TECHNICAL REPORT

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Plastics piping systems — Multilayer M (metal) pipes — Test method for strength of the weld line in the metal layer and bonding between layers by use of a cone

Systèmes de tuyauteries en plastiques — Tubes M (métal) multi-couches — Méthode d'essai de la résistance de la ligne de soudure et du collage entre les couches en utilisant un cone

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Foreword

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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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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ISO/TR 18124 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

Introduction

This Technical Report is one of several documents developed by ISO/TC 138/SC 5, following the creation of the Subcommittee's Working Group WG 16 at Kyoto, Japan, in 1998, in response to worldwide demand for specifications, requirements and test methods for multilayer plastics pipes. The other documents include ISO 17454 [1], ISO 17455 [2] and ISO 17456 [3].

Initially, it was intended also to publish this Technical Report, together with ISO 17453, as International Standards. The Working Group then proposed the cancellation of both these projects, for the following reasons:

— because of the great variety of multilayer pipes, no identical forces for different types of multilayer M pipes can be created using the test principle;

— the realised force is very dependent on the tolerances of the pipe — because of the great variation of tolerances (even for the same product), it is extremely difficult to realise the same expansion for different types of multilayer M pipe;

— while the test method can very well be used as a product verification test during production, to give an indication of the quality of the multilayer M pipe product, International Standards are not intended for the setting up of such tests.

ISO/TC 138/SC 5 acknowledged the difficulty of standardization in this area owing to the different thicknesses of the inside layer of various types of multilayer pipes and the fact that the test force is strongly dependent on pipe dimensions and therefore on tolerances, which also vary strongly. Nevertheless, in order not to lose the acquired information, the Subcommittee decided at its 2004 plenary meeting to combine the two committee drafts, ISO/CD 18124 and ISO/CD 17453, into a single Technical Report, ISO/TR 18124.

Only multilayer pipes are dealt with in this Technical Report and for its purposes cross-linked polyethylene (PE-X) as well as adhesives are to be considered as a thermoplastics material.

Plastics piping systems — Multilayer M (metal) pipes — Test method for strength of the weld line in the metal layer and bonding between layers by use of a cone

1 Scope

This Technical Report specifies a method for testing the strength of the weld line in the metal layer and the adhesion between the different layers of multilayer M pipes by the use of a cone.

NOTE 1 Acceptance of any inner layer made from a specific grade of material is subject to the relevant product standard or system standard and the requirements detailed in that standard.

NOTE 2 The test can be used as a product verification test during production to give an indication of the quality of the multilayer M pipe product.

2 Principle

A test piece of specified length, cut from a multilayer M pipe, is subjected to a radial expansion by inserting a cone to verify the strength of the weld line of the metal layer and to assess the bond between the different layers. By visual inspection after withdrawal of the cone, the weld line is inspected for any damage and the test piece for any delamination.

NOTE 1 Acceptance of any inner layer (see definitions) made from a specific grade of material is subject to the relevant product standard or system standard and the requirements detailed in that standard.

NOTE 2 It is assumed that the following test parameters are set by the referring standard or the manufacturer's instructions:

a) for the preparation of the cone,

   1) the dimension d_i of the cone of the test piece, see Figure 1, and

   2) the dimension d_f of the cone, see Figure 1 and 5.1;

b) number of test pieces, see 6.2;

c) preconditioning requirements and test temperature, see Clause 7.

3 Terms, definitions and symbols

For the purpose of this document, the following terms, definitions and symbols apply.

3.1
multilayer pipe
pipe comprising layers of different materials

3.2
multilayer M pipe
pipe comprising layers of polymers and one or more metal layers

NOTE The wall thickness of the pipe consists of at least 60 % of polymeric materials (e.g. PE-X/Al/PEX or PE-RT/Al/PE-X).

3.3
inner layer
layer in contact with the conveyed fluid (liquid or gas)

3.4
outer layer
layer exposed to the outer environment

3.5
embedded layer(s)
layer(s) between the outer and inner layer

4 Symbols

d_i specified inside diameter of the (pipe) test piece

$d_{i,act}$ measured (actual) inside diameter of the (pipe) test piece

d_e specified outside diameter of the (pipe) test piece

$d_{e,act}$ measured (actual) outside diameter of the (pipe) test piece

d_f nominal internal diameter of the test piece after diameter increase for the welding line test (see 5.2)

l length of the test piece

e_n nominal wall thickness

5 Apparatus

5.1 Testing machine, consisting of a clamping devices to hold the test piece, a cone and press–pull device.

5.2 Cone, as shown in Figure 1, whose principal design shall take the following into account:

— the lead in angle, α, shall be 7,5°;

— d_f shall be equal to the maximum tolerable value, taking into account the manufacturer's pipe tolerances, or, unless otherwise specified, shall be at least 1,1 × d_i;

— different tolerance fields.

Dimensions in millimetres

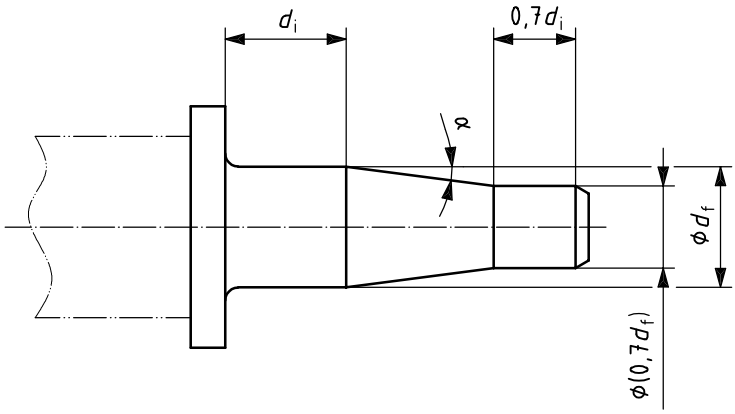

Figure 1 — Cone dimensions

5.3 Clamping devices, capable of holding the test piece and cone in radial and angular alignment during the test.

5.4 Press–pull device, capable of inserting, pressing and pulling the cone centre-lined into the test piece at a specified constant speed.

5.5 If applied forces are requested [see Clause 9, j)], **force measuring device**, capable of measuring the applied force required to insert the cone in the test piece at the specified constant speed, as well as the applied force required to withdraw the cone from the test piece.

6 Test pieces

6.1 Preparation

The test piece shall have a free length of 4d_e, with a minimum of 50 mm.

Test pieces shall be prepared in accordance with the manufacturer's instructions, taking into account the minimum free length.

6.2 Number of test pieces

Unless otherwise specified in the referring standard or specification, three test pieces shall be prepared and tested.

NOTE An additional test piece or pieces can be necessary in the event of slippage during insertion of the cone in the test piece.

7 Preconditioning and test temperature

7.1 Preconditioning shall conform to the referring standard or specification.

7.2 Unless otherwise specified by the referring standard or specification, the test temperature shall be (23 ± 2) °C.

8 Procedure

8.1 Measure and record the dimensions $d_{i,m}$, $d_{e,m}$, e_n and the length l of the test piece.

8.2 Prior to testing, condition the test piece in accordance with the referring standard or specification.

8.3 Clamp the test piece in the clamping device uniformly and sufficiently tightly to prevent any slipping of the test piece.

8.4 Ensure that both the cone and the (pipe) test piece are radial and angularly aligned, and carefully insert the cone into the test piece until it touches the test piece, slightly.

8.5 Ensure that the testing temperature is in accordance with 7.2.

8.6 When necessary, add lubricant inside the test piece and/or on the cone to avoid any force occurring from roughness of the inner layer surface and/or the cone.

8.7 Using the press–pull device, press the cone with a speed of (50 ± 5) mm/min into the test piece until the insertion limit is reached and, if requested, measure during insertion the applied force and record the maximum applied force.

8.8 In the event of any slipping of the test piece or the cone during insertion of the cone, stop and repeat the test with a fresh test piece.

8.9 Withdraw the cone (15 ± 1) min after the insertion limit is reached and, if requested, measure during withdrawal the applied force and record the maximum applied force.

8.10 Remove the test piece from the clamping device.

8.11 Measure and record the internal diameter of the test piece at the mouth of the test piece on the side of the d_f zone.

8.12 Inspect the test piece visually and record any visible damage on the weld line or any place of the metal section.

NOTE 1 Visual inspection can take place at the mouth of the test piece on the side of the d_f part (without cutting the test piece).

NOTE 2 For a complete visual inspection, it is advisable to remove the adjacent layers over a length of d_i (where expansion of d_f has taken place) to expose the welded layer, and inspect the test piece visually for any damage on the weld line or any place of the metal section.

NOTE 3 For visual inspection, additional sectioning in the d_f section of the test piece, to determine whether the bond between the layers has been destroyed, can be required.

9 Test report

The test report shall include the following information:

a) reference to this Technical Report and the referring standard or specification and the manufacturer's information;

b) complete identification of the multilayer pipe component from which the test piece was taken, including manufacturer, material type, code number, size, source and significant history, if any;

c) the dimensions of the pipes used for the testing;

d) the test conditions;

e) number of test pieces;

f) observations of any damage and any delamination and their location;

g) location and type of failures (ductile of brittle cracks) relative to the weld line, if any;

h) the dimension d_f of the cone;

i) the internal diameter of the test piece at the mouth of the test piece on the side of the d_f zone after the test;

j) if requested, the average of the forces applied to insert the cone and the average of the forces to withdraw the cone from the test piece;

k) any factors which could have affected the results, such as incidents, or any operation details not mentioned in this Technical Report;

l) date of the test.

Bibliography

[1] ISO 17454:2006, *Plastics piping systems — Multilayer pipes — Test method for the adhesion of the different layers using a pulling rig*

[2] ISO 17455:2005, *Plastics piping systems — Multilayer pipes — Determination of the oxygen permeability of the barrier pipe*

[3] ISO 17456:2005, *Plastics piping systems — Multilayer pipes — Determination of long-term strength*

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