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EAST AFRICAN STANDARD

Plastics piping systems for water supply — Polyethylene (PE) — Part 1: General

EAST AFRICAN COMMUNITY

First Edition 2010

Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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Introduction

In the preparation of this East African Standard, the following source was consulted extensively:

ISO 4427-1:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 1: General*

Assistance derived from this source and others inadvertently not mentioned is hereby acknowledged.

INTERNATIONAL STANDARD

ISO 4427-1

First edition
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Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply —

Part 1:
General

Systèmes de canalisations en plastique — Tubes et raccords en polyéthylène (PE) destinés à l'alimentation en eau —

Partie 1: Généralités

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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.

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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 4427-1 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

This first edition, together with ISO 4427-2, cancels and replaces ISO 4427:1996, of which it constitutes a technical revision.

ISO 4427 consists of the following parts, under the general title *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 5: Fitness for purpose of the system*

Introduction

ISO 4427, the system standard, specifies the requirements for a piping system and its components when made from polyethylene (PE). The piping system is intended to be used for water supply intended for human consumption, including the conveyance of raw water prior to treatment and that of water for general purposes.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the products covered by ISO 4427:

a) ISO 4427 provides no information as to whether the products may be used without restriction;

b) existing national regulations concerning the use and/or the characteristics of these products are in force.

NOTE Guidance for assessment of conformity can be found in Bibliographical references [9] and [10].

Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply —

Part 1: General

1 Scope

This part of ISO 4427 specifies the general aspects of polyethylene (PE) piping systems (mains and service pipes) intended for the conveyance of water for human consumption, including raw water prior to treatment and water for general purposes.

It also specifies the test parameters for the test methods to which it refers.

In conjunction with the other parts of ISO 4427, it is applicable to PE pipes, fittings, their joints and to mechanical joints with components of other materials, intended to be used under the following conditions:

a) a maximum operating pressure (MOP) up to and including 25 bar[1)];

b) an operating temperature of 20 °C as the reference temperature.

NOTE 1 For applications operating at constant temperatures greater than 20 °C and up to 40 °C, see Annex A.

NOTE 2 ISO 4427 covers a range of maximum operating pressures and gives requirements concerning colours and additives. It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national guidance or regulations and installation practices or codes.

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 3:1973, *Preferred numbers — Series of preferred numbers*

ISO 472, *Plastics — Vocabulary*

ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

ISO 1133:2005, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

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

ISO 1167-1, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 4065:1996, *Thermoplastics pipes — Universal wall thickness table*

ISO 4427-2:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 2: Pipes*

ISO 4427-3:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 3: Fittings*

ISO 4427-5:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 5: Fitness for purpose of the system*

ISO 6259-1:1997, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method*

ISO 6259-3:1997, *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes*

ISO 6964:1986, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method and basic specification*

ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

ISO 11357-6:2002, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time*

ISO 11414, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion*

ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient*

ISO 13479:1997, *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes (notch test)*

ISO 13761:1996, *Plastics pipes and fittings — Pressure reduction factors for polyethylene pipeline systems for use at temperatures above 20 °C*

ISO 13953:2001, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 16871, *Plastics piping and ducting systems — Plastics pipes and fittings — Method for exposure to direct (natural) weathering*

ISO 18553, *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

EN 12099, *Plastics piping systems — Polyethylene piping materials and components — Determination of volatile content*

ISO 15512, *Plastics — Determination of water content*

Guidelines for drinking water quality, Volume 1: Recommendations, WHO, Geneva, 1984

EC Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, *Official Journal of the European Communities*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3, ISO 472 and ISO 1043-1, and the following, apply.

3.1.1 Geometrical characteristics

3.1.1.1
nominal size
DN
numerical designation of the size of a component, other than a component designated by a thread size, which is a convenient round number approximately equal to the manufacturing dimension in millimetres (mm)

3.1.1.2
nominal size
DN/OD
nominal size, related to the outside diameter

3.1.1.3
nominal outside diameter
d_n
specified outside diameter, in millimetres, assigned to a nominal size DN/OD

3.1.1.4
outside diameter at any point
d_e
value of the measurement of the outside diameter through its cross-section at any point of the pipe rounded to the next greater 0,1 mm

3.1.1.5
mean outside diameter
d_{em}
value of the measurement of the outer circumference of the pipe or spigot end of a fitting in any cross-section divided by π (= 3,142), rounded to the next greater 0,1 mm

3.1.1.6
minimum mean outside diameter
$d_{em\,min}$
minimum value of the outside diameter as specified for a given nominal size

3.1.1.7
maximum mean outside diameter
$d_{em\,max}$
maximum value of the outside diameter as specified for a given nominal size

3.1.1.8
out-of-roundness
ovality
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-section of the pipe or spigot end of a fitting

3.1.1.9
nominal wall thickness
e_n
numerical designation of the wall thickness of a component, which is a convenient round number approximately equal to the manufacturing dimension in millimetres

3.1.1.10
wall thickness at any point
e
value of the measurement of the wall thickness at any point around the circumference of a component

3.1.1.11
minimum wall thickness at any point
e_{min}
minimum value of the wall thickness at any point around the circumference of a component as specified

3.1.1.12
maximum wall thickness at any point
e_{max}
maximum value of the wall thickness at any point around the circumference of a component as specified

3.1.1.13
mean wall thickness
e_m
arithmetic mean of a number of measurements regularly spaced around the circumference of the component in the same cross-section of the component, including the measured minimum and the measured maximum values of the wall thickness

3.1.1.14
pipe series
S
dimensionless number for pipe designation conforming to ISO 4065

NOTE The relationship between the pipe series, S, and the standard dimension ratio, SDR, is given by the following equation from ISO 4065:

$$S = \frac{SDR - 1}{2}$$

3.1.1.15
standard dimension ratio
SDR
ratio of the nominal outside diameter, d_n, of a pipe to its nominal wall thickness, e_n

3.1.1.16
tolerance
permissible variation of the specified value of a quantity expressed as the difference between the permissible maximum and permissible minimum values

3.1.2 Related to service conditions

3.1.2.1
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of the component of a piping system

NOTE For plastic piping systems conveying water, it corresponds to the maximum continuous operating pressure, expressed in bar, which can be sustained with water at 20 °C, based on the minimum design coefficient.

3.1.2.2
maximum operating pressure
MOP
maximum effective pressure of the fluid in the piping system, expressed in bar, which is allowed in continuous use

It takes into account the physical and the mechanical characteristics of the components of a piping system

NOTE It is calculated using the following equation:

$$\text{MOP} = \frac{20\,(\text{MRS})}{C \times \left[(\text{SDR}) - 1\right]}$$

3.1.2.3
allowable operating pressure
PFA
maximum hydrostatic pressure that a component is capable of withstanding continuously in service

3.1.3 Related to material characteristics

3.1.3.1
lower confidence limit of the predicted hydrostatic strength at 20 °C for 50 years
σ_{LPL}
quantity, with the dimensions of stress expressed in megapascals, which can be considered as a property of the material, and which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at 20 °C for 50 years with internal water pressure

3.1.3.2
minimum required strength
MRS
value of σ_{LPL} rounded down to the next smaller value of the R10 series or R20 series, depending on the value of σ_{LPL}

NOTE R10 and R20 series are the Renard number series according to ISO 3 and ISO 497.

3.1.3.3
design stress
σ_{S}
allowable stress, expressed in megapascals, for a given application derived by dividing MRS by the coefficient C and rounding to the next lower value in the R20 series

NOTE It is expressed as

$$\sigma_{\text{S}} = \frac{\text{MRS}}{C}$$

3.1.3.4
overall service (design) coefficient
C
overall coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit

3.1.3.5
melt mass-flow rate
MFR
value relating to the viscosity of the molten material at a specified temperature and load measured in accordance with ISO 1133

3.2 Symbols

C	overall service (design) coefficient
d_{em}	mean outside diameter
$d_{em\ min}$	minimum mean outside diameter
$d_{em\ max}$	maximum mean outside diameter
d_e	outside diameter at any point
d_n	nominal outside diameter
E	wall thickness at any point of a fitting or valve body
e	wall thickness (at any point)
e_m	mean wall thickness
e_{max}	maximum wall thickness (at any point)
e_{min}	minimum wall thickness (at any point)
e_n	nominal wall thickness
σ_{LPL}	lower confidence limit at 20 °C for 50 years
σ_s	design stress

NOTE Symbols d_e, e, e_{min} and e_{max} in ISO 4427 are equivalent to d_{ey}, e_y, $e_{y,min}$ and $e_{y,max}$, respectively, used in ISO 11922-1.

3.3 Abbreviated terms

DN/OD	nominal size, outside-diameter-related
MFR	melt mass-flow rate
MRS	minimum required strength
OIT	oxidation induction time
PE	polyethylene

PFA allowable operating pressure

PN nominal pressure

S pipe series

SDR standard dimension ratio

4 Material

4.1 Compound

The compound from which the products are produced shall be made by adding to the polyethylene base polymer only those additives necessary for the manufacture and end use of the products, in accordance with the applicable parts of ISO 4427.

All additives shall be uniformly dispersed.

NOTE Components manufactured from PE 32 materials are not covered by ISO 4427.

4.2 Colour

4.2.1 General

The colour of the compound shall be either blue or black.

Other colours and non-pigmented compounds are permitted for coated pipe, provided the outer coating layer material is either blue or black (see ISO 4427-2:2007, Annex B).

4.2.2 Black compound

The carbon black used in the production of black compound shall have an average (primary) particle size of 10 nm to 25 nm.

4.3 Use of reprocessable and recyclable material

Clean, reprocessable material generated from a manufacturer's own production and works testing of products according to ISO 4427 may be used if it is derived from the same compound as used for the relevant production. Reprocessable material obtained from external sources and recyclable material shall not be used.

4.4 Physical characteristics of the compound

The compound used for the manufacture of pipes, fittings and valves shall be in accordance with Table 1 as granules and Table 2 in the form of pipe.

NOTE Information on resistance to rapid crack propagation is given in Annex B.

Table 1 — Characteristics of PE compound as granules

Characteristic	Requirement [a]	Test parameters: Parameter	Test parameters: Value	Test method
Compound density	⩾ 930 kg/m^3	Test temperature	23 °C	ISO 1183-2
		Number of samples	According to ISO 1183-2	
Carbon black content (black compound only)	(2 to 2,5) % by mass	In accordance with ISO 6964		ISO 6964
Carbon black dispersion (black compound only)	⩽ grade 3	In accordance with ISO 18553 [c]		ISO 18553
Pigment dispersion (blue compound only)	⩽ grade 3	In accordance with ISO 18553 [c]		ISO 18553
Water content [d]	⩽ 300 mg/kg	Number of test pieces [b]	1	ISO 15512
Volatile content	⩽ 350 mg/kg	Number of test pieces [b]	1	EN 12099
Oxidation induction time	⩾ 20 min	Test temperature	200 °C [e]	ISO 11357-6
		Number of test pieces [b]	3	
Melt mass-flow rate (MFR) for PE 40	0,2 to 1,4 g/10 min Maximum deviation of ± 20 % of the nominated value [f]	Load	2,16 kg	ISO 1133:2005, Condition D
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces [b]	According to ISO 1133	
Melt mass-flow rate (MFR) for PE 63, PE 80 and PE 100	0,2 to 1,4 g/10 min Maximum deviation of ± 20 % of the nominated value [f]	Load	5 kg	ISO 1133:2005, Condition T
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces [b]	According to ISO 1133	

[a] Conformity to these requirements shall be proved by the compound manufacturer.

[b] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan.

[c] In case of dispute, the test pieces for carbon black dispersion and pigment dispersion shall be prepared by the compression method.

[d] Only applicable if the measured volatile content is not in conformity with its specified requirement. In case of dispute, the requirement for water content shall apply. The requirement applies to the compound producer at the stage of compound manufacturing and to the compound user at the stage of processing (if the water content exceeds the limit, drying is required prior to use).

[e] The test may be carried out as an indirect test at 210 °C provided there is a clear correlation to the results at 200 °C. In case of dispute, the test temperature shall be 200 °C.

[f] Nominated value given by the compound producer.

Table 2 — Characteristics of the PE compound in pipe form

Characteristic	Requirement [a]	Test parameters: Parameter	Test parameters: Value	Test method
Tensile strength for butt-fusion [b]	Test to failure: Ductile — Pass; Brittle — Fail	Pipe diameter	110 mm	ISO 13953
		Pipe diameter ratio	SDR 11	
		Test temperature	23 °C	
		Number of test pieces [c]	According to ISO 13953	
Slow crack growth pipe size 110 mm or 125 mm SDR 11	No failure during test period	Test temperature	80 °C	ISO 13479
		Internal test pressure for:		
		PE 63	6,4 bar	
		PE 80	8,0 bar	
		PE 100	9,2 bar	
		Test period	500 h	
		Type of test	Water in water	
		Number of test pieces [c]	According to ISO 13479	
Effect on water quality	According to existing national regulations			
Resistance to weathering [e]	Weathered test pieces shall have:	Cumulative solar radiation	$\geqslant$ 3,5 GJ/m^2 [d]	ISO 16871
a) Decohesion of electrofusion joint	Percentage of brittle failure: $\leqslant$ 33,3 %	Temperature	23 °C	ISO 13954
		Assembly procedure	[f]	
b) Elongation at break	According to ISO 4427-2:2007, Table 5			ISO 6259-1 ISO 6259-3
c) Hydrostatic strength at 80 °C	According to ISO 4427-2:2007, Table 3			ISO 1167-1

NOTE 1 bar = 0,1 MPa = 105 Pa; 1 MPa = 1 N/mm^2.

[a] Conformity to these requirements shall be proven by the compound manufacturer.

[b] Preparation of samples in accordance with ISO 11414, normal conditions at 23 °C.

[c] The number of test pieces given indicate the quantity required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan.

[d] The value of 3,5 GJ/m^2 represents the yearly exposure to sunlight near the 50th degree of latitude. This value may be adapted in national standards and regulations.

[e] Blue compounds only.

[f] To be decided.

4.5 Fusion compatibility

The following applies:

a) the compound manufacturer shall demonstrate that each compound conforming to Table 1 is fusible by testing the tensile strength of a butt fusion joint of pipes manufactured from the compound in accordance with Table 2;

b) compounds conforming to Table 1 are considered fusible to each other, and on request this shall be demonstrated by the compound manufacturer on compounds from his own product range by the testing of a butt fusion joint for tensile strength in accordance with Table 2.

4.6 Classification and designation

Compounds shall be designated by the material type (PE) and the level of minimum required strength (MRS), in accordance with Table 3.

The compound shall have a MRS equal to the values specified in Table 3. The MRS value and compound classification shall be derived from the σ_{LPL} in accordance with ISO 12162. The σ_{LPL} shall be determined by analysis, in accordance with ISO 9080, of hydrostatic pressure tests carried out in accordance with ISO 1167-1.

In the determination of the long-term hydrostatic strength of PE 100 materials in accordance with ISO 9080, the detection of a knee on the 80 °C extrapolation curve before 5 000 h is unacceptable.

The classification of the compound in accordance with ISO 9080 shall be certified by the compound producer.

NOTE Where fittings are manufactured from the same compound as the pipe, then the material classification will be the same as for the pipe.

When a compound is intended only to be used for the manufacture of fittings, the compound shall be classified using test pieces prepared in accordance with ISO 1167-2.

Table 3 — Material designation and corresponding maximum design stress values

Designation	**Minimum required strength (MRS)** MPa	σ_s MPa
PE 100	10,0	8,0
PE 80	8,0	6,3
PE 63	6,3	5,0
PE 40	4,0	3,2
Design stress, σ_s, is derived from the MRS by application of the overall service (design) coefficient, $C = 1{,}25$.		
NOTE A higher value for C can be used; for example, if $C = 1{,}6$, this gives a design stress of 5,0 MPa for PE 80 materials. A higher value for C can also be obtained by choosing a higher PN class.		

5 Effect on water quality of pipes intended for conveyance of water for human consumption

When used under the conditions for which they are designed, materials in contact with, or likely to come into contact with, drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to an unpleasant taste or odour, to cloudiness or to discoloration of the water.

The concentrates of substances, chemicals and biological agents leached from materials in contact with drinking water, and measurements of the relevant organoleptic/physical parameters, shall not exceed the maximum values recommended by the World Health Organization (WHO) or as required by EC Council Directive 98/83/EC, whichever is the more stringent in each case.

Attention is also drawn to the requirements of national regulations (see also the Introduction).

Annex A
(informative)

Pressure reduction coefficients

When a PE piping system is to be operated at a continuous constant temperature higher than 20 °C and up to 40 °C, a pressure reduction coefficient as given in Table A.1 may be applicable for PE 80 and PE 100. For coefficients for PE 40 and PE 63, refer to ISO 13761.

Table A.1 — Pressure reduction coefficients for PE 80 and PE 100

Temperature [a, b] °C	**Coefficient**
20	1,00
30	0,87
40	0,74

NOTE Unless analysis according to ISO 9080 demonstrates that less reduction is applicable, in which case higher factors and hence higher pressures may be applied.

[a] For other temperatures between each step, interpolation is permitted (see also ISO 13761).

[b] For higher temperatures, consult the compound manufacturer.

NOTE The allowable operating pressure (PFA) is derived from the following equation:

$$\text{PFA} = f_T \times f_A \times \text{PN}$$

where

f_T is the coefficient according to Table A.1;

f_A is the derating factor (or uprating factor) related to the application (for the conveyance of water $f_A = 1$);

PN is the nominal pressure.

Annex B
(informative)

Resistance to rapid crack propagation

B.1 General

Rapid crack propagation (RCP) is the generation of a low ductility crack running at high speed (approximately 300 m/s) along a pressurized pipeline. Propagation or arrest of the crack is dependent on the strain energy at the crack tip, which is influenced by the internal pressure of the fluid, which is in turn affected by the rate at which the fluid decompresses.

If a fracture occurs in a water pipeline, the fluid is not subject to the same compression and energy release as that of a pipeline containing air or a gas. Therefore, propagation of a fast-running crack is much less likely to occur in a water pipe. Indeed, full-scale (FS) and S4 RCP tests on water pipes have shown that propagation does not occur when the pipe is completely filled [6]. However, tests on large-diameter pipe containing both water and air at low temperature (< 3 °C) have shown that the crack can propagate along the top of the pipe within the air pocket, but that higher pressures are required to sustain this propagation than those of air alone [6], [7]. The pressure to sustain propagation increases as the entrapped volume of air is decreased, hence minimizing the volume of entrapped air reduces the risk. Thus it is concluded that the risk of this phenomenon occurring in a water pipe is extremely low and requires certain coincident conditions, i.e. initiation of a fast-running crack at the location of an air pocket in a large-diameter pipe operated at high pressure and in low-temperature conditions.

In the development of European standards for polyethylene water pipe, [8], [9], it has been concluded that RCP only needs to be taken into account for pipe of wall thickness > 32 mm. Testing has shown that most modern-day pipe compounds are resistant to RCP and have high resistance to slow crack growth, considerably reducing the risk of initiation. Conditions and examples of requirements can be found in References [8] and [9].

B.2 Initiation

The initiation of RCP could be the result of impact damage, the growth of a crack through the wall or a crack developing from a poor fusion weld in certain coincident operating and environmental conditions.

The phenomenon of RCP has been reported in pipelines of different materials, including steel and, in a few examples, plastics pipeline systems.

B.3 Parameters governing propagation/arrest

The parameters that govern RCP if a crack is initiated are

a) internal pressure,

b) pipeline temperature,

c) rate of decompression of the conveyed fluid (see B.1), and

d) fracture toughness of the pipe material.

B.4 Test methods

The susceptibility of pipes in a particular material to RCP increases with increasing pipe diameter and wall thickness. It is assessed experimentally in order to allow the system to be designed to eliminate the risk. Standardized test methods have been published for PE pipes: the ISO 13477 S4 test and the ISO 13478 FS test.

These tests require extreme conditions to initiate fast-running cracks, i.e. creating sharp notches in test pipe and impacting with a sharp blade, and, in the case of the full-scale test, cooling of the initiation pipe to −70 °C.

Bibliography

[1] ISO 497:1973, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

[2] ISO 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

[3] ISO 13477, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-state test (S4 test)*

[4] ISO 13478, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full-scale test (FST)*

[5] GREIG, M., *Rapid crack propagation in hydrostatically pressurized polyethylene pipe,* Plastics and Rubber Institute Plastics Pipes VII Conference, September 1988

[6] GREENSHIELDS, C.J., *Fast brittle fracture of plastics pipes — Part 1: Water pressurised, plastics, rubber and composites processing and applications*, 1997, Vol. 26, No. 9, p. 387

[7] EN 12201-1, *Plastics piping systems for water supply — Polyethylene (PE) — Part 1: General*

[8] EN 13244-1, *Plastics piping systems for buried and above ground pressure systems for water for general purposes, drainage and sewerage – Polyethylene (PE) — Part 1: General*

[9] CEN/TS 12201-7, *Plastics piping systems for water supply — Polyethylene (PE) — Part 7: Guidance for the assessment of conformity*

[10] CEN/TS 13244-7, *Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage — Polyethylene (PE) — Part 7: Guidance for the assessment of conformity*

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