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Thermoplastics piping systems for non-pressure underground drainage and sewerage — Joints for buried non-pressure applications — Test method for the long-term sealing performance of joints with elastomeric seals by estimating the sealing pressure

Systèmes de canalisations thermoplastiques pour branchements et collecteurs d'assainissement enterrés sans pression — Assemblages pour applications enterrées sans pression — Méthode d'essai de la performance à long terme des assemblages avec garnitures d'étanchéité en élastomère par l'estimation de la pression d'étanchéité

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Foreword

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ISO 13265 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 1, *Plastics pipes and fittings for soil, waste and drainage (including land drainage)*.

Thermoplastics piping systems for non-pressure underground drainage and sewerage — Joints for buried non-pressure applications — Test method for the long-term sealing performance of joints with elastomeric seals by estimating the sealing pressure

1 Scope

This International Standard specifies a method for determining the long-term sealing pressure of elastomeric seals in assembled joints for buried non-pressure sewerage plastics piping and ducting systems.

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 9967, *Thermoplastics pipes — Determination of creep ratio*

EN 681-1, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 1: Vulcanized rubber*

EN 681-2, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 2: Thermoplastic elastomers*

EN 681-3, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 3: Cellular materials of vulcanized rubber*

EN 681-4, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 4: Cast polyurethane sealing elements*

EN 837-1, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

3 Symbols

B	theoretical pressure, in bar[1)], in the PTFE tube at $t = 1$ h
D	drop factor of extrapolated pressure data at 24 h and 100 years
M	gradient of the curve
p_t	pressure measured in the PTFE tube at a flow of 120 ml/min and the time t hours
p_0	initial leakage pressure, in bar, measured in the PTFE tube after completing the assembly
p_{ta}, p_{tb}, p_{tc}	pressure measured in the three PTFE tubes in the tested joint, marked a, b and c, respectively, at time t hours
p_x	extrapolated pressure, in bar, at 100 years
p_y	calculated pressure, in bar, at 24 h
p_{xa}, p_{xb}, p_{xc}	extrapolated pressure, in bar, at 100 years in the three PTFE tubes in the tested joint, marked a, b and c, respectively
p_{100y}	arithmetic mean value of the pressures obtained for each of the three extrapolated values, p_x, at 100 years
p_{24h}	arithmetic mean value of the pressures obtained for each of the three calculated values, p_y, at 24 h
R	correlation coefficient
t	time, in hours

4 Principle

The sealing pressure in a joint is estimated by measuring the pressure necessary to lift the seal, in each of three PTFE tubes equally distributed over the circumference of a joint located between the rubber seal and the spigot or socket, as appropriate (see Figure 1).

In a temperature-controlled environment and at increasing time intervals, a constant flow rate of 120 ml/min of nitrogen or air is forced through three flexible PTFE tubes.

The nitrogen or air pressure, p, necessary to achieve this flow, is measured. The pressure, p_t, is measured at increasing time intervals over a period of time. The extrapolated regression lines for p_t are used to calculate the estimated value p_x at 100 years and p_y at 24 h.

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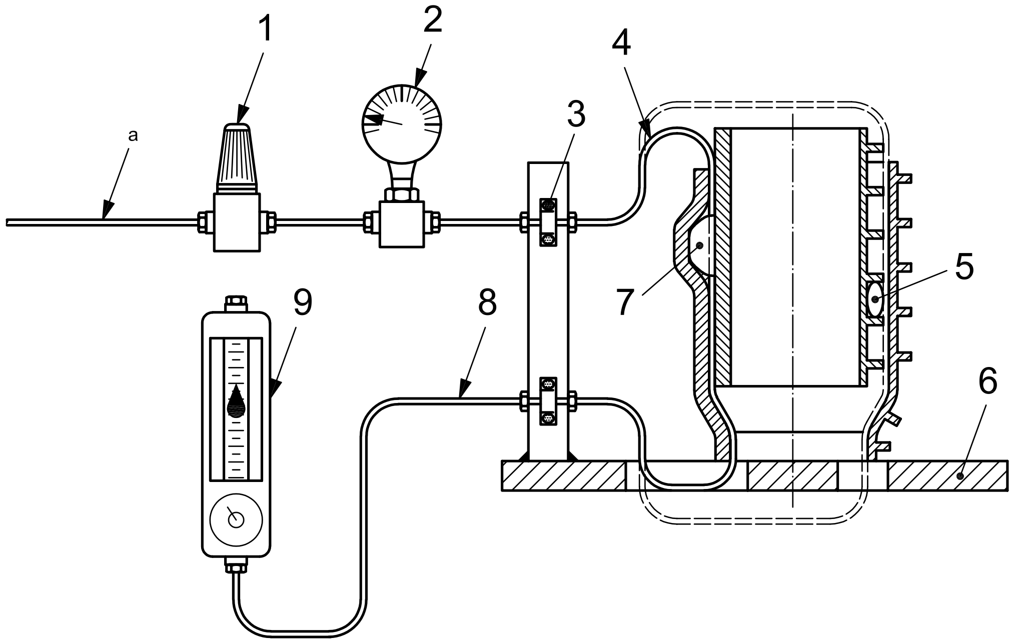
1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.



Key

1 regulator/pressure controller
2 pressure gauge
3 fixed coupler
4 PTFE tube
5 position of the tube in a joint with the sealing ring positioned on the spigot
6 test assembly base
7 position of the tube in a joint with sealing ring positioned in the socket
8 connecting tube
9 flow meter

[a] Source of nitrogen or clean air.

Figure 1 — Typical arrangement of the test assembly

5 Apparatus

5.1 Source of nitrogen, with a purity of at least 99,8 % or, alternatively, cleaned air (oil-free), both capable of supplying a flow of up to 200 ml/min and at a pressure of at least 10 bar.

5.2 Regulator/pressure controller, capable of regulating a stable pressure and flow increase up to 120 ml/min.

5.3 Pressure gauge, for measuring the pressure in the main line and capable of checking conformity to 7.2 (class 0,6 or better, as specified in EN 837-1).

5.4 Connecting tube, with an inside diameter of at least 4 mm.

5.5 PTFE tube, conforming to the following:

a) capable of sustaining at least 10 bar pressure;

b) the total thickness of the flattened PTFE tube shall be between 0,16 mm and 0,24 mm, measured in the middle of the sample and carried out in two positions perpendicular to each other;

c) the total width of the flattened tube shall be between 6 mm and 10 mm.

NOTE The PTFE tube used for this test is a blown-up tube, normally applied as a shrinkage tube. The original diameter and wall thickness after shrinkage are normally specified. Blown-up dimensions are normally not specified.

The given tolerances should be seen as a guide for the supplier.

Care should be taken that the wall thickness and the diameter of the tube as received are verified.

5.6 Flow meter, with a capacity of 200 ml/min and a tolerance of ±5 ml/min.

5.7 Means for storing test assembly, capable of fixing and storing the test assembly in such a way that no additional movements in the joint can occur. It shall be capable of fixing the PTFE tubes in such a way that, when connecting or disconnecting to the pressure gauge and flow meter, no movement of the PTFE tube in the sealing area can occur.

5.8 Lubricant, an aerosol of silicon (polydimethylsiloxane) with gas propellant (propane/butane).

6 Test pieces

6.1 General

Each test piece shall consist of a complete joint, together with its elastomeric seal and PTFE tube(s). Unless otherwise specified in the referring standard, the number of PTFE tubes shall be three, marked as a, b and c, equally spaced around the spigot.

6.2 Assembly

Prior to assembly, the test pieces shall be conditioned at the test temperature for at least 24 h.

Clean the rubber sealing ring, the socket and the spigot.

Prepare the PTFE tube by pressing it together several times until permanently flattened and place it along the smooth surface of the spigot or socket.

Lubricate the smooth wall in the joint (spigot or socket), the seal and PTFE tube(s). The lubricant defined in 5.8 shall be used. Use sufficient lubricant to ensure that the PTFE shrinkage tube(s) and seal can be assembled without damage, and the seal can equalize its position within the groove circumference.

Assemble the socket and spigot, including the seal, in accordance with the manufacturer's instructions and the following requirements.

a) The joint shall be assembled in such a way that the PTFE tubes are mounted between the spigot or socket and the seal (see Figure 1); precautions shall be taken to avoid squeezing the PTFE tube outside the sealing area.

b) It is permitted to mill a grove, insert thin plastics strips along the tube, drill holes in the spigot or socket or any other method that gives room for sufficient flow through the tube outside the sealing area. The method selected shall not significantly influence the creep behaviour of the joint in the sealing housing area.

c) Make sure that the PTFE tube can move freely in the axial direction and that the flattened section of the PTFE tube is located under the sealing ring, and not distorted, when the joint is made.

6.3 Leaktightness of the test system

Make sure the pressurized side of the test equipment is leaktight after installation. Identify any leakage by soap solution. If necessary, reassemble the leaking joints. Avoid flow through the sealing zone during this operation.

7 Test procedure

7.1 General

The testing shall start between half an hour and 8 h after assembly and a leaktightness test performed in accordance with Clause 6.

For each of the installed PTFE tubes, carry out the procedure according to 7.2 with the test pieces kept in the temperature-controlled environment at (23 ± 2) °C.

Measure and record the sealing pressure, p, in bar, at 24 h, 168 h, 336 h, 504 h, 600 h, 696 h, 862 h, 1 008 h, 1 392 h and 2 000 h.

Where it is not possible to read the pressure at the appropriate time between 500 h and 2 000 h, it is permitted to deviate by up to 48 h, provided the actual measurement time is used in preparing the plots described in Clause 8.

7.2 Procedure for determining the pressure

7.2.1 Measure the leakage pressure, p_0, in each of the three tubes individually, using the following procedure.

a) Using the procedure described in 7.2.2 a), steadily increase pressure until a flow of 120 ml/min through the PTFE tube occurs.

b) Measure and record this initial leakage pressure, p_0.

c) Reduce pressure to zero.

7.2.2 At each time interval as specified in 7.1, achieve a flow of 120 ml/min and measure and record the nitrogen (or air) pressure, p_t, in bar, using the following procedure for each of the three tubes individually.

a) Increase pressure in increments of 0,5 bar until the level is 0,5 bar below p_0 or the previous measurement. Then continue to increase the pressure gradually and slowly. Occasionally, allow time for the pressure and flow to stabilize. Continue this process until the flow rate has been (120 ± 5) ml/min for 60 s at the same pressure. Record the pressure as p_{ta} in bar.

   If the pressure reaches 10 bar, stop pressurizing and record the pressure as 10 bar.

   If the pressure in all three tubes is recorded as 10 bar after the reading at 504 h, the assembly shall be deemed to have passed the requirements.

   If one or two of the tubes show a pressure less than 10 bar at the 504 h reading, the test shall be continued and the calculation shall be done based on the pressure readings below 10 bar.

b) Reduce pressure to zero.

c) If, during testing, the actual flow reaches a level 10 % higher than 120 ml/min, stop the test and repeat the whole procedure after waiting for at least 30 min.

8 Calculation and expression of results

8.1 Calculation

Calculate the extrapolated 100 years pressure for each individual tube using the measurements of the pressure, p_{ta}, p_{tb}, p_{tc} respectively, taken at each period of time, t, in accordance with 7.1 and 7.2, and determine the best-fit straight line by using least squares analysis in accordance with ISO 9967.

Plot the measured values against the logarithm of time, in hours, into a semi-logarithmic co-ordinate system, and determine by linear regression the equation of the straight lines:

$$p_t = B + M \lg t \tag{1}$$

where

p_t is the theoretical extrapolated pressure, in bar, in the PTFE tube marked a, b or c, at time t,

B is the theoretical pressure, in bar, in the PTFE tube at $t = 1$ h,

M is the gradient of the curve,

through all 10 points; through the last 9 points; through the last 5 points (see Table 1), where the values for B and M and the correlation coefficient, R , are determined using the method of least squares; the factor R shall be calculated in five digits.

For each of the six equations $p_t = B + M \log t$, calculate the extrapolated pressure p_x at 100 years and, if applicable, the pressure p_y at 24 h.

Choose, as the value for p_x and p_y, the value that has the highest correlation coefficient, R. The value for R shall be at least 0,90.

If the highest value of R is less than 0,90, extend the measurements for all of the three tubes according to 8.3.

8.2 Example of calculation results

A typical set of data of measured pressures at one position is given in Table 1.

In the fourth column, the range of measuring points are given, from which the regression factors at the right-hand side of Table 1 are derived. To select the highest value of R, five digits are needed.

Calculate the arithmetic mean value of p_{100y} and, if applicable, of p_{24h} of the values obtained for each of the three extrapolated values of p_x and p_y, using Equations (2) and (3), as applicable:

$$p_{100y} = \frac{(p_{xa} + p_{xb} + p_{xc})}{3} \tag{2}$$

$$p_{24h} = \frac{(p_{ya} + p_{yb} + p_{yc})}{3} \tag{3}$$

If applicable, calculate the pressure drop using Equation (4):

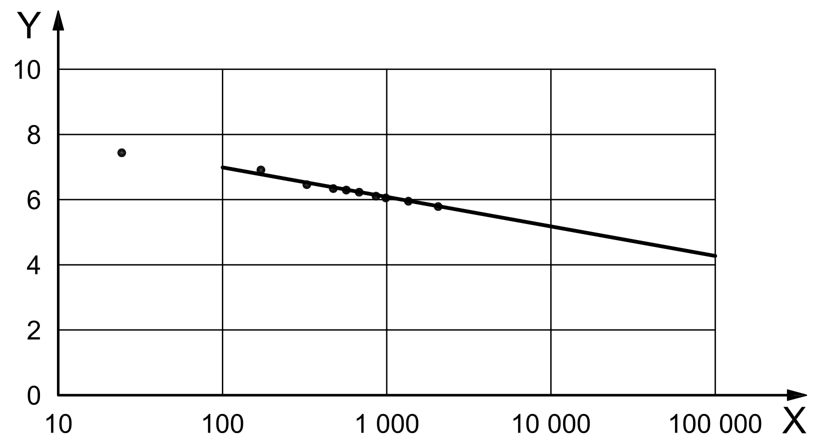
$$D = \frac{p_{24h} - p_{100y}}{p_{24h}} \times 100\,\% \tag{4}$$

Table 1 — Typical set of data and regression analysis for one measuring position

Test report No.				Joint identification			Tube marked a, b or c		
Measurement data				Linear logarithmic regression of the data					
Point number	Time		Pressure	Range of points	$p_t = M \times \lg t + B$				
	t	$\lg t$	p					p_x: 100y	p_y: 24 h[a]
	hours		bar		M	B	R	bar	bar
1	24	1,38	7,50	1 to 10	−0,889 8	8,810 3	0,982 23	3,52	7,58
2	168	2,23	7,00	2 to 10	−1,031 7	9,220 5	0,983 76	3,09	7,8
3	336	2,53	6,54	3 to 10	−0,912 5	8,865 1	0,993 67	3,44	7,61
4	504	2,70	6,40	4 to 10	−0,944 3	8,962 0	0,993 44	3,35	7,66
5	600	2,78	6,35	5 to 10	−0,960 1	9,011 0	0,992 04	3,31	7,69
6	696	2,84	6,30	6 to 10	−0,947 2	8,970 4	0,988 71	3,34	7,66
7	862	2,94	6,18						
8	1 008	3,00	6,10						
9	1 392	3,14	6,00						
10	2 000	3,30	5,85						

[a] If applicable.

The resulting plot is given in Figure 2.



Key

X time, logarithmic scale

Y pressure, bar

Figure 2 — Plot of measured pressures for one measuring position, and extrapolation curve for the highest calculated R value

8.3 Continuation of test

In all cases, except if the pressures are recorded as 10 bar [see 7.2.2 a)], there shall be a trend to lower pressures after 504 h at all of the three PTFE tubes. If this condition is not fulfilled, the test result(s) shall be disregarded. If after 504 h, the measured values in the three tubes deviate by more than 30 % from their average value, the test results shall be disregarded. In both cases a new test with a new test piece conforming to Clause 6 shall be carried out.

If the calculation procedure does not lead to a correlation coefficient, R, higher than 0,90 in the regression analysis, for any of the measuring positions, the test results shall either be disregarded, or the test shall be continued by measuring the sealing pressure with increments in time of at least 200 h until the correlation coefficient, R, exceeds the value of 0,90, using all the measurements from and including 504 h.

9 Test report

The test report shall include the following information:

a) identification of the laboratory and the responsible person;

b) reference to this International Standard, i.e. ISO 13265:2010, and the referring standard;

c) number of test pieces;

d) gas used in the test, i.e. nitrogen or cleaned air;

e) full description of the piping components forming the test piece (e.g. manufacturer's name, production date, material, type, diameter, wall thickness, shape of the sealing zone);

f) identity of the seal (type of material in accordance with EN 681-1, EN 681-2, EN 681-3 or EN 681-4, as applicable; hardness of material; shape/type; diameter);

g) at each test time, the measured pressure, $p_{t\text{a}}$, $p_{t\text{b}}$, $p_{t\text{c}}$, in bar,

h) results of regression analysis for each position;

i) average pressure, p_{24h}, in bar, if applicable;

j) average pressure, p_{100y}, in bar;

k) pressure drop, D, if applicable;

l) any factors that could have affected the results, such as any incidents or any operating details not specified in this International Standard;

m) dates of the tests.

Annex A
(informative)

Example of a tube manufacturer's specification

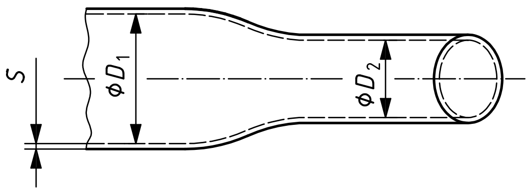


Figure A.1 — Product specification sheet

Table A.1 — Item No. 24-316-10-1220S3

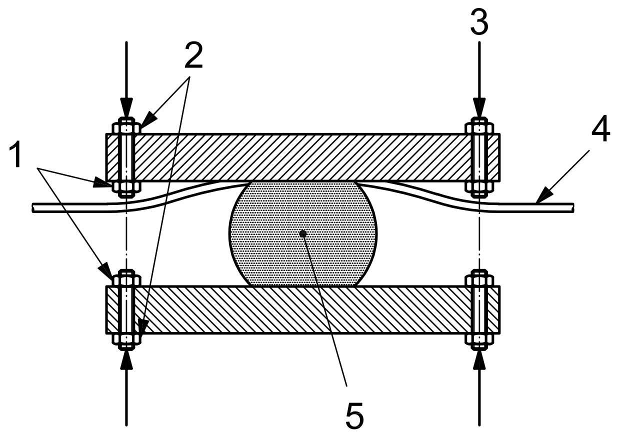
Type	V3/16	manufactured by	IFK-Isofluor GmbH
Order-No.	A24V3/1610	dimension	0,188″
Expanded ID, D_1	4,75 mm	tolerance	+0,65/–0,00 mm
Shrunk ID, D_2	1,27 mm	tolerance	+0,00/–0,30 mm
Wall after max. shrinkage, S	0,30 mm	tolerance	±0,08 mm
Wall	standard wall	colour	natural transparent
Material	IFK PTFE201TB	shrink tested	yes
Length	production length on spool	elongation at tear at 23 °C	$>$ 200 %
Length	1,220 mm fixed	yield point at 23 °C	$>$ 10 N/mm^2
Thermal conductivity at 23 °C	0,23 (W/K*m)	upper temperature for continued use, no load	250 °C – 260 °C
Combustibility	non combustible	shrink temperature	320 °C – 360 °C
Specified according to	MIL-DTL-23053 Revision E/12, Class 5	tubing material specified according to	AMS 3584
Approved	H.E. de la Motte	date	2003-09-02

Annex B
(informative)

Description of a training test assembly

B.1 General

The following is a description of a simple procedure for first test trials in a new laboratory or for new laboratory personnel and equipment. In this test rig, a correlation coefficient of $R = 0{,}98$ should be easily obtainable.



Key
1 distance nut
2 counter nut
3 screw
4 shrinkable tube
5 rubber seal

Figure B.1 — Basic test assembly

B.2 Test assembly

Basic test rig consisting of two rigid plates of size ~50 mm × 50 mm and thickness ⩾ 5 mm (no bending of the plate during assembly).

At the four corners, screw connections of ~5 mm are positioned, distance nuts used for adjustment of the distance and parallelism of the plates, locked with counter nuts after adjustments.

An O-ring (or a similar stable design) should be chosen (~ from pipes DN 150 to DN 250) as the seal.

Seal the 50 mm long segment, positioned between the plates. Crosswise, a shrinkage tube is positioned between the seal and one plate. To support quick settlement of the seal and tube between the pressed plates, sufficient lubricant should be used around the seal segment.

The seal is compressed to about 30 %.

In a first test, air is blown through the tube. The required air pressure for the flow of 120 ml/min should be close to 10 bar, and at least 7 bar (in order to obtain measurable relaxation drops in a relatively short time).

If the pressure is outside the ~7 bar to 10 bar range, change the distance between the plates until a pressure of 7 bar to 10 bar is reached. Then the plates are locked with counter nuts (for stabilization against transport influences).

The test assembly is completed.

B.3 Preliminary testing

In a preliminary test, the laboratory personnel should train to increase the air pressure gradually and slowly, watch and control the increasing flow and try to reach the target flow slowly. To manage slow and gradual increase of the pressure (and flow), this exercise may be repeated several times.

B.4 Start of a test

Before starting a second phase of test procedures, the completed test rig is stored in a place at constant temperature for at least 2 h.

After 2 h, the first flow test can be started, following the test procedure described in the referring standard. The test can be repeated much more frequently than defined in the referring standard, for example every 24 h (but not more often than every 2 h). The results should be recorded and plotted in a graph, as indicated below.

B.5 Typical test results, plotted in a graph

When showing the test readings in a logarithmic/linear graph, the test results over several days should drop slightly.

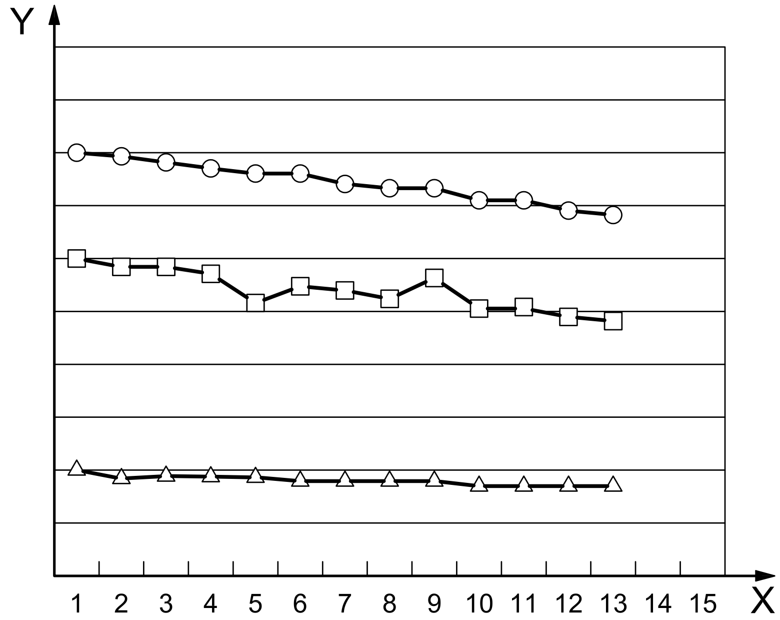
Comments:

a) The measured pressure drop over time is created by the relaxation of the seal material; the stabile test rig does not contribute to the results.

   For typical seal materials, the expected drop for a period of 100 years (extrapolated values between 24 h and 100 years) is ~30 %.

b) In practice, slight result variations cannot be avoided but, after several measurements, the correlation coefficient, R, of the findings should be at least 0,98 (see Clause 8).

Typical results are given in Figure B.2.



Key

X time, logarithmic scale

Y air pressure at 120 ml blow

○ qualified results

□ poor results: relaxation of the seal appears continuously. Jumps as shown here cannot be created by the test rig, their cause should be analysed and corrected. B.6 gives a list of possible external influences. The list is not considered to be complete.

△ new qualified results: based on the accuracy of the pressure gauge, the daily drops cannot necessarily be determined and can then only be found after several measurements (influence of pressure level and time between the measurements).

Figure B.2 — Air pressure to reach the flow of 120 ml

B.6 External influences on the test results

External influences on the test results are the following:

— tube installation of the test equipment is not tight;

— pressure regulator is not accurate (either the regulator or the type and size of the regulator should be changed);

— storage temperature of the test assembly is variable;

— changes in the test rig (sealing compression) during handling and transport;

— test personnel should take more care during the process of regulating and reading the pressure and flow.

B.7 The accuracy of test results

The quality of the test results is shown by the correlation coefficient, R, for calculation (see referring standard). This International Standard sets a limit of $R > 0{,}9$ for tests on a complete joint, several laboratories have no problems reaching $R > 0{,}95$ up to even 0,99 on complete joints.

Bibliography

[1] AMS 3584, *Plastic tubing, electrical insulation, polytetrafluoroethylene, heat shrinkable, overexpanded*

[2] MIL-DTL-23053 Revision E/12, *Insulation sleeving, electrical, heat shrinkable, polytetrafluoroethylene*

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