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Plastics piping systems — Multilayer pipes — Determination of the oxygen permeability of the barrier pipe

Systèmes de canalisations en plastiques — Tubes multicouches — Détermination de la perméabilité à l'oxygène de la couche barrière d'un tube

Reference number
ISO 17455:2005(E)

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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.

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 17455 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

In response to the worldwide demand for specifications, requirements and test methods for multilayer pipes, WG 16 of ISO/TC 138/SC 5 was created at a meeting held in Kyoto, Japan, in 1998. The working group then started drafting three test standards (including ISO 17455) for multilayer pipes:

— ISO 17456, *Plastics piping systems — Multilayer pipes — Determination of long-term strength*;

— ISO 17454, *Plastics piping systems — Multilayer pipes — Test method for the adhesion of the different layers by using a pulling rig*.

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

Plastics piping systems — Multilayer pipes — Determination of the oxygen permeability of the barrier pipe

1 Scope

This International Standard specifies two test methods for determining the oxygen permeability of barrier pipe: the dynamic (Method I) and the static (Method II). In principle, both methods give the same results. The method to be applied is not application-dependent, but can be specified in the referring standard.

2 Principle

The principle is measurement of the oxygen transfer through the wall of the test piece under specified conditions.

The oxygen increase is measured in a system of which the test piece forms part. Oxygen can only be transported through the wall of the test piece. Therefore, the increased amount of oxygen in the closed system is the result of the functioning of the barrier layer of the test piece.

NOTE A certain continuous oxygen permeation through the barrier layer is allowed.

3 Terms and definitions

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

3.1
multilayer pipe
pipe comprising layers of different materials

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

NOTE The wall thickness of the pipe consists of at least 60 % polymer layers.

3.3
multilayer P pipe
multilayer pipe comprised of two or more polymer layers

3.4
inner layer
layer in contact with the liquid or gas

3.5
outer layer
layer exposed to the outer environment

3.6
embedded layer
layer between the outer and inner layer

NOTE There can be more than one embedded layer.

3.7
barrier layer
layer intended to prevent or greatly diminish oxygen transport from outside the pipe into the inside water

NOTE For multilayer P pipes, the barrier layer is normally not stress-designed.

3.8
closed system
system which comprises stainless steel pipes, couplings and a tap, as well as the test piece, allowing only oxygen to permeate from the outside to the inside of the test piece

3.9
flux
oxygen permeability of the barrier layer of the pipe

4 Symbols and abbreviated terms

A_{barr} outside surface of the barrier layer, in square metres (m^2)

$C_{ox,\,t}$ oxygen concentration after time , in grams per cubic metre (g/m^3)

F_{ox} flux expressed in oxygen transfer per unit per area (of the barrier layer),in grams per square metre per hour ($g/m^2 \cdot h$)

T test temperature (40°C or 80°C), expressed in degrees Centigrade

V_{app} volume of the closed system, excluding the volume of the test piece, in cubic metres (m^3)

V_{pipe} volume of the test piece (pipe sample), in cubic metres (m^3)

d_b outside diameter of the barrier layer, millimetres (mm)

d_e manufacturer's nominal outside diameter, expressed in millimetres (mm)

d_i inside diameter of the test piece (pipe), in millimetres (mm)

l length of the test piece, in metres (m)

P_a standard atmospheric pressure (1 000 mbar at 20°C), expressed in bar[1)]

P_{fin} atmospheric pressure at the end of the measurement, expressed in bar

P_{init} atmospheric pressure at the start of the measurement, expressed in bar

t test period, in hours (h)

β_{pr} dimensionless correction factor to atmospheric pressure

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

$\int_0^6 O_{2,\text{fin}}$ total amount of oxygen after six hours, in grams (g)

$\int_0^{6=0} O_{H_2O,\text{init}}$ total amount of oxygen in the water at the start of the test, in grams (g)

5 Apparatus

The test assembly shall include the following main elements:

NOTE 1 The test temperature (40°C or 80°C) is specified in the relevant product- or system standard.

NOTE 2 1 ppb = 1 g/m^3.

5.1 Oven, capable of maintaining a constant temperature of (40 ± 0,5) °C and/or (80 ± 0,5) °C.

5.2 Test rig, a closed system consisting of stainless steel parts of pipes, couplings, valves (only for Method II) and taps, including the test piece.

5.3 Water circulation pump, capable of a variable delivery with a capacity range of from 0,15 dm^3/min to 0,5 dm^3/min.

5.4 Oxygen sensor, Capable of functioning at (40 ± 0,5) °C and/or (80 ± 0,5) °C, with a range of from 0,1 ppb to 20 ppm[2)].

5.5 Water pressure meter, with a range of (1 ± 0,1) to (4 ± 0,1) bar.

5.6 Atmospheric pressure meter, with a range of from (965 ± 1) mbar to (1035 ± 1) mbar.

5.7 Water flow meter, with a range of from (0,15 ± 0,05) dm^3/min to (0,5 ± 0,05) dm^3/min.

5.8 Water temperature meter, capable of functioning at (40 ± 0,05) °C and/or (80 ± 0,05) °C.

5.9 Air temperature meter, capable of functioning at (40 ± 0,05) °C and/or (80 ± 0,05) °C.

5.10 Airtight vessel, for preparation of water with an oxygen concentration of $<$ 10 ppb (nominally oxygen-free)

NOTE 3 Normally, sink plates or nitrogen are used to remove the oxygen from the water by purging.

5.11 Test medium, deionized water with PH 7 (demi/water).

5.12 Registration device, capable of registering (graphical writer or computer) oxygen concentration as a function of time.

2) "Parts per billion (ppb)" and "parts per million (ppm)" are used exceptionally in this International Standard in order to correspond to other, closely related and already published standards. The accepted SI form for the expression of a volume fraction is in units of microlitres per litre (µl/l), or, alternatively, as 10^{-6}, or as a percentage by volume (% by volume); for mass fractions it is expressed in micrograms per gram (µg/g). See ISO 31-0:1992, 2.3.3, and ISO 31-8-15:1992.

