INTERNATIONAL STANDARD

ISO 10380

Second edition
2003-02-01

Pipework — Corrugated metal hoses and hose assemblies

Tuyauteries — Tuyaux et tuyauteries métalliques flexibles onduleux

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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

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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.

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 10380 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 11, *Flexible metallic hoses and expansion joints*.

This second edition cancels and replaces the first edition (ISO 10380:1994), which has been technically revised.

Introduction

It was decided to produce an International Standard under the Vienna Agreement on technical cooperation between ISO and the European Committee for Standardization (CEN) in order to maintain one document. The opportunity was taken to re-format the document and to add additional information which was not available for the first edition of ISO 10380.

The major changes to the standard are

— introduction of an extra flexibility type;

— reduction in the average number of cycles before failure in the cyclic test;

— introduction of a cyclic test for hoses in the size range DN 125 to DN 300;

— introduction of nickel materials;

— increased requirement for information to be supplied by the purchaser;

— the temperature derating factors have been modified based on values in ISO 9328-5;

— introduction of the requirement for the provision of adequate user instructions;

— the addition of equivalent European standards including those for materials and the corresponding temperature derating factors which are given in Annex A.

This International Standard is a base standard for hose and hose assemblies for general purposes. Other International Standards for specific applications are in preparation.

Pipework — Corrugated metal hoses and hose assemblies

1 Scope

This International Standard specifies the requirements for the design, manufacture and testing of corrugated metal hoses and hose assemblies for general purposes.

It also specifies sizes from DN 4 to DN 300, pressures from PN 0,5 to PN 250, pressure derating factors for elevated temperatures, two methods of construction and three types of flexibility of hose assembly.

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 6208, *Nickel and nickel alloy plate, sheet and strip*

ISO 7369, *Pipework — Metal hoses and hose assemblies — Vocabulary*

ISO 9328-5, *Steel plates and strips for pressure purposes — Technical delivery conditions — Part 5: Austenitic steels*

ISO 9723, *Nickel and nickel alloy bars*

ISO 9724, *Nickel and nickel alloy wire and drawing stock*

ISO 10806, *Pipework — Fittings for corrugated metallic hoses*

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

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

EN 10028-7, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

EN 10088-1, *Stainless steels — Part 1: List of stainless steels*

EN 13133, *Brazing — Brazer approval*

EN 13134, *Brazing — Procedure approval*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7369 apply.

4 Information to be supplied by the purchaser

4.1 The purchaser shall state the following in enquiries and orders:

a) intended application;

b) nominal size and hose assembly length;

c) flexibility type;

d) maximum operating pressure;

e) construction method;

f) materials of construction;

g) temperature range;

h) type of fitting for hose assembly.

4.2 Dependent on application, the purchaser shall provide the following information:

a) whether vacuum or any additional testing is required;

b) service cycle life;

c) product to be conveyed;

d) product velocity;

e) any special information concerning choice of materials;

f) whether additional protection is required;

g) movement and/or vibration;

h) any additional requirements for cleaning and post-test treatment;

i) whether “water hammer” can occur;

j) requirements for test certificates;

k) if a coloured cover or other identification is required;

l) any special requirements for packaging.

5 Requirements

5.1 Materials

Materials for the manufacture of corrugated metal hose assemblies shall be selected on the basis of their suitability for fabrication, e.g. cold forming, welding, etc., and for the conditions under which they will be used (see 4.1 and 4.2).

A list of suitable materials is given in Table 1.

Alternative equivalent materials are given in Table A.1.

Table 1 — Materials

Materials of construction	Hose	Braid	End fittings [a] and ferrules
Stainless steel hose assemblies	Austenitic stainless steel in accordance with ISO 9328–5, types X 2 CrNi 18 10, X 6 CrNiTi 18 10, X 2 CrNiMo 17 12, X 5 CrNiMo 17 12 and X 6 CrNiMoTi 17 12	Austenitic stainless steel in accordance with the composition given in ISO 9328-5, types X 2 CrNi 18 10, X 5 CrNi 18 9, X 6 CrNiTi 18 10, X 2 CrNiMo 17 12, X 5 CrNiMo 17 12 and X 6 CrNiMoTi 17 12	Austenitic stainless steel in accordance with the composition given in ISO 9328-5, types X 2 CrNi 18 10, X 5 CrNi 18 9, X 6 CrNiTi 18 10, X 2 CrNiMo 17 12, X 5 CrNiMo 17 12 and X 6 CrNiMoTi 17 12 Carbon steel containing a maximum of 0,05 % sulfur and 0,05 % phosphorus[b]. Copper based alloy, if formed, deep-drawing quality.
Copper-based alloy hose assemblies	Deep-drawing quality phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Copper-based alloy, if formed, deep-drawing quality.
Nickel alloy hose assemblies	Nickel alloy strip in accordance with ISO 6208, Nos. NW 0276 NW 4400 NW 6600 NW 6625 NW 8800 and NW 8825	Austenitic stainless steel in accordance with the composition given in ISO 9328-5, types X 2 CrNi 18 10, X 5 CrNi 18 9, X 6 CrNiTi 18 10, X 2 CrNiMo 17 12, X 5 CrNiMo 17 12 and X 6 CrNiMoTi 17 12 Nickel alloy in accordance with ISO 9724, Nos. NW 0276 NW 4400 NW 6600 NW 6625, NW 8800 and NW 8825	Austenitic stainless steel in accordance with the composition given in ISO 9328-5 types X 2 CrNi 18 10, X 5 CrNi 18 9, X 6 CrNiTi 18 10, X 2 CrNiMo 17 12, X 5 CrNiMo 17 12 and X 6 CrNiMoTi 17 12 Nickel alloy in accordance with ISO 9723, Nos. NW 0276 NW 4400 NW 6600 NW 6625, NW 8800 and NW 8825

[a] The material specified for end fittings applies only to the parts which are welded or brazed to the hose.

[b] Carbon steel shall not be used for ferrules.

5.2 Hose dimensions

5.2.1 Bore

The minimum bore size of the hose shall be at least 98 % of the nominal size DN given in Table 2.

Table 2 — DN sizes and bend radii

DN	Pliable test		Cyclic test	
	Type 1 and 2	Type 3	Type 1	Type 2
	Bend radius mm			
4	25	10	100	120
6	25	12	110	140
8	32	16	130	165
10	38	20	150	190
12	45	25	165	210
15	58	25	195	250
20	70	30	225	285
25	85	45	260	325
32	105	60	300	380
40	130	80	340	430
50	160	100	390	490
65	200	115	460	580
80	240	130	660	800
100	290	160	750	1 000
125	350	—	1 000	1 250
150	400	—	1 250	1 550
200	520	—	1 600	2 000
250	620	—	2 000	2 500
300	720	—	2 400	3 000

NOTE The dimensions listed in this table may be used for design purposes. Refer to manufacturer for confirmation.

5.2.2 Overall length

The overall length of a hose assembly shall be the length as ordered to a tolerance of $^{+3}_{-1}$ %.

5.3 Design

5.3.1 Pressure

5.3.1.1 Hose assemblies shall be designed to be in accordance with one of the following pressures PN: 0,5; 2,5; 4; 6; 10; 16; 20; 25; 40; 50; 65; 100; 150; and 250.

5.3.1.2 Pressures, in bars, at 20 °C shall be selected from the values given in 5.3.1.1.

The maximum allowable pressure of the hose assembly shall be the lowest of any component of the assembly.

5.3.1.3 The burst pressure of the hose assembly shall not be less than four times the maximum allowable pressure (see 6.4.2).

5.3.1.4 When tested in accordance with 6.4.3, and with the test pressure released, the permanent elongation shall not exceed 1 % of the test length.

NOTE The length of a hose assembly will change with pressure. For applications where the length under pressure is important, it is essential that the manufacturer be consulted.

5.3.1.5 It is essential that the maximum operating pressure, including surge pressure to which the hose assembly is subjected in service, does not exceed the specified maximum allowable pressure.

5.3.2 Temperature

The maximum allowable pressure of the hose assembly at any temperature is the lowest value of the pressure at 20 °C of each component multiplied by its appropriate derating factor.

The derating factors for the materials given in Table 1 are given in Table 3. The derating factors for materials given in Table A.1 are given in Table A.2.

Table 3 — Derating factors and limiting temperatures

Parameters		Temperatures, °C														
		– 200 to – 20	20	50	100	150	200	250	300	350	400	450	500	550	600	650
		Derating factors														
Material	X 2 CrNi 18 10	1	1	0,93	0,81	0,70	0,64	0,60	0,57	0,54	0,51	0,50	0,49	0,47	0,47	—
	X 5 CrNi 18 9	1	1	0,93	0,81	0,70	0,64	0,60	0,57	0,54	0,52	0,51	0,50	0,49	0,47	0,19
	X 6 CrNiTi 18 10	1	1	0,94	0,86	0,76	0,73	0,70	0,67	0,65	0,63	0,61	0,60	0,59	0,57	0,19
	X 2 CrNiMo 17 12	1	1	0,93	0,83	0,72	0,66	0,62	0,59	0,56	0,55	0,53	0,51	0,50	0,50	—
	X 5 CrNiMo 17 12	1	1	0,93	0,83	0,72	0,66	0,63	0,60	0,55	0,53	0,52	0,51	0,50	0,50	0,26
	X 6 CrNiMo Ti 17 12	1	1	0,94	0,84	0,75	0,69	0,65	0,62	0,60	0,58	0,56	0,54	0,53	0,52	—
	Carbon steel	—	1	0,98	0,90	0,89	0,86	0,82	0,76	0,73	0,70	0,41	0,24	—	—	—
	Copper alloy	—	1	A	A	A	A	A	—	—	—	—	—	—	—	—
	NW 0276	1	1	1	0,99	0,98	0,85	0,81	0,77	0,73	0,70	0,67	0,66	0,66	0,57	0,39
	NW 4400	1	1	0,96	0,87	0,83	0,80	0,79	0,79	0,79	0,78	0,67	—	—	—	—
	NW 6600	1	1	1	1	1	1	1	1	1	1	1	0,63	0,29	0,14	—
	NW 6625	1	1	1	1	0,99	0,97	0,95	0,93	0,92	0,90	0,88	0,87	0,86	0,83	0,46
	NW 8800	1	1	1	1	1	1	1	1	0,99	0,99	0,98	0,97	0,93	0,66	0,35
	NW 8825	1	1	1	1	1	1	1	1	0,99	0,98	0,97	0,95	0,52	—	—
Assembly method	Silver brazing	Suitable						A	A	—	—	—	—	—	—	—
	Arc welding	Suitable														
	Other	A														

NOTE "A": Refer to manufacturer.

5.4 Flexibility and pliability

5.4.1 General

Three types of hose flexibility are specified.

5.4.2 Type 1

5.4.2.1 When tested in accordance with 6.3, hose assemblies shall have an average life of 10 000 cycles but not less than 8 000 cycles.

Up to DN 100 they shall be tested in accordance with 6.3.2 and the bend radius (cyclic test type 1) as in Table 2, above DN 100 according to 6.3.3 and Table 4.

5.4.2.2 When tested in accordance with 6.2, a hose assembly shall exceed 10 cycles when tested at the bend radii (pliable) given in Table 2.

5.4.3 Type 2

5.4.3.1 When tested in accordance with 6.3 hose assemblies shall have an average life of 10 000 cycles but not less than 8 000 cycles.

Up to DN 100 they shall be tested in accordance 6.3.2 and the bend radius (cyclic test type 2) as in Table 2, above DN 100 according to 6.3.3 and Table 4.

5.4.3.2 When tested in accordance with 6.2 a hose assembly shall exceed 10 cycles when tested at the bend radii (pliable) given in Table 2.

5.4.4 Type 3 (where only pliability is required and the bend radius is as given in Table 2)

When tested in accordance with 6.2 a hose assembly shall exceed 10 cycles when tested at the bend radii (pliable) given in Table 2.

NOTE 1 Passing a test does not imply that the minimum or average cyclic lifetime can be reached in circumstances other than those specified in the test procedure.

NOTE 2 The life expectancy of a hose assembly is affected by bend radius, pressure and temperature.

NOTE 3 The lubrication condition of the braid influences the life expectancy of a hose assembly. A reduction of lubrication can occur during assembly, cleaning, transportation, storage or in service conditions.

NOTE 4 Where a user requires a higher fatigue life to those given above the manufacturer shall be consulted.

5.5 Hose manufacture

The hose may be made from seamless tube, welded tube or strip. Where welded construction is used the hose may be butt- or lap- welded, the weld being either axial or spiral along the length of the hose and in accordance with qualified procedures. Corrugations may be annular or helical.

Two methods of hose construction are possible, X and Y:

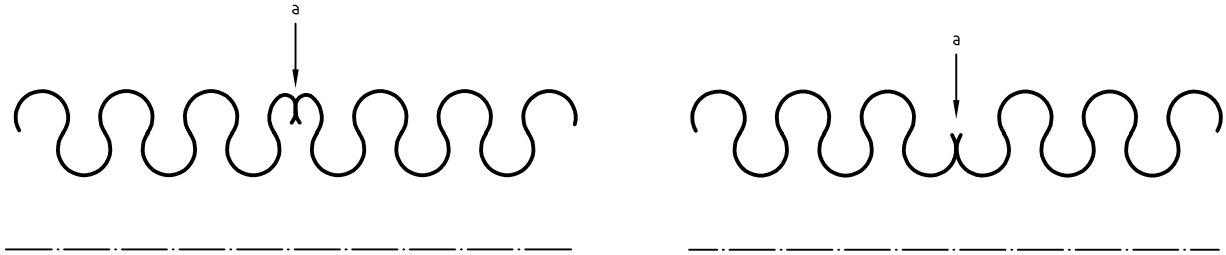
— type X: seamless annular hose and butt-welded annular hose;

— type Y: lap-welded annular hose and helical hose seamless, butt- or lap-welded.

The corrugations shall be of regular form, continuous along the length of the hose, and shall be free from any defects such as scores, dents, cuts or weld variations that might cause premature failure. Where required, a hose may be heat-treated after manufacture.

5.6 Hose joining

Where a manufacturer uses hose joints such joints shall be either butt-welded or edge-welded, as shown in Figure 1 and in accordance with qualified procedures.



a) Butt-welded **b) Edge-welded**

[a] Weld here

Figure 1 — Details of butt-welded and edge-welded hose joints

5.7 Braid

Where braided, the hose shall be uniformly covered by wire, either machine woven around the hose or fitted by hand as a stocking.

5.8 Assembly

5.8.1 General

All joining methods employed in hose assemblies shall be qualified. Manual welds shall be in accordance with EN 287-1 and EN 288-1, manual brazed joints shall be in accordance with EN 13133 and EN 13134.

Fittings shall conform to ISO 10806 unless otherwise agreed between the manufacturer and purchaser. Welded and brazed joints shall be free from globular deposits, discontinuities, porosity and undercutting, and shall have a regular surface.

5.8.2 Braid

5.8.2.1 For braided hose assemblies to meet the characteristics given in this International Standard, the assembly shall be of such a length that there is at least one complete revolution of braid along the length of the hose.

NOTE Where operating conditions require a long life expectancy, consideration should be given to braid lubrication.

5.8.2.2 Care shall be taken to ensure that all braid wires are securely bonded to end fittings.

5.8.3 Additional protection

5.8.3.1 Where required, hose assemblies may be provided with additional external protection to prevent mechanical damage. This shall be provided by either

— an anti-abrasion protective coil of metal or non-metal construction suitable for the operating conditions envisaged, or

— an additional outer sleeve resistant to tear, weathering and abrasion.

5.8.3.2 Where additional protection affects the bend radii given in Table 2, the manufacturer shall notify the purchaser accordingly.

5.8.3.3 Where a protective coating is used on a stainless steel hose, it shall not contain zinc, lead or tin.

5.8.3.4 If the material of a synthetic cover contains corrosive agents as ingredients, such as sulfur or chlorine, care shall be taken to ensure that such agents are not released during the manufacturing process or in the conditions of service.

6 Type tests

6.1 General

Tests shall be carried out at ambient temperature and the test medium shall be water.

Type tests shall consist of those given in 6.2 to 6.4.

Prior to these tests, the hose assemblies shall be tested as specified in Clause 7.

The manufacturer shall demonstrate that hose assemblies tested are representative of production.

6.2 Pliable test

Two samples of each nominal size of hose assembly shall be subjected to a bend test as shown in Figure 2. With one hose end rigidly fixed the other shall be moved in a circular arc around a former having a radius calculated from the bend radius (pliable test) as given in Table 2, until the hose assembly is in intimate contact with the full length of the arc of the former.

One cycle comprises one bend and return movement to the straight position. The test shall consist of the assembly being flexed through the number of cycles specified in 5.4 without pressure. The test frequency shall be between 5 cycles/min and 25 cycles/min.

After the test, the assembly shall be subjected to the leakage test specified in 7.3. There shall be no visible leakage or any other mode of failure.

6.3 Cyclic tests

6.3.1 General

6.3.1.1 For a given range of corrugated hose assemblies a minimum of 25 samples, but not less than three per DN size, shall be subjected to the tests specified in 6.3.2 or 6.3.3. If a DN size fails the test requirement (see 5.4), five further samples of the same DN size shall be tested without failure (see 6.3.2 or 6.3.3).

6.3.1.2 The test shall be conducted with the hose at the relevant maximum allowable pressure. The bend radius at this pressure shall be recorded.

6.3.1.3 No lubricant shall be added before or during the test.

6.3.1.4 Failure is defined as

a) leakage of the hose and/or

b) a localized reduction of the hose radius of more than 50 % (as measured in 6.3.1.2) during the test.

6.3.2 U bend test

The test shall be conducted using hose assemblies mounted to form a vertical loop as shown in Figure 3. The flexible length of the assembly l, shall be as given in the equation below.

The distance between the axes of the end fittings shall be equal to twice the bend radius (cyclic test) given in Table 2.

The hose shall be subjected to repeated flexing at a sinusoidal rate of from 5 cycles/min to 30 cycles/min in a direction parallel with the axis of the hose through a movement of $2x$.

$$l = 4r + x$$

where

r is the bend radius (cyclic test);

x is equal to 4 DN or 125 mm, whichever is greater;

DN is the nominal size.

6.3.3 Cantilever bend test

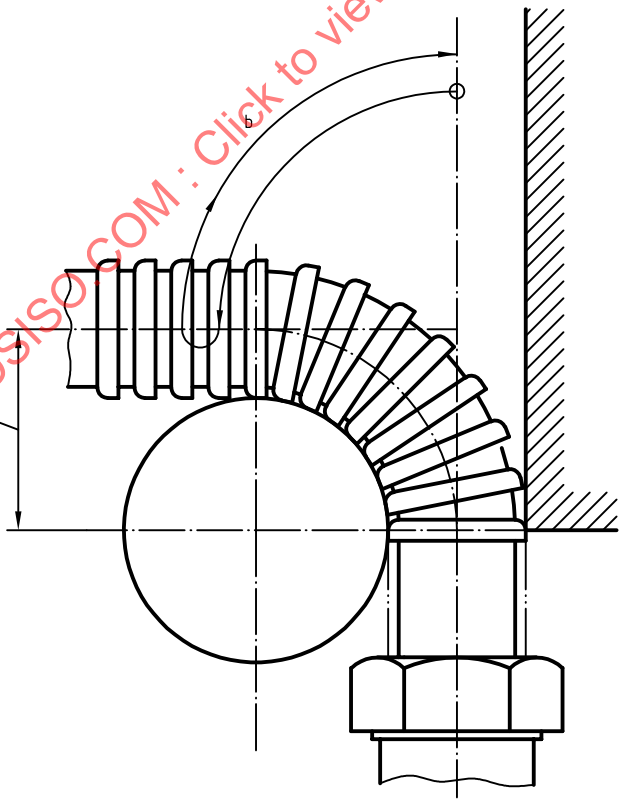
The hose assembly shall be rigidly fixed at point A (see Figure 4), the other end shall be moved by means of a lateral force applied at point P, located at the end of the flexible length, so that a stroke as given in Table 4 will be achieved. The flexible length *l* shall be six times the nominal size.

The hose shall be subjected to repeated flexing at a sinusoidal rate of from 3 cycles/min to 15 cycles/min in a lateral direction to the axis of the hose.

Table 4 — Cantilever bend test

Nominal size DN	**Flexibility**	
	Type 1	Type 2
	Stroke mm	
125	65	50
150	70	55
200	80	65
250	90	70
300	100	80

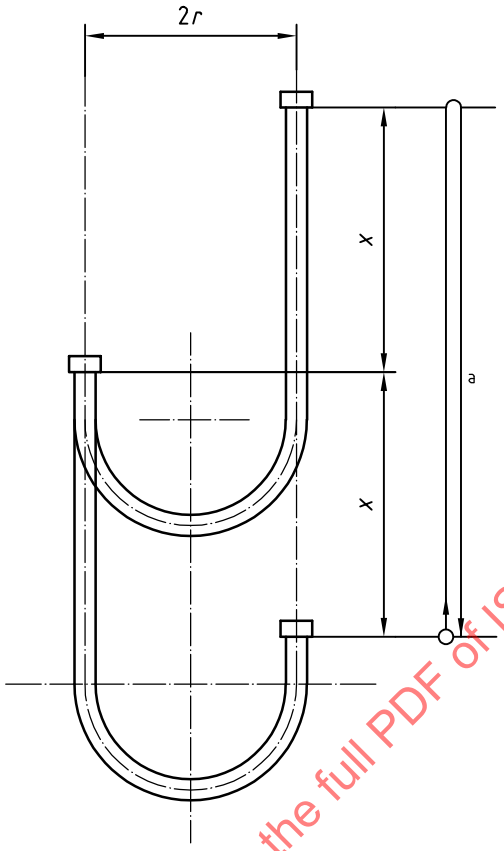
In Table 4 the stroke represents approximately the bend radius cyclic test given in Table 2 and it is based on test experience.



a Bend radius

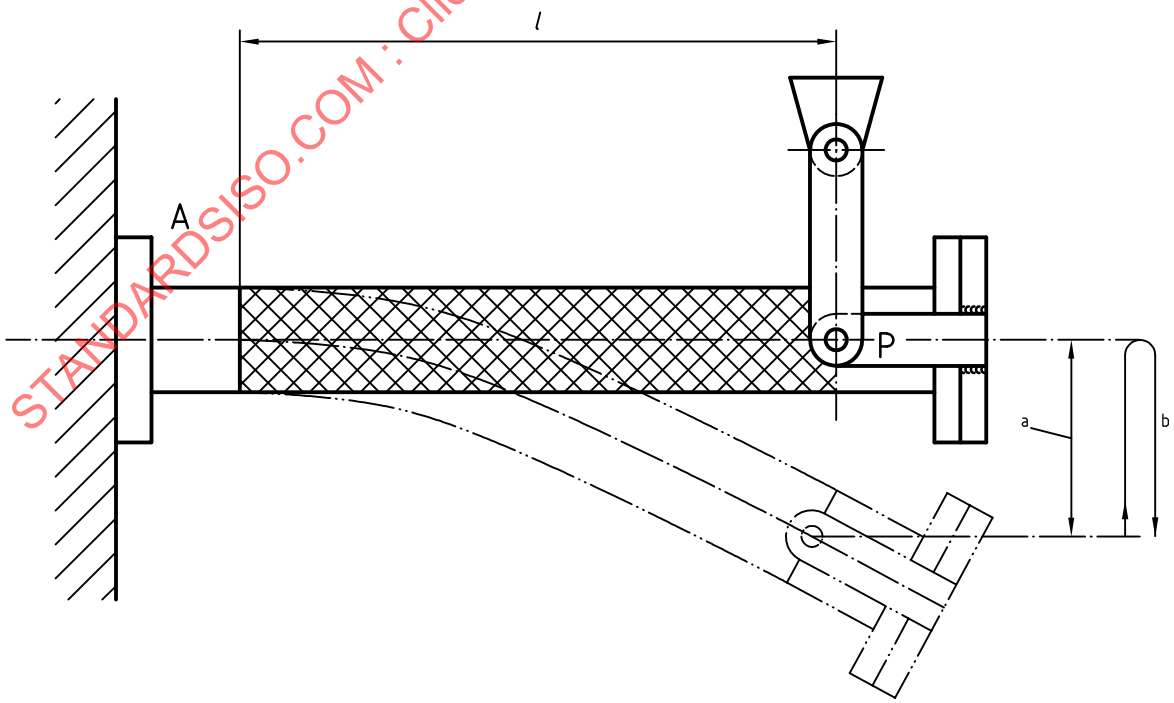
b One cycle

Figure 2 — Pliable test



a One cycle

Figure 3 — U bend test



a Stroke

b One cycle

Figure 4 — Cantilever bend test

6.4 Pressure test

6.4.1 General

A test sample assembly shall have a flexible length of not less than 500 mm or 5 × DN, whichever is greater.

6.4.2 Burst test

Subject a straight sample assembly to a hydraulic pressure applied gradually in increments over a minimum period of 1 min until the assembly fails by visible leakage or rupture of any of the components (see 5.3.1.3).

6.4.3 Elongation test

Subject a straight sample assembly to a hydraulic test pressure of 1,5 times the maximum allowable pressure (see 5.3.1.4), for not less than 1 min.

7 Production tests

7.1 General

After manufacture, every hose assembly shall be subjected to a pressure proof test and a leakage test.

7.2 Pressure proof test

7.2.1 General

The manufacturer may chose between a hydraulic or pneumatic pressure proof test.

7.2.2 Hydraulic test

Unless otherwise stated by the purchaser the test medium shall be water.

There shall be no visible sign of leakage or of any other mode of failure.

The test pressure shall be 1,5 times the pressure given in 5.3.1.1. The test pressure shall be applied and maintained for a sufficient length of time to permit a visual examination of all surface joints, but in any case for not less than 1 min for hoses of DN = 50, 2 min for hoses 50 < DN = 100 and 3 min for hoses of DN > 100.

NOTE 1 Where liquids other than water are used, additional precautions may be necessary.

NOTE 2 Attention is drawn to the need to control the chloride content of the water used for hydraulic tests on stainless steel to below 30 mg/l.

7.2.3 Pneumatic test

When a pneumatic pressure test is carried out, the test conditions shall be as given in 7.2.2.

There shall be no visible sign of leakage (or detectable with equivalent accuracy where an alternative detection method is used).

NOTE Pneumatic testing is potentially a much more dangerous operation than hydraulic testing, in that, irrespective of size, any failure during test is likely to be of a highly explosive nature.

7.3 Leakage test

a) When tested with air and under water, for a minimum of 2 min,

   1) hose assemblies with pressure ratings up to and including 20 bar shall be tested at 10 % of the rated pressure, and

   2) hose assemblies rated above 20 bar shall be tested at 2 bar,

   no visible leakage shall occur; or with the customer's agreement,

b) When tested with an equivalent method no leakage greater than 10^{-3} mbar l/s occurs.

7.4 Cleaning

The hose assemblies shall be cleaned internally and dried before dispatch. All other conditions shall be agreed between the purchaser and manufacturer.

8 Designation

The designation for a pressure-tight corrugated metal hose assembly in accordance with this International Standard is:

a) reference to this International Standard, i.e. ISO 10380;

b) type of flexibility;

c) the hose material (for stainless steels or nickel alloys, use only the ISO or NW number as given in Table 1; for the equivalent materials given in A.2 use the EN or NW number);

d) the nominal size, DN;

e) maximum allowable pressure, PN.

EXAMPLE A corrugated metal hose assembly of flexibility type 1, of ISO 9328-5 type X 2 CrNi 18 10 hose material, of size DN 25 and pressure equal to PN 16 is designated as follows:

Corrugated metal hose assembly ISO 10380-1 - X 2 CrNi 18 10 - DN 25 - PN 16

9 Marking

Corrugated metal hose assemblies shall carry, as a minimum, the following marking:

a) name of manufacturer or trademark;

b) year of manufacture;

c) designation in accordance with Clause 8.

10 Instructions

The manufacturer shall make available to the user adequate instructions for the use of the hose assemblies (handling, installation, putting into service, use and maintenance).