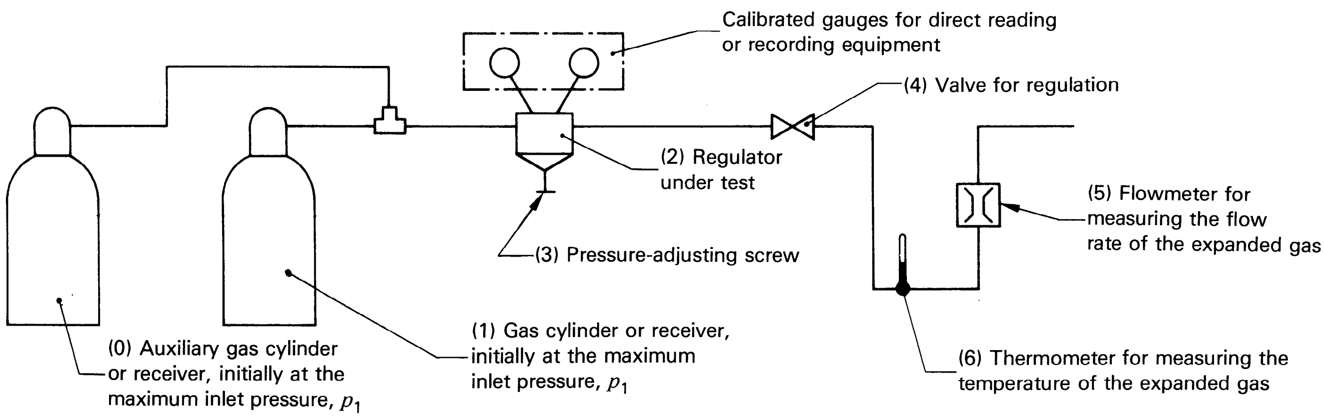


Figure 6 — Example of test set-up for plotting the dynamic curve for outlet pressure

6.2.4 Verification of the combined coefficient

Verify that $i + R \leqslant 0,7$ for regulators without relief valve.

6.2.5 Testing the relief valve

Blank off the inlet opening. Apply an increasing pressure to the outlet opening until the value of p_4 is reached. At this pressure the relief valve shall not operate.

Then increase the pressure up to the opening pressure of the relief valve. Increase the pressure up to the pressure $p_{RV} = 2\,p_2$. At this pressure, measure the discharge Q_{RV} of the relief valve. With decreasing pressure, the relief valve shall close at a pressure greater than p_2.

Verify that $Q_{RV} \geqslant 0,5\,Q_1$.

6.3 Mechanical tests

6.3.1 Internal pressure test

6.3.1.1 Fitness test

See 5.2.1.

The relief valve and pressure gauges shall be replaced by plugs, the diaphragm by a disk. The low- and high-pressure chambers shall be hydraulically pressurized for 5 min. There shall be no permanent deformation (for example, measured by comparator).

The pressures applied shall be as follows:

300 bar, at high pressure;

30 bar, at low pressure.

6.3.1.2 Safety tests

The gauges and the relief valve, if any, shall be replaced by plugs, and the high-pressure inlet shall be blanked off.

Apply an increasing hydraulic pressure through the low-pressure orifice, if possible up to a pressure of p_1. If no rupture occurs, the test is satisfactory.

If decompression of the low-pressure chamber occurs, due to a rupture of the diaphragm, an additional test with compressed air shall be performed as follows.

Fit the regulator with a new diaphragm and apply an increasing air pressure through the outlet orifice (low pressure) until rupture of the diaphragm occurs. After the test it shall be verified that

— the spring cover withstood the pressure, and that

— no component part of the regulator has been ejected.

The regulator diaphragm shall not burst before a pressure of at least 3 p_2 has been reached.

6.3.2 Pressure adjusting

Check that the pressure-adjusting screw is not removable.

For acetylene regulators, after the gas outlet has been plugged, it shall be impossible to set a pressure greater than 1,5 bar.

6.4 Leakage tests

Leakage tests shall be performed with air, but regulators intended for hydrogen and helium shall be tested with the gases for which they are intended.

The regulator shall be fitted with its filter.

6.4.1 External leakage

The tightness of the regulator shall be checked at pressure p_1. Adjust the pressure-adjusting screw to give pressure p_2 and close the outlet orifice. During the test period of 2 min the leakage shall comply with the requirements of ISO 9090.

6.4.2 Internal leakage

Close the pressure regulator valve (pressure-adjusting screw unscrewed) and open the outlet orifice. Apply pressure p_1 for 5 min from upstream. Gas leakage shall not exceed the internal leakage rate as specified in 5.2.2.1.

Repeat the test at pressure p_3.

6.5 Ignition test for oxygen manifold regulators

(See figure 7.)

6.5.1 Principle

The regulator, with its valve completely closed (pressure-adjusting screw completely unscrewed), is exposed through the inlet to pressure shocks from industrial oxygen (minimum 99,5 % purity without hydrogen). Each test consists of 20 pressure shocks at intervals of 30 s. Each pressure shock is applied for 10 s. After each pressure shock the test regulator is brought back to atmospheric pressure. This is done not by the regulator but by a tap situated upstream.

NOTE — In the case of multi-stage regulators an additional test shall also be carried out with the first stage valve in the closed position, i.e. with the first stage pressure-adjusting screw loosened.

6.5.2 Test set-up

The test system shall be provided with a system for preheating the oxygen at (60 ± 3) °C at a minimum pressure of 200 bar. It shall be equipped with a quick-opening valve (maximum pressure-increasing time 20 ms), and its bore shall not be less than 3 mm. The link connection (accelerating tube) between the quick-opening valve and the manifold regulator under test conditions shall be 750 mm long and 14 mm in internal diameter.