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PLASTICS PIPES FOR THE TRANSPORT OF FLUIDS

DETERMINATION OF THE RESISTANCE TO INTERNAL PRESSURE

1st EDITION

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For each individual country the only valid standard is the national standard of that country.

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BRIEF HISTORY

The ISO Recommendation R 1167, *Plastics pipes for the transport of fluids – Determination of the resistance to internal pressure*, was drawn up by Technical Committee ISO/TC 5, *Pipes and fittings*, the Secretariat of which is held by the Association Suisse de Normalisation (SNV).

Work on this question led to the adoption of a Draft ISO Recommendation.

In November 1967, this Draft ISO Recommendation (No. 1334) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	India	South Africa, Rep. of
Belgium	Ireland	Spain
Canada	Israel	Sweden
Chile	Italy	Switzerland
Czechoslovakia	Japan	Turkey
Denmark	Korea, Dem. P. Rep. of	U.A.R.
France	Netherlands	United Kingdom
Germany	Norway	U.S.S.R.
Greece	Poland	Yugoslavia

One Member Body opposed the approval of the Draft :

New Zealand

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in January 1970, to accept it as an ISO RECOMMENDATION.

ISO Recommendation | R 1167 | January 1970

PLASTICS PIPES FOR THE TRANSPORT OF FLUIDS

DETERMINATION OF THE RESISTANCE TO INTERNAL PRESSURE

1. SCOPE

This ISO Recommendation describes the testing apparatus and the test procedure to be applied for determining the resistance of plastics pipes to a constant internal pressure and the bursting time of these pipes.

The test requirements are given in the specification concerning the types of pipes under test.

2. PRINCIPLE OF METHOD

The method consists in subjecting specified lengths of pipe to a specified constant internal pressure for a specified period of time, or until the test piece bursts.

The test pieces are conditioned before testing, and throughout the test they are kept at a specified constant temperature equal to the conditioning temperature. The tests are carried out "with water under water" (see clause 7.6).

NOTE. – The method is based on the correlation between the circumferential stress exerted on the pipe and the time after which bursting is observed.

Consequently, it is based also on the shape of the circumferential stress/bursting time curve, which can be obtained by submitting a number of test pieces to various pressures. The shape of this curve depends on

- the nature of the product used (PVC; PE, high-density; PE, low-density; etc.);
- the processing conditions of the material.

If the tests are performed at elevated temperature, the circumferential stresses required to produce bursting decrease, but the shape of the curve is maintained.

At elevated temperatures, singularities in this curve, in particular points of flexion, develop sooner. This circumstance is utilized to facilitate extrapolation.

The extrapolation, by suitable methods, of the circumferential stress/bursting time curve, determined at 20 °C in accordance with the test conditions fixed by this method, allows approximate estimation of the maximum circumferential stress which the pipe can withstand, without bursting, over a reasonably long period, say 50 years.

The ratio between this maximum circumferential stress obtained by extrapolation and the circumferential stress to which the pipe will be subjected in continuous service defines what is called a "factor of safety", which is only applicable when water under pressure at a temperature of 20 °C is transported. It makes allowance for the service conditions of the pipe, its handling qualities, etc.

For applications where higher temperatures and/or higher aggressiveness of the fluids to be transported are to be expected, special tests can be considered.

Two types of test are provided for :

- *Acceptance tests*, carried out at a temperature of 20 °C.
  These allow a fast verification of the conformity of a batch of pipes to a specified type.
- *Quality tests*, carried out at an elevated temperature as a function of the nature of the pipe tested. These allow evaluation of the standard of the production and the pipe material used.

The first type of test may be applied by the manufacturer for the continuous inspection of his products and/or by the consumer for the acceptance of a batch of pipes.

3. APPARATUS

The essential parts of the apparatus are as follows :

3.1 *Fittings*, to be mounted at the ends of the test piece.
The fittings should be designed to make a pressure-tight connection to the test piece and to the pressure appliance.
Three types of fittings are allowed, as follows :

3.1.1 Fittings rigidly connected to the test piece so that the lower end of the test piece carries the weight of one of the fittings and the thrust of the pressure (see Fig. 1).

3.1.2 Caps, provided with ring joints sealing on to the *external* surface of the test piece, and connected to one another by a metal rod allowing some longitudinal movement at the ends of the test piece. Pressure is applied through one cap end, or through the connecting rod (see Fig. 2).

3.1.3 Metal plugs provided with ring joints sealing onto the *inner* surface of the test piece, and connected to one another by a metal rod with a central bore allowing some longitudinal movement at the ends of the test piece (see Fig. 3).

3.2 *Tank* filled with water at the required temperature and provided with a thermostat allowing the temperature to be maintained within ± 1 °C.

NOTE. Provision should be made for effective stirring.

3.3 A suitable appliance allowing the required pressure to be built up gradually and without shock and to be subsequently maintained within ± 2 % throughout the test.

NOTE. It is recommended to apply the pressure to each test piece individually, by means of a cylinder of compressed gas connected to the water-filled test pieces. A device which allows the pressure to be applied to several test pieces at the same time should not be used, because at the moment of bursting of one of the test pieces the pressure will also fall to zero in the other ones. It is not permitted to raise the pressure again to its initial value and continue the test, since the requirements of clause 3.3 would then not be complied with.

3.4 *A number of pressure gauges*, equal to the number of test pieces, with suitable scales to check the pressure in the pipes.

NOTE. The pressure gauges should permit reading within ± 1 %. It is recommended to check the pressure gauges regularly, for example once a week, and, in the case of short-duration tests, every day.

3.5 An appliance designed to register the duration of the pressure application till the moment of bursting, or the first pressure fall.

NOTE. – It is recommended to use an apparatus which is sensitive to the pressure variations caused by rupture and which can stop the time counter and, eventually, close the pressure circuit.
A pressure gauge with electrical contacts or similar systems can be used for this purpose.

4. SAMPLING

4.1 From a batch of pipes take at random a sample of sufficient length.

4.2 From this sample cut lengths of pipe, or test pieces, one after another. The ends of the test pieces should be flat and perpendicular to the axis of the pipe.

4.3 The free length of each test piece between the connecting caps should be L mm as determined by equation 1, but not less than 250 mm.

$$L = 3\,d_e \qquad \text{(equation 1)}$$

where d_e is the outside diameter of the pipe in millimetres.

4.4 Number of test pieces

4.4.1 *Acceptance test :* five test pieces.

4.4.2 *Quality test :* five test pieces for each required test condition.

5. CONDITIONING

Test pieces should not be tested within a period of 15 hours after production of the pipe.

Test pieces should be brought to the specified temperature and conditioned at that temperature for 1 hour.

They may be immersed in the tank to be used in the burst tests.

6. CALCULATION OF THE PRESSURE

6.1 Acceptance test

The pressure p in newtons per square metre (or kilogrammes-force per square centimetre) should be calculated to three significant figures by means of equation 2 :

$$p = \sigma \frac{2e}{d_e - e} \qquad \text{(equation 2)}$$

where

σ is the circumferential stress in newtons per square metre (or kilogrammes-force per square centimetre). For each material the value of σ to be applied to the test pieces is laid down in the particular specification applicable to the pipes under test;

d_e is the nominal outside diameter of the pipe, in millimetres;

e is the nominal wall thickness of the pipe, in millimetres.

6.2 Quality test

The pressure p in newtons per square metre (or kilogrammes-force per square centimetre) should be calculated to three significant figures for each test piece by means of equation 3 :

$$p = \sigma \frac{2e_{min}}{d_{m,\,max} - e_{min}} \qquad \text{(equation 3)}$$

where

σ is the circumferential stress in newtons per square metre (or kilogrammes-force per square centimetre) (see clause 6.1);

$d_{m,max}$ is the maximum mean outside diameter, in millimetres, measured on each test piece;

e_{min} is the minimum wall thickness, in millimetres, measured on each test piece to within 0.01 mm by means of a micrometer.

NOTE. – It is essential to have available a micrometer designed to measure the wall thickness of a test piece at all points along its length.

7. TEST PROCEDURE

7.1 Cut the test pieces according to section 4.

7.2 Wipe the test pieces free from any trace of dirt, oil or wax, etc.

7.3 Measure the dimensions of the test pieces (quality test only) and calculate the test pressure (see section 6) corresponding to the specified circumferential stress.

7.4 Put the fittings on the ends of the test pieces.

7.5 Fill the test pieces with water and condition them (see section 5).

7.6 Connect the test pieces to the apparatus, release the air from the test pieces and within 60 seconds apply the specified pressure with an accuracy of ± 2 %.

Throughout the test, the test pieces should be immersed in the cistern, the temperature of which is maintained within ± 1 °C (see clause 3.2).

7.6.1 *Acceptance test.* Five test pieces should be subjected to the pressure corresponding to the circumferential stress laid down in the particular specification applicable to the pipes under test.

7.6.2 *Quality test.* Five test pieces should be subjected to the pressure corresponding to the higher circumferential stress.

Five test pieces should be subjected to the pressure corresponding to the lower circumferential stress.

These stresses are laid down in the particular specification applicable to the pipes under test.

7.7 The requirements of this test have been complied with if, after the period of time given in the particular specification applicable to the pipes under test, no test piece has burst.

7.8 **Retests in case of bursting**

7.8.1 *Acceptance test.* If any one of the five test pieces bursts before the specified period of time has elapsed, the test should be stopped and repeated with a second set of five test pieces taken at random from the batch.

7.8.2 *Quality test.* If any one of the five test pieces in a required test condition bursts before the specified period of time has elapsed, the test should be stopped and repeated with a second set of five test pieces taken at random from the batch.

8. INTERPRETATION OF RESULTS

A batch or a manufacture should be deemed to comply with the requirements

– if no test piece bursts before the specified period of time has elapsed,

or

– if a test piece has burst during the first series of tests, but no bursting occurs during the second set of tests.

If a rupture occurs within a distance of 0.1 L from the clamp, it should be disregarded. Such a failed test piece should be replaced by another test piece.