
**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

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.

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:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

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order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn.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again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.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.

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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)

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.

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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 = 10⁵ 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 Twaron²⁾, Kevlar²⁾.

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 cyclicality

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

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 $23\text{ °C} \pm 2\text{ °C}$

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

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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.