Polybutene
Piping Systems Association

# Polybutene-1 Piping Systems Standards

## Mechanical Performance | Potable Water Quality


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# Polybutene-1 – Properties

The following table illustrates the physical, mechanical and thermal properties of Polybutene-1.

The values shown are typical mid-range figures and should not be considered as a specification. Several different grades of Polybutene-1 are produced with properties tailored to satisfy different applicational requirements.

| **Physical Properties** | **Method** | **Unit** | ***Akoalit* PB 4267** | ***Akoafloor* PB R 509** |
|---|---|---|---|---|
| Melt flow rate MRF 190°C/2.16 kg | ISO 1133 | dg/min | 0.4 | 0.7 |
| Density | ISO 1183 | g/cm$^3$ | 0.925 | 0.925 |
| Hardness Shore D | ISO 868 | – | 60 | 60 |
| **Mechanical Properties** | | | | |
| Tensile strength at yield | ISO R 527 | MPa | 20 | 18 |
| Tensile strength at break | ISO R 527 | MPa | 35 | 38 |
| Elongation at break | ISO R 527 | % | 300 | 330 |
| Flexural Elastic Modulus | ISO 178 | MPa | 450 | 330 |
| Notched Impact Strength at 20°C | ISO 180 | kJ/m2 | 20 | 65 |
| Notched Impact Strength at 0°C | ISO 180 | kJ/m2 | 7 | 25 |
| **Thermal Properties** | | | | |
| Melting point range | DSC (a) | °C | 127 - 129 | 124 - 126 |
| Vicat Softening Temperature | ISO 306 | °C | 120 | 117 |
| Coefficient of linear thermal expansion | ASTM D696 | mm/m.K | 0.13 | 0.13 |
| Thermal conductivity (30-70°C) | ASTM E1530 | W/m.K | 0.19 | 0.19 |
| Glass transition temperature | DMTA (b) | °C | -16 | -18 |
| **Specific Characteristics** | | | | |
| Wet abrasion (sand slurry test, 23°C, 2h) | | % | 2.5 | 1.5 |

(a) Differential Scanning Calorimetry
(b) Dynamic Mechanical Thermal Analysis

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# Polybutene-1 – Standards

**Standards applicable to Polybutene-1 piping systems**

Historically, the creation of 'standards' to control the use of pipe products in specific applications has been a matter for national standardisation bodies such as BSI (British Standards Organisation) in the UK and DIN (Deutsches Institut für Normung) in Germany.

More recently, the European Union Competition Commission has expressed concerns that national standards could be a restriction to trade and have therefore promoted the harmonisation of National standards into EN (European Normalisation) and ISO (International Standards Organisation) standards.

Although this process has not yet been completed for piping systems in hot and cold water applications, it can be expected that in future, the performance of piping systems will be measured and approved according to EN and/or ISO standards.

In due course therefore, accreditation bodies in individual European countries such as DVGW (Deutscher Verein des Gas und Wasserfaches) in Germany, KIWA (Keuringinstituut voor wasserleidingartikelen) in the Netherlands, and BSI (British Standards Organisation) in the UK will grant approvals based on pipe performance measured against these EN/ISO standards.

**Important note:**

It is the responsibility of every manufacturer to ensure that the products they sell are fit for their intended purpose. Standardisation bodies such as BSI, DIN, EN and ISO, provide the test methods and performance testing protocols by which manufacturers seek accreditation of their products. Using these standard test methods, accreditation bodies such as DVGW, KIWA, BSI and BBA provide the manufacturer with a recognised certification that their product meets an acceptable level of performance.

The Standards listings provided on the Standards pages of the PBPSA website and downloadable PDF file are for information only and although updated periodically, are not guaranteed to be exhaustive. Therefore, the responsibility to determine the standards to which a manufactured product must comply and obtaining approvals for those products and assembled systems from National and International hygiene and water quality authorities lies with the manufacturers of such products.

Questions relating to accreditations for particular products should therefore be addressed to the specific manufacturer.

Product compliance to the relevant National and International standards provides the purchaser and consumer with an assurance that the product will prove to be suitable for its intended purpose. The standardisation procedures associated with the performance of hot and cold water pressure pipes are extensive and demanding.

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# Polybutene-1 – Mechanical Performance

With respect to determining the suitability of Polybutene-1 piping systems for hot and cold water applications, the following standards are applicable. In some cases the ISO standards have been or are in the process of being accepted as EN standards. In such instances, the ISO number is followed by (EN).

## ISO 1167 (EN)

**Thermoplastics pipes, fittings and assemblies for the conveyance of fluids – Determination of the resistance to internal pressure.**

This series of standards specifies a general test method for determining the resistance to internal hydrostatic pressure at a given temperature of thermoplastics pipes, fittings and piping systems for the transport of fluids. The method accommodates water-in-water, water-in-air and water-in-liquid tests.

**ISO 1167-1** Part 1: General method

**ISO 1167-2** Part 2: Preparation of pipe test pieces

**SO 1167-3** Part 3: Preparation of components

**ISO 1167-4** Part 4: Preparation of assemblies

Hydrostatic pressure testing in accordance with ISO 1167 provides the basis for long-term extrapolation of creep rupture data according to ISO 9080 and quality testing as specified in product standards such as ISO 15876 series for PB-1 compounds.

Replacement for EN 921 and EN 12107.

## ISO 12230

**Polybutene (PB) pipes – Effect of time and temperature on the expected strength.**

This standard specifies minimum values for the expected strength as a function of time and temperature in the form of reference lines and tabulated data, for use in calculations on pipes made of:

- Polybutene-1 homopolymer (PB-H), and
- Polybutene-1 random copolymer (PB-R).

Equations with parameters describing these reference lines can be used when applying Miner's rule if a profile with more than one temperature or pressure is to be applied.

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## ISO 10508

**Plastics piping systems for hot and cold water installations**
**– Guidance for classification and design**

This standard gives guidance for the classification and design of hot and cold water pressure systems which use plastics pipes and plastics or metal fittings.

It establishes a classification system for common service conditions for pressurized hot and cold water systems. It gives a basis for evaluation and design of thermoplastics pipes and fittings in relation to the system performance requirements.

It applies to plastics piping systems used to carry water in distribution systems of hot and cold water, including potable water, and in transportation systems of hot water for heating, under design pressures up to at least 10 bar at 20 degrees Celsius and up to 10 bar at temperatures according to the class of application.

## ISO 9080 (EN)

**Plastics piping and ducting systems**
**– Determination of long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation**

This standard specifies a method for predicting the long-term hydrostatic strength of thermoplastics materials by statistical extrapolation. The method is applicable to all types of thermoplastics pipe at applicable temperatures. It was developed on the basis of test data from pipe systems.

The method is based on statistical treatment of hydrostatic pressure failure (measured according to ISO 1167) to obtain the expected strength and its confidence level at different values of time and temperature by extrapolation.

## ISO 12162 (EN)

**Thermoplastics materials for pipes and fittings for pressure applications**
**– Classification and designation and design coefficient**

This standard establishes the classification of thermoplastics materials in pipe form and specifies the material designation. It also specifies a method for calculating the design stress.

It is applicable to materials intended for pipes and fittings for pressure applications.

Classifies polymers on the basis of the lower confidence limits of extrapolated hoop stress data, rounded down to the next smaller value of a Renard series (ISO 497) to get the MRS value, defined at 20° C/50 years. The standard is extended to include CRS (categorized required strength, like MRS but at a specified temperature / time combination, e.g. 70° C/50 years). The standard also specifies minimum design coefficients for different materials by which the stress values are reduced for design reasons. Application standards may apply larger factors.

## ISO 13760 (EN)

**Plastic pipes for the conveyance of fluids under pressure – Miner's rule - Calculation method for cumulative damage**

When pipes are subjected to varying temperature and/or pressure profiles, the design of the system cannot be done using only one set of operating condition. Miner's rule is a method of combining the effect of varying conditions into a single value for the maximum allowable design stress. The standard contains an example of calculating the design stress for a PB-H pipe for application class 2 (hot water transport at 70°C) as specified in ISO 10508.

## ISO 15876 (EN)

**Plastic piping systems for hot and cold water installation – Polybutene (PB)**

**ISO 15876-1** Part 1: General

**ISO 15876-2** Part 2: Pipes

**ISO 15876-3** Part 3: Fittings

**ISO 15876-5** Part 5: Fitness for purpose of the system

**ISO/TS 15876-7** Part 7: Guidance for assessment of conformity

A comprehensive systems standard applicable to all Polybutene-1 piping systems covering all aspects of specification and performance including water quality testing, fitness for purpose and regular assessment of conformity. Performance assessment is based on the reference lines of Polybutene-1 (ISO 12230), application temperature profiles (ISO 10508), design factors (ISO 12162), thermal shrinkage (ISO 2505) and delta MFR upon processing (ISO 1133-1).

The standards described above are considered to be the main standards used in determining the mechanical long-term suitability of Polybutene-1 piping systems for hot and cold water applications. There are however many other standards which may be utilised to determine more specific performance associated with the application of Polybutene-1 piping systems.

Performance requirements are based on specific temperature profiles, representative for various hot water applications using Miner's rule ISO 13760. Test methods for thermal cycling, cyclic pressure shock, resistance to pullout of assembled joints, leaktightness under vacuum and to bending of joints are given in separate standards (ISO 19893, ISO 19892, ISO/DIS 3501, ISO 13056 and ISO/DIS 3503).

A number of National standards on dimensions, system requirements and testing are based on ISO 15876 series and will follow revisions of these standards upon periodic review.

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## ISO 15494 (EN)

**Plastics piping systems for industrial applications – Polybutene (PB), polyethylene (PE) and polypropylene (PP) - Specifications for components and the system - Metric series**

This International Standard specifies the characteristics and requirements for a piping system and its components made from polybutene (PB), polyethylene (PE) or polypropylene (PP), as applicable, intended to be used for industrial applications above ground by authorities, design engineers, certification bodies, inspection bodies, test laboratories, manufacturers and users.

It is applicable to PB, PE or PP pipes, fittings, valves and ancillary equipment, to their joints and to joints with components made of other plastics and non-plastics materials, depending on their suitability, intended to be used for the conveyance of liquid and gaseous fluids as well as of solid matter in fluids for industrial applications such as:

- Chemical plants
- Industrial sewerage engineering
- Power engineering (cooling and general-purpose water supply)
- Electroplating and pickling plants
- Semiconductor industry
- Agricultural production plants
- Water treatment

Other application areas are permitted if the requirements of this International Standard and/or applicable national requirements are fulfilled.

Relevant regulations in respect of fire behaviour and explosion risk are applicable if applications are envisaged for inflammable media.

The components have to withstand the mechanical, thermal and chemical demands to be expected and have to be resistant to the fluids to be conveyed.

Performance requirements specified for PB-1 compounds are very similar to those described in ISO 15876.

## ISO 21003 (EN)

**Multilayer piping systems for hot and cold water installations inside buildings**

**ISO 21003-1** Part 1: General

**ISO 21003-2** Part 2: Pipes

**ISO 21003-3** Part 3: Fittings

**ISO 21003-5** Part 5: Fitness for purpose of the system

**ISO/TS 21003-7** Part 7: Guidance for assessment of conformity

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**ISO 21003 (EN) (cont.)**

ISO 21003 series specify the general aspects of multilayer piping systems intended to be used for hot and cold water installations inside buildings for the conveyance of water – whether or not the water is intended for human consumption (domestic systems) or heating systems – under specified design pressures and temperatures appropriate to the class of application.

ISO 21003 is a reference product standard. It is applicable to multilayer pipes, fittings, their joints, and also to joints with components made of other plastics and non-plastics materials intended to be used for hot and cold water installations.

ISO 21003 applies only to multilayer pipes with their inner layer made of plastics. It also covers a range of service conditions (application classes) and design pressures.

The polymeric materials used for the stress-designed layers are the following: polybutene (PB), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), polypropylene (PP) and chlorinated poly(vinyl chloride) (PVC-C).

The PE-X used shall be fully crosslinked and shall comply with the requirements of the relevant reference product standard (ISO 15875).

Solid-wall pipes with thin outer layers (applied as protection layers or barrier layers, for instance) are not covered by ISO 21003 but are specified in amendments to relevant product standards. The total thickness of such outer layers, including the thickness of the adhesives used, shall be ≤ 0,4 mm

**Additional Polybutene-1 related standards with brief explanations**

## ISO 80000

**Quantities and units – Part 1: General**

This standard gives general information and definitions concerning quantities, systems of quantities, units, quantity and unit symbols, and coherent unit systems, especially the International System of Quantities, ISQ, and the International System of Units, SI.

The principles laid down in ISO 80000-1 are intended for general use within the various fields of science and technology and as an introduction to other parts of the Quantities and units series.

ISO 80000 series contains 13 additional parts dealing with quantities and units related to specific fields of science and technology.

Rules are specified for using the ISO system of treating quantities, units, equations, symbols, etc, including the use of prefixes like mega and nano, the use of italics and a guide to the rounding of numbers in an informative annex.

## ISO 3

**Preferred numbers – Series of preferred numbers**

This International Standard specifies series of preferred numbers.

Preferred numbers are the conventionally rounded of term values of geometrical series, including the integral powers of 10 and having as ratios special factors in accordance with the specified tables. Basic, expectional, R 80 and derived series are designated.

## ISO 17

**Guide to the use of preferred numbers and of series of preferred numbers**

## ISO 497

**Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers**

This is an additional guide to ISO 17 for selecting specified series with more rounded values. It shows the conditions for the use of these preferred numbers.

Listing the so-called Renard numbers, a geometrical series used, i.e. for pipe dimensions, MRS-values, etc.

## ISO 1133-1 (EN)

**Plastics – Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics – Part 1: Standard method.**

This part of ISO 1133 specifies two procedures for the determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastic materials under specified conditions of temperature and load. Procedure A is a mass-measurement method. Procedure B is a displacement-measurement method. Normally, the test conditions for measurement of melt flow rate are specified in the material standard with a reference to this part of ISO 1133. The test conditions normally used for thermoplastics are listed in an Annex.

The MVR is particularly useful when comparing materials of different filler content and when comparing filled with unfilled thermoplastics. The MFR can be determined from MVR measurements, or vice versa, provided the melt density at the test temperature is known.

This part of ISO 1133 is also possibly applicable to thermoplastics for which the rheological behaviour is affected during the measurement by phenomena such as hydrolysis (chain scission), condensation and cross-linking, but only if the effect is limited in extent and only if the repeatability and reproducibility are within an acceptable range. For materials which show significantly affected rheological behaviour during testing, this part of ISO 1133 is not appropriate. In such cases, ISO 1133-2 applies.

## ISO 2505 (EN)

**Thermoplastics pipes – Longitudinal reversion – Test methods and parameters**

This International Standard specifies a method for determining the longitudinal reversion of thermoplastics pipes, to be carried out in either a liquid or in air. In case of dispute, heated liquid is used as the reference.

This International Standard is applicable to all thermoplastics pipes with smooth internal and external walls of constant cross-section. It is not applicable to non-smooth structured-wall thermoplastics pipes. The parameters appropriate to the pipe material and recommendations for the maximum levels of reversion as a function of the pipe material are given in Annex A. Measurement of longitudinal reversion is not considered relevant for pipe wall thickness greater than 16 mm.

Shrinkage on heating is measured and may be used as an indication of frozen-in stresses.

Replacement for EN 743.

## ISO 6259 (EN - Part 1)

**Thermoplastics pipes – Determination of tensile properties**

**ISO 6259-1** Part 1: General test method

**ISO 6259-3** Part 3: Polyolefin pipes

Part 1 of this series of standards specifies a short-term tensile test method for determining the tensile properties of thermoplastics pipes, including in particular the following properties:

- Stress at yield point
- Elongation at break

This part is applicable to all types of thermoplastics pipe, regardless of their intended use.

It can provide data for further testing for the purpose of research and development.

It cannot be regarded as significant for applications in which the conditions of application of the force differ considerably with those in this test method, such applications requiring the appropriate impact, creep and fatigue tests.

The tests of tensile properties should be principally regarded as tests of material in the form of pipe. The results can be useful as a material process control test, but are not a quantitative assessment of long term pipe performance.

ISO 6259 has been drawn up on the basis of ISO 527.

For ease of use, it has been thought preferable to draw up a complete document that can be used for determining the tensile properties of thermoplastics pipes. For greater detail, reference should be made to ISO 527.

**ISO 6259 (EN - Part 1) (cont.)**

It should however be noted that ISO 527 is applicable to materials in sheet form, whereas ISO 6259 is applicable to materials in pipe form.

As it was considered essential to test the pipes as supplied, i.e. without reduction in thickness, difficulties are those in the choice of test piece.

ISO 527 specifies test pieces a few millimetres thick, whereas the thickness of a pipe can be up to around 60 mm. This is why certain changes have been made on this point.

For thin-walled pipes, the test piece can be obtained by die cutting, while for thick pipes, it can be obtained only by machining.

Part 3 of ISO 6259 provides particular information on the execution of tests on pipe made from polyolefin pipe materials. The basic specifications for the various materials are given in informative annexes in the relevant parts.

## ISO 8986 (EN)

**Plastics – Polybutene-1 (PB-1) moulding and extrusion materials**

**ISO 8986-1** Part 1: Designation system and basis for specifications

**ISO 8986-2** Part 2: Preparation of test specimens and determination of properties

ISO 8986-1 establishes a system of designation for Polybutene-1 (PB-1) thermoplastic materials which may be used as the basis for specifications.

The types of polybutene plastics are differentiated from each other by a classification system based on appropriate levels of the designatory property melt volume-flow rate and on information about basic polymer parameters, intended application and/or method of processing, important properties, additives, colorants, fillers and reinforcing materials.

ISO 8986-1 is applicable to all butene homopolymers and to copolymers of butene with a maximum content of other olefinic monomers of less than 50% by mass and with a content of non-olefinic monomers with functional groups up to a maximum of 1% by mass.

It applies to materials ready for normal use in the form of powder, granules or pellets and to materials unmodified or modified by colorants, additives, fillers, etc.

ISO 8986-2 specifies the methods of preparation of test specimens and the test methods to be used in determining the properties of Polybutene-1 (PB-1) moulding and extrusion materials. Requirements for handling test material and for conditioning both the test material before moulding and the specimens before testing are also specified.

Procedures and conditions for the preparation of test specimens and procedures for measuring properties of the materials from which these specimens are made are given.

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**ISO 8986 (EN) (Cont.)**

Properties and test methods which are suitable and necessary to characterize PB moulding and extrusion materials are listed.

The properties have been selected from the general test methods in ISO 103501. Other test methods in wide use for or of particular significance to these moulding and extrusion materials are also included in this part of ISO 8986, as is the designatory property specified in Part 1.

ISO 8986 deals with general properties of PB-1 compounds irrespective of final use. It is not restricted to pipe extrusion grades.

## ISO 11357-6 (EN)

**Plastics - Differential scanning calorimetry (DSC)**
**– Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)**

ISO 11357-6 specifies methods for the determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT) of polymeric materials by means of differential scanning calorimetry (DSC). It is applicable to polyolefin resins that are in a fully stabilized or compounded form, either as raw materials or finished products.

The oxidation induction time (isothermal OIT) or temperature (dynamic OIT) may be used for checking the stabiliser content of polyolefins. Attention is drawn to the fact that OIT values depend on the type of stabiliser and may be affected by other additives, too. Consequently, it shall not be used as a measure of stabilisation or predicting operating life at much lower temperatures.

## ISO 11922

**Thermoplastics pipes for the conveyance of fluids - Dimensions and tolerances.**

**ISO 11922-1** Metric series

**ISO 11922-2** Inch-based series

In the past. International Standards specifying the tolerances to be applied to thermoplastics pipes have covered individual materials separately. The philosophy of ISO 11922 is to combine these already published standards into a single two-part standard covering the tolerances for extruded pipes manufactured from all thermoplastics materials, thus avoiding the need for a standard to be developed for each individual material. It is intended that the tolerance grades specified in product standards be selected from the relevant part of ISO 11922, taking into account the material and the intended application.

ISO 11922 therefore contains a number of tolerance grades covering the mean outside diameter, the out-of-roundness of the outside diameter, the wall thickness at any point and the mean wall thickness.

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**ISO 11922 (Cont.)**

The bodies responsible for writing the various product and system standards will choose, from the specified tolerance grades, that grade which is suitable for the application and material involved.

It is applicable to smooth thermoplastics pipes of constant circular cross-section along the whole length of the pipe, whatever the method of manufacture, the pipe material or the intended application.

## ISO 19892

**Plastics piping systems**
**– Thermoplastics pipes and fittings for hot and cold water – Test method for the resistance of joints to pressure cycling**

This International Standard specifies a method for testing the resistance of joints to pressure cycling. It is applicable to piping systems based on thermoplastics pipes intended to be used in hot and cold water applications. It is referred to in ISO 15876.

Replacement for EN 12295.

## ISO 19893

**Plastics piping systems**
**– Thermoplastics pipes and fittings for hot and cold water – Test method for the resistance of mounted assemblies to temperature cycling**

This International Standard specifies a method for testing the resistance to temperature cycling of joints for piping systems with rigid or flexible thermoplastics pipes.

It is applicable to thermoplastics piping systems intended to be used in hot and cold water pressure applications. It is referred to in ISO 15876.

Replacement for EN 12293.

## ISO 13056

**Plastics piping systems**
**– Pressure systems for hot and cold water – Test method for leaktightness under vacuum**

This International Standard specifies a method for testing the leaktightness under vacuum of joints for thermoplastics piping systems.

It is applicable to piping systems based on thermoplastics pipes intended to be used in hot and cold water pressure applications.

Replacement for EN 12294.

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## EN 496

**Plastics piping and ducting systems**
**– Plastics pipes and fittings - Measurement of dimensions and visual inspection of surfaces.**

Replaced by ISO 3126.

## ISO 3126 (EN)

**Plastics piping systems**
**– Plastics components – Determination of dimensions**

This International Standard specifies methods for measurement and/or determination of the dimensions of plastics pipes and fittings and the accuracy of the measurement. It specifies procedures for measuring angles, diameters, lengths, squareness and wall thicknesses for the purposes of checking conformity to geometric limits.

This document is using metric units. However the procedures and tolerances are applicable to other units by using appropriate conversion factors.

## ISO/DIS 3501

**Plastics piping systems**
**– Mechanical joints between fittings and pressure pipes – Test method for resistance to pull-out under constant longitudinal force**

Replacement for EN 712.

## ISO/DIS 3503

**Plastics piping systems**
**– Mechanical joints between fittings and pressure pipes – Test method for leaktightness under internal pressure of assemblies subjected to bending**

Replacement for EN 713.

## EN 743

**Plastics piping and ducting systems**
**– Thermoplastics pipes – Determination of the longitudinal reversion.**

Withdrawn and replaced by ISO 3126.

## EN 921

**Plastics piping systems**
**– Thermoplastics pipes - Determination of resistance to internal pressure at constant temperature Similar (not identical) to EN ISO 1167.)**

Withdrawn and replaced by ISO 1167.

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## EN 1264

**Ware based surface embedded heating and cooling – Systems and components**

This European Standard series specifies systems and components for water based surface heating (underfloor heating) and cooling systems. It contains methods for determination of thermal output, describes procedures for dimensioning and installation and provides procedures for conversion of thermal output results obtained for floor heating systems into different surface orientations, e.g. ceiling and wall heating as well as for application as cooling surfaces, e.g. floor, ceiling and wall cooling.

The standard provides guidelines for wall thickness, pipe spacing, service temperature limits, recommended operation conditions, etc.

**EN 1264-1** Part 1: Definition and symbols

**EN 1264-2** Part 2: Floor heating: Prove methods for the determination of the thermal output using calculation and test methods

**EN 1264-3** Part 3: Dimensioning

**EN 1264-4** Part 4: Installation

**EN 1264-5** Part 5: Heating and cooling surfaces embedded in floors, ceilings and walls Determination of the thermal output

## EN 12107

**Plastics piping systems**
**– Injection-moulded thermoplastics fittings, valves and ancillary equipment**

Determination of long-term hydrostatic strength of thermoplastics materials used for injection-moulded piping components, similar (not identical) to EN ISO 1167 (revision being prepared)

Withdrawn and replaced by ISO 1167.

## EN 12293

**Plastics piping systems**
**– Thermoplastics pipes and fittings for hot and cold water**

Method of test for the resistance of piping systems to thermal cycling Adopted by ISO as ISO CD 19893; Referred to in EN ISO 15876

Replaced by ISO 19893.

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## EN 12294

**Plastics piping systems for hot and cold water**
**– Method of test for leak-tightness under vacuum Referred to in EN ISO 15876.**

Replaced by ISO 13056.

## EN 12295

**Plastics piping systems**
**– Thermoplastics pipes and fittings for hot and cold water**

Method of test for resistance of piping systems under pressure cycling Adopted by ISO as ISO CD 19892; Referred to in EN ISO 15876.

Replaced by ISO 19892.

## EN 15632

**District heating pipes - Pre-insulated flexible pipe systems**

This European Standard series provides classification, general requirements and test methods for flexible, pre-insulated, directly buried district heating pipe systems. For plastics service pipes, this European Standard a temperature profile of 29 years at 80°C (continuous operating temperature), 1 year at 90°C (maximum temperature) and 100 h at 95°C (malfunction temperature) is specified using operating pressures of 6 bar to 10 bar. The pipe systems are designed for a lifetime of 30 years.

Pipe design is specified for PB-1, PE-X and multilayer pipes.

**EN 15632-1** Part 1: Classification, general requirements and test methods

**EN 15632-2** Part 2: Bonded plastic service pipes - Requirements and test methods

**EN 15632-3** Part 3: Non bonded system with plastic service pipes; requirements and test methods

**EN 15632-4** Part 4: Bonded system with metal service pipes; requirements and test methods

## ISO/TR 10358

**Plastics pipes and fittings**
**– Combined chemical-resistance classification table**

The materials covered by the classification in this Technical Report are: low-density polyethylene; high-density polyethylene; polypropylene; Poly(vinyl chloride), unplasticized; Poly(vinyl chloride), chlorinated; polybutene; Acrylonitrile/butadiene/styrene; Poly(vinylidene fluoride); cross-linked polyethylene. Three classes are distinguished: satisfactory resistance, limited resistance, resistance not satisfactory. Corrosion resistance is given to 427 chemicals of different concentration at different temperatures.

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## ISO/TR 10501

**Thermoplastics pipes for the transport of liquids under pressure – Calculation of head losses**

This Technical report gives a method of calculating head loss in the transport of liquids under pressure in hydraulically smooth thermoplastic pipes. The formulae given (for calculating head drop and head loss, for temperature correction) apply to the transport of water under pressure, or to all other liquids of the same dynamic viscosity, at temperatures of up to 45 °C.

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# Polybutene-1 – Potable Water Standards

**Standards applicable to the potable water quality of Polybutene-1 piping systems**

All plastics and non-plastics material used as components of Polybutene-1 piping systems when in permanent or temporary contact with water which is intended for human consumption must not adversely affect the quality of the drinking water in accordance with the applicable EC Directives and EFTA Regulations on the quality of drinking water.

Currently, however, unilateral European standards are unavailable for the accreditation of potable water piping systems. Consequently in June 2000, in an attempt to address this situation, the European Commission initiated a European Acceptance Scheme (EAS) with the objective of harmonising the existing national certification procedures for testing construction products in contact with water intended for human consumption, under the umbrella of the Joint Research Centre of the European Commission.

The accreditation bodies responsible for drinking water quality in each of the member states are contracted to undertake the necessary development work in four co-operative working groups. Until the scheme comes into force, national accreditation procedures for potable water systems will still apply. Polybutene-1 grades marketed for pipe production in Europe conform to all existing national standards. Manufacturers of polybutene-1 piping systems however are responsible for obtaining national accreditations for their own specific products in the countries where they are marketed. Questions on product accreditations should therefore be addressed to the specific manufacturer.

The responsibility of obtaining approvals for manufactured products and assembled systems from national/international hygiene and water quality authorities lies with the manufacturers of such products.

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# Polybutene-1 – Potable Water Quality

Existing ISO/EN water quality standards

## ISO 7686 (EN)

**Plastics pipes and fittings**
**– Determination of opacity**

The test method is necessary for a pipe or fitting used for water supply which is exposed to visible light during service to be sufficiently opaque to prevent algae growth.

Replacement for EN 578.

## ISO 8795 (EN)

**Plastic piping systems for the transport of water intended for human consumption**
**– Migration assessment**

Determination of migration values of plastics pipes and fittings and their joints.

Evaluation of the data is described in ENV 852.

## EN 578

**Plastics piping systems**
**– Plastics pipes and fittings - Determination of the opacity.**

Of importance when algae growth must be considered.

Withdrawn and replaced by ISO 7686.

## EN 806

**Specification for installations inside buildings conveying water for human consumption**

**EN 806-1** Part 1: General

**EN 806-2** Part 2: Design

**EN 806-3** Part 3: Pipe sizing – Simplified method

**EN 806-4** Part 4: Installation

**EN 806-5** Part 5: Operation and maintenance

This European standard specifies requirements for and gives recommendations on the design, installation, alteration, testing, maintenance and operation of drinking water installations within buildings and for certain purposes pipework outside buildings but within the premises. It is applicable to the system of pipes, fittings and connected appliances installed for supplying drinking water.

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## ENV 852

**Plastic piping systems for the transport of water intended for human consumption – Migration assessment - Guidance on the interpretation of laboratory derived migration values**

This Technical Report is applicable to plastics pipes, joints and fittings to be used for the transport of water intended for human consumption and raw water used for the manufacture of water intended for human consumption. It gives guidance on: a) the number of successive migration periods to be carried out; b) how to interpret M values calculated from successive migration periods; c) a method for converting M values into values that reflect field use conditions; d) acceptance criteria for the duplicate M values obtained by testing in accordance with EN ISO 8795.

## EN 1420

**Influence of organic materials on water intended for human consumption – Determination of odour and flavour of water in piping systems - Test method**

Draft under evaluation.

## EN 12873

Influence of materials on water intended for human consumption - Influence due to migration

**EN 12873-1** Part 1: Test method for non-metallic and non-cementitious factory made products

**EN 12873-2** Part 2: Test method for non-metallic and non-cementitious site-applied materials

**EN 12873-3** Part 3: Test method for ion exchange and adsorbent resins

**EN 12873-4** Part 4: Test method for water treatment membranes

This European Standard specifies a procedure to determine the migration of substances from non-metallic and non-cementitious factory made or factory applied products for use in contact with water intended for human consumption. This standard is applicable to products intended to be used under various conditions for the transport and storage of water intended for human consumption, including raw water used for the production of water intended for human consumption. It covers the extraction by water of substances from the finished products.

## EN 12108

**Plastics piping systems – Guidance for the installation inside buildings of pressure piping systems for hot and cold water intended for human consumption**

This European Technical Report recommends practices to be followed in the application and installation of thermoplastics pipes and associated fittings. These fall within the scope of EN 806-1 and, EN ISO 15874, EN ISO 15875, EN ISO 15876, EN ISO 15877 and EN ISO 22391 to be used for hot and/or cold water distribution intended for human consumption inside buildings. This document

**EN 12108** (Cont.)

can also be used for heating installations if applicable, except for under floor heating for which EN 12164 can apply. Guidance is also given on acceptable methods of jointing polybutylene (PB), crosslinked polyethylene (PE-X), polypropylene (PP), chlorinated poly(vinyl chloride) (PVC-C) and Polyethylene of raised temperature resistance (PE-RT) pipes and associated fittings, together with recommendations for their storage, handling and transportation.

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# Polybutene-1 – Potable Water Quality

Existing ISO/EN water quality standards

Until requirements and methods are set up on an international level for all piping systems and associated components in contact with potable water, the applicable regulations on water quality and health relating to each country must be observed.

**The European national water authorities/accreditation bodies are as follows:**

| | |
|---|---|
| **Austria** | Österreichisches Forschungsinstitut für Chemie und Technik |
| **Denmark** | Dansk Toksikologi Center |
| **France** | ACS (Attestation de Conformité Sanitaire)<br>by Direction Générale de la Santé (DGS)<br><br>Accreditation<br>- Groupe CARSO, Lyons, France<br>- Eurofins IPL, Maxeville, France |
| **Germany** | DVGW - TZW Deutsche Vereinigung des Gas- und Wasserfaches<br>Technologiezentrum Wasser |
| **Great Britain** | WRAS |
| **Italy** | Istituto Superiore di Sanità |
| **Portugal** | Empresa Portuguesa das Águas Livres, SA |
| **Spain** | Universitat Autònoma de Barcelona |
| **Sweden** | SP Swedish National Testing and Research Institute |
| **The Netherlands** | KIWA N.V. |

Components made from Polybutene-1 intended for use in the conveyance of water for human consumption fulfil all existing requirements of national/international applicable standards in Europe.

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# Important National Standards

## AUS & NZL

### AS/NZS 2642

**Polybutene (PB) plumbing pipe systems**

| | |
|---|---|
| **AS/NZS 2642.1** | Part 1: Polybutene (PB) pipe extrusion compounds |
| **AS/NZS 2642.2** | Part 2: Polybutene (PB) pipe for hot and cold water applications |
| **AS/NZS 2642.3** | Part 3: Mechanical jointing fittings for use with Polybutene (PB) pipes for hot and cold water applications |

This series of standards specifies requirements for PB-1 pipe compounds, dimensions and tolerances for pipes and fittings and quality control procedures and criteria.
The standard is applicable for imperial size pipes in Australia and New Zealand.

### AS/NZS 5082

**Polybutene (PB) plumbing pipe systems - Metric series**

| | |
|---|---|
| **AS/NZS 5082.1** | Part 1: Metric Polybutene (PB) pipes for hot and cold water applications |
| **AS/NZS 5082.2** | Part 2: Mechanical and fusion jointing systems |

Part 1 of these standards specifies requirements for materials, dimensions and performance for polybutylene pipe for hot and cold water applications (metric series), including domestic, industrial and agricultural purposes.

Part 2 contains requirements for mechanical and fusion jointing fittings suitable for use as fixed joints with polybutene pipes manufactured in accordance with Part 1 of this series
The standard is applicable for metric size pipes in Australia and New Zealand.

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# CHN

## GB/T19473

**Polybutene (PB) Piping Systems for Hot and Cold Water Installations**

**GB/T 19473.1** Part 1: General

**GB/T 19473.2** Part 2: Pipes

**GB/T 19473.3** Part 3: Fittings

Similar to ISO 15876-1 to -3. Applicable in China.

# DEU

## DIN 16968

**Pipes made of Polybutene-1 (PB-1)**
**– PB 125 - General quality requirements and testing**

This standard is applicable to straight, round, seamless pipes with dimensions in accordance to DIN 16969 made of compounds

- Polybutene-1 Homopolymer (PB-H)
- Polybutene-1 Random Copolymer (PB-R)

This basic standard specifies compound requirements in terms of composition and use of reprocessable material. It contains reference lines for PB homopolymers and copolymers in graphical form and in form of equations for calculating creep rupture strength at any time and temperature. In addition it contains procedures and criteria for quality control testing of pipes.

## DIN 16969

**Pipes made of Polybutene-1 (PB-1)**
**– PB 125 - Dimensions**

This standard is applicable to straight, round, seamless pipes with dimensions in accordance to DIN 16969 made of compounds

For pipes specified in DIN 16968 this standard specifies dimensions, tolerances, applicable pressures and marking requirements of PB-1 homo- and copolymer pipes.
DIN 16968 and DIN 16969 are applicable in Germany.

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# GBR & IRL

## BS 7291

**Thermoplastic pipes and fittings for hot and cold water for domestic purposes and heating installations in buildings**

**BS 7291-1** Part 1: General requirements

**BS 7291-2** Part 2: Specification for Polybutene (PB) pipe and associated fittings

**BS 7291-3** Part 3: Specification for cross-linked polyethylene (PE-X) pipe and associated fittings

**BS 7291-4** Part 4: Specification for chlorinated polyvinyl chloride (PVC-C) pipe and associated fittings and solvent cement

Part 1 of these standards specifies general requirements and methods of test for thermoplastic pipes and associated fittings intended for use within buildings for conveyance of water under pressure, for distribution of hot and cold water, including drinking water, and for circulation of hot water for heating purposes. The specified pipe systems are also suitable cold water at 50 years / 20°C and design pressure 12,5 bar. The standard contains service temperature requirements, testing procedures and quality control criteria. It is applicable to pipes having a nominal outside diameter up to and including 110 mm with or without incorporated polymeric layer to inhibit gas permeation through the pipe wall.

Parts 2, 3 and 4 specify particular requirements for PB-1, PE-X and PVC-C pipe systems, respectively. The standard is applicable in UK and Ireland.

# JPN

## JIS K 6778

**Polybutene (PB) pipes**

This standard is based on ISO 15876-2 and specifies Polybutene-1 pipes for conveyance of water at temperatures up to and including 90°C. Pipes shall be in accordance with JIS K 6792.

## JIS K 6792

**Polybutene (PB) pipes for water supply**

This standard also based on ISO 15876-2 specifies polybutene-1 pipes used for indoor water piping systems with a working pressure of up to and including 7.5 bar. JIS K 6778 and JIS K 6792 are applicable in Japan.

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# KOR

## KS M 3363

**Polybutene (PB) pipes**

This standard based on ISO 15876 specifies polybutene pipe for water works below 95°C. KS M 3363 is applicable in Korea.

# RUS

## GOST R 52134

**Pressure thermoplastic pipes and fittings for water-supply and heating systems – General requirements**

This Standard includes pipes made from the following thermoplastics: polyethylene, unplasticized polyvinylchloride, polypropylene and propylene copolymers, cross-linked polyethylene, chlorinated polyvinylchloride and polybutene.

Also, this Standard establishes the requirements for pipes made from all types of thermoplastics, for fittings and their joints - that is for the whole water-supply and heating piping systems.

This Standard regulates the pipes dimensions as well as the service life parameters:

- Long-term strength of the materials in the form of diagrams "time – pipe wall strain – temperature"
- Operating conditions (classes) defined by a complex of temperatures and their action time as well as the pressure values
- Load factors

This Standard specifies the calculation procedure for the minimum pipe wall thickness depending on the pipe material long-term strength and a class of operation. A unified approach to the pipes quality monitoring is developed and a full scope of the test methods is presented which allow their estimation with the maximum reliability.  GOST R 52134 is applicable in Russia.

# THA

## TIS 910-2532

**Polybutene (PB) pressure pipe and tubing for drinking water services**

This standard specifies classes, types and grades, sizes and tolerances, requirements, packing, marking, sampling and criteria for conformity and testing for polybutylene pressure pipe and tubing for drinking water services. TIS M 3363 is applicable in Thailand.

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# PBPSA | Polybutene Piping Systems Association

The Polybutene Piping Systems Association (PBPSA) is an international association of market leading companies committed to the use of the thermoplastic material, Polybutene-1 (PB-1) for the manufacture of piping systems. Also known as polybutylene, PB-1 is used worldwide in applications including piping systems for large-scale building projects, district energy networks, heating and cooling, and plumbing installations.

**Polybutene Piping Systems Association**
Postfach 3377
8021 Zürich
SWITZERLAND

info@pbpsa.com
www.pbpsa.com

## PBPSA Members

| | |
|---|---|
| +GF+ GF Piping Systems | www.gfps.com |
| wavin | www.wavin.com |
| RWC | www.rwc.com |
| LYB LyondellBasell | www.lyondellbasell.com |
| NUEVA TERRAIN S.L. | www.nuevaterrain.com |
| THERMAFLEX ® | www.thermaflex.com |