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Plastics pipes and fittings — Reinforced thermoplastics pipe systems for the supply of gaseous fuels for pressures up to 4 MPa (40 bar)

Tubes et raccords en matières plastiques — Systèmes de canalisations en matière thermoplastique renforcée pour la distribution de combustibles gazeux à des pressions allant jusqu'à 4 MPa (40 bar)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 18226 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

Introduction

A reinforced thermoplastics pipe (RTP) comprises a thermoplastics liner with continuous reinforcement and a thermoplastics outer cover. An RTP “system” comprises runs of RTP, along with the fittings required to connect them to each other and to the other components of a conventional gas transmission system.

This Technical Specification is applicable for operating pressures up to 4 MPa (40 bar). However it may be used for guidance in the development of RTP systems for higher operating pressures. It is intended to accommodate the upgrading of the performance of RTPs and to provide a framework within which future development can take place.

RTP can be used in both new pipe systems and in the replacement of corroded metallic pipes.

The principal load-bearing components of the RTP are high-strength reinforcing members in the form of fibres, yarns, tapes or wire, which generally carry load only in tension. The reinforcing element may take the form of helically-wound yarns or fibre-reinforced tapes, in which the matrix may be a thermoplastics resin.

In the most frequently employed configuration of reinforcement, dry (non-impregnated) aramid-fibre yarns are encapsulated in a tape of polymer resin or adhesive. It is also possible to employ other classes of reinforcement, such as glass, carbon or textile fibres, or metallic wire or strip.

The reinforcement may or may not be bonded to the liner or to the outer cover.

Several types of fitting design are possible, with joints made by mechanical means, electrofusion or other methods of bonding or welding.

Plastics pipes and fittings — Reinforced thermoplastics pipe systems for the supply of gaseous fuels for pressures up to 4 MPa (40 bar)

1 Scope

This Technical Specification describes the use of reinforced thermoplastics pipe (RTP) systems for transmission of gaseous fuels at maximum operating pressures up to and including 4 MPa (40 bar)[1)], and service temperatures in the region – 50 °C to 120 °C, depending on the liner and cover materials.

This Technical Specification relates to transmission systems in which wear and damage to the liner are restricted by limiting pigging operations to soft pigging only.

The recommendations in this Technical Specification are confined to RTP and its associated in-line fittings and end-fittings. Where the other system components (elbows, tees, valves, etc.) are of conventional construction, they will be governed by existing standards and codes of practice.

This Technical Specification specifies a qualification testing procedure for RTP systems. It also provides a procedure for reconfirmation of the design basis that may be used for product variants where changes have been made in design, materials or the manufacturing process.

This Technical Specification provides informative annexes relating to quality assurance, product marking, handling and storage.

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 4433-1:1997, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 1: Immersion test method*

ISO 4433-2:1997, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 2: Polyolefin pipes*

ISO 4433-3:1997, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 3: Unplasticized poly(vinyl chloride) (PVC-U), high-impact poly(vinyl chloride) (PVC-HI) and chlorinated poly (vinyl chloride) (PVC-C) pipes*

ISO 4433-4:1997, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 4: Poly (vinylidene fluoride) (PVDF) pipes*

ISO 4437, *Burried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications*

1) 1 bar = 0,1 MPa = 10^5 Pa.

ISO 9080:2003, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

ISO 12162:1995, *Thermoplastics materials for pipes and fittings for pressure applications — Clarification and designation — Overall service (design) coefficient*

ISO 12176-1:1998, *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 1: Butt fusion*

ISO 14531-1, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 1: Pipes*

ISO 14531-2, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 2: Fittings for heat-fusion jointing*

ISO 14531-3, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)*

ISO 14531-4, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 4: System design and installation guidelines*

ASTM D2992-01, *Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings*

3 Terms, definitions and abbreviations

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

3.1 General terms and definitions

3.1.1
aramid
class of high-strength organic fibre "aromatic amide"

EXAMPLES Twaron[2)], Kevlar[2)].

3.1.2
application-related service factor(s)
multiplication factor(s) applied to the manufacturer's nominal pressure rating, to allow for effects such as cyclicity

3.1.3
ballooning
inflation of the cover of an RTP, by pressurised gas, that has accumulated in the reinforcing layer

3.1.4
blistering
damage in polymer materials caused by the release of absorbed gas on sudden decompression

3.1.5
carbon fibre
class of high-strength graphite-based reinforcing fibre

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2) Twaron and Kevlar are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

3.1.6
cyclic
fatigue
service conditions where the internal pressure fluctuates

3.1.7
dynamic
service condition involving external time-dependent loads

3.1.8
elevated temperature test
constant-pressure survival test aimed at verifying that no undesirable failure mode can occur between the end of the qualification test period and the end of the design life

3.1.9
end-fitting
joint that occurs at either end of a run of RTP, where it is connected to other parts of the system

3.1.10
fitting
coupler
pipe joint

3.1.11
glass fibre
high-strength inorganic reinforcement based on E-glass or S-glass

3.1.12
in-line fitting
pipe joint between adjacent lengths of RTP

3.1.13
lower prediction limit
97,5 % lower prediction limit of the mean regression curve

3.1.14
minimum required strength
lower prediction limit at 20°C in a thermoplastics pipe at 50 years in accordance with ISO 9080:2003, rounded down in accordance with ISO 12162:1995

3.1.15
Principal
party that initiates and pays for a project, or his agent

NOTE The Principal will generally specify the technical requirements of a project.

3.1.16
principal mode
only failure mode that shall be permitted in the pressure testing of RTP

3.1.17
product family
group of RTP products having certain similarity characteristics

3.1.18
product-family representative
member of a product family, chosen for full qualification

3.1.19
product variability factor
factor, allowing for product variability, applied to the Lower Prediction Limit (LPL) pressure, to give the Manufacturer's Nominal Pressure Rating (MNPR)

3.1.20
product variant
member of the same product family, to which certain permissible changes have been made

3.1.21
rapid crack propagation
undesirable fracture mode, in which a crack propagates along a pipeline at very high speed

3.1.22
regression analysis
statistical procedure to establish a design rating from pressure test results carried out over a period of 104 h (or a number of pressure cycles)

3.1.23
safety class
classification associated with a particular probability of failure

3.1.24
stress rupture
static fatigue
failure, as a result of a period under steady stress or pressure

3.1.25
survival test
constant-pressure test, to demonstrate that a product performs at least as well as the qualified product

3.2 Temperature- and pressure-related definitions

3.2.1
design temperature
maximum operating temperature of the RTP system

3.2.2
FAT pressure
Factory Acceptance Test pressure

3.2.3
LPL pressure
pressure obtained by extrapolating the LPL to the design life

3.2.4
long-term hydrostatic pressure
pressure obtained by extrapolating the mean regression curve to the design life

3.2.5
manufacturer's nominal pressure rating
pressure obtained by multiplying the LPL pressure by the product variability factor

3.2.6
maximum service pressure
pressure obtained by multiplying the manufacturer's nominal pressure rating by application-related service factors

3.2.7
maximum operating temperature
maximum temperature to which the piping is expected to be exposed during normal operational activities, including start-up and shut-down operations, but excluding abnormal situations such as a fire

3.2.8
minimum operating temperature
minimum temperature to which the piping is expected to be exposed during normal operational activities, including start-up and shut-down operations and controlled blow-out, but excluding abnormal situations such as piping rupture

3.2.9
qualification test temperature
temperature at which pressure tests are carried out to establish the lower prediction limit

NOTE The design temperature shall not exceed this temperature.

3.2.10
short-term hydrostatic pressure
pressure corresponding to the LPL pressure at a prescribed time of 100 h or less

3.2.11
short-term burst pressure
burst pressure measured in a short-term test, where pressure is increased at a prescribed rate at Standard Laboratory Temperature (SLT)

3.2.12
standard laboratory temperature
temperature of 23 °C ± 2 °C

3.2.13
survival test pressure
pressure for a 1 000 h survival test

NOTE This is the pressure of the LPL line at 1 000 h.

3.3 Abbreviations

ASTM American Society for Testing and Materials

API American Petroleum Institute

BS British Standard

CEN Comité Européen de Normalisation

COV Coefficient of Variation

DVS German Standard

EN European Standard

ESC Environment-Sensitive Cracking

FAT Factory Acceptance Test

F Regression relationship constant

G Regression line gradient

IGE Institution of Gas Engineers

ISO International Standard Organization

LPL Lower Prediction Limit

LTHP Long-Term Hydrostatic Pressure

MNPR Manufacturer's Nominal Pressure Rating

MRS Minimum Required Strength

MSP Maximum Service Pressure

PA11 Polyamide 11 (Trade name Rilsan[3])

PE Polyethylene

PE-X Cross-linked polyethylene (also referred to as XLPE)

PM Principal Mode of failure

PVDF Polyvinylidene fluoride

PVF Product Variability Factor

QA Quality Assurance

RCP Rapid Crack Propagation

RTP Reinforced Thermoplastic Pipe

SLT Standard Laboratory Temperature

STBP Short-Term Burst Pressure

STHP Short-Term Hydrostatic Pressure

UV Ultraviolet

WIS Water Industry Specification

4 Performance requirements

4.1 Materials

4.1.1 Liner materials

Liner materials shall conform to an appropriate Standard for gas applications (i.e. ISO 4437 and EN 1555 in the case of polyethylene, and ISO 14531 for PE-X). For polyethylene and PE-X liners, the MRS shall be at least 8 MPa.

3) Rilsan is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Other thermoplastics materials (for example, PVDF and PA11) may be used, provided they conform to the material requirement of a relevant ISO pipe standard and that fitness for the purpose has been established. In all cases, materials shall be evaluated and classified in accordance with ISO 12162:1995 (see Annex E, E.2).

The liner shall possess RCP resistance at a stress equal to a minimum of 1,5 times the stress induced at the MSP and minimum operating temperature (see E.3.2).

The liner material shall have adequate resistance to blistering. A suitable procedure is described in API Spec 17J, Section 6.2.3.2.

4.1.2 Cover materials

Cover materials shall conform to the material requirements of a relevant ISO pipe standard, for example ISO 4437 or ISO 14531, and fitness for the purpose shall be established.

In the case of pipes that may be exposed to sunlight during storage or service the manufacturer shall demonstrate that the cover possesses adequate resistance to UV and to UV-transmissions when the reinforcement is susceptible to UV-damage.

4.1.3 Reinforcements

The manufacturer shall provide the data required to demonstrate the short-term and long-term load-bearing capability of the reinforcement, as described in Annex A.

The manufacturer shall ensure that the tape supplier operates an effective quality plan relating to all aspects of tape manufacture. The following characteristics shall be considered in the quality plan: reproducible strength, dimensional consistency, evenness and reproducibility of cord spacing.

4.2 Pipes and fittings

Each type of RTP pipe body shall be qualified by means of the regression procedure described in Annex E. The fittings used for these tests may be fittings as used in the field or re-usable test end-fittings. At least one regression point shall be measured in excess of 10 000 h, with field end-fittings attached to both ends of the pipe body.

The regression test results shall be used to determine the regression-line gradient, the LTHP and the LPL for the RTP system, using the statistical procedure described in ISO 9080:2003.

In addition to the regression tests, every field fitting/pipe body combination shall pass an elevated temperature test, as described in Annex C, to verify the integrity of the fitting/pipe body connection.

The manufacturer shall inform the Principal of any substantial change to the fittings and/or pipe body.

The manufacturer shall prove and guarantee that any change to the field fittings or to the re-usable test end-fittings does not invalidate the results of qualification tests.

RTP products shall be divided into product families, as described in Annex E. Each product family shall have a representative named the product-family representative. Other products within the family are termed “product variants”.

The qualification test temperature shall be greater than or equal to the design temperature.

Other qualification issues are examined in Annex E.