PS:4533-1999

ICS No.

Pakistan Standard for

Types 1, 2 and 3 Polypropylene (PP) Pipes

General Quality Requirements and Testing

PAKISTAN STANDARDS AND QUALITY CONTROL AUTHORITY

STANDARDS DEVELOPMENT CENTRE

(STANDARDIZATION WING),

1ST FLOOR, ST-7-A, BLOCK-3

GULISTAN-E-JAUHAR

Karachi

MEMBERS LIST OF TECHNICAL COMMITTEE
BUILDERS HARDWARE AND SANITARY FITTINGS (BDC- 6)

S. No.	NAME & DESIGNATION	S. No.	NAME & DESIGNATION
1	The Registrar, NED University of Engineering & Technology, Karachi.	10	The Vice Chancellor, Quaid-e-Awam University, of Engineering & Technology, Nawabshah.
2	The Registrar Pakistan Engineering Council (PEC), Ataturk Avenue (East) G – 5/2 Islamabad.	11	Engr. Rizwan-ur-Rehman Principal Engineer (Rtd.) PCSIR, 4/G, Block-6, PECHS, Karachi.
3	The Secretary, Institution of Engineer Pakistan Karachi Centre, 177/2, Liaquat Barraks, 4th Floor, I.E.P Building Karachi.	12	Engr. Tasneem Ahmed Qazi, Technical Managing (Q.A), Dadex Eternit Limited, Dadex House, 34 – A/2, PECHS, Block – 6, Shahrah-e-Faisal, Karachi.
4	The Chairman, Association of Builders & Developers, ST – 1/D, Block – 16, Gulistan-e-Johar Karachi.	13	The Director International Industries Ltd. (I.I.L.) 101 Beaumount Plaza 10, Beaumount Road Karachi.
5	The Director Quality Control Centre, PSQCA Complex, Karachi.	14	The Director Glaxy Corporation (Galco) 4th Floor Bank House, No. 01 Habib Square M.A. Jinnah Road, Karachi.
6	The Vice Chancellor, Mehran University of Engineering & Technology Jamshoro.	15	Mr. Tariq Jamal Manager (Q.C) Plastic Technology Centre, ST-2/1 Sector 30, Korangi Industrial Area, Karachi.
7	The Director M/s. Akbar & Zikria Pipes Pvt. Ltd., 314, 3rd Floor, Anum Blessing, Shahrah-e-Faisal Karachi.	16	Mr. Muhammad Altaf, Director, Popular Plastic Industry F-441/A-3, S.I.T.E., Karachi.
8	The Director M/s. ALICO Pipe Industries 4/3, Arkay Square (Ext.) Shahrah-e-Liaquat Karachi-74400.	17	Syed Amir Ali Council for Works and Housing Research (CWHR) F – 40, S. I. T. E., Karachi.
9	Mr. Shaheen Ilyas Sarwana Managing Director M/s. Euro Gulf Industries D-60, S.I.T.E., Phase-I Off Super Highway, Karachi.	18	Mr. M. Azeem Siddiqui DGM Sales Euro Gulf Industries D-60, S.I.T.E., Phase-I, Super Highway, Karachi.

19	The Director M/s. Pelikan Industries SD-1, Block-B, Com'I Area North Nazimabad Karachi-74700	23	Engr. Ashraf Pervez Department of Antiquities Govt. of Sindh Banglow No.C-82, Block-II, Clifton, Near Ziauddin Hospital, Karachi.
20	The Director M/s. ZAKA Sons A-10/C, Manghopir Road S.I.T.E., Karachi.	24	Tahseen Ahmad Chief Executive 6/1, Block 7 & 8, Bahadur Yar Jang Housing Society, Ameer Khusro Road, Karachi.
21	Mr. Arif Ejaz Marketing Manager Jeddah Polymer 639/1, F. B. Industrial Area, Block-22, Karachi	25	Engr. Ghulam Qadir National Engineering Services Pakistan (Pvt) Ltd. NESPAK 13th Floor, NIC Building, Abbasi Shaheed Road, off Shara-e-Faisal, Karachi.
22	Azfar Khan Market Development Section In-charge Engro Polymer & Chemicals 16th Floor, The Harbor Front Building, HC-3, Marine Drive, Block-04, Clifton, Karachi-75600		

Pakistan Standard for

Types 1, 2 and 3 Polypropylene (PP) Pipes

General quality requirements and testing

FOREWORD:

0.1 This Standard was adopted by Pakistan Standard & Quality Control Authority after recommendations of the Technical Committee for "**BUILDER'S HARDWARE AND SANITARY FITTINGS**" (**BDC-06**) on 1**999**. The same had been approved and endorsed by the Civil Engineering National Standards Committee (CENSC) on **06-12-1999**.

0.2 This Standard has been prepared after taking into consideration the views and suggestions of the manufacturers, technologists, suppliers and utilizing agencies.

0.3 In preparation of this Standard the Technical Committee acknowledges with thanks the assistance drawn from the standard **DIN 8078.**

0.4 This Standard is subject to periodical review in order to keep pace with development in industry. Any suggestions for improvement will be recorded and placed before the committee in due course.

Pakistan Standard for
Types 1, 2 and 3 Polypropylene (PP) Pipes
General quality requirements and testing

1 Scope and field of application

This standard specifies requirements and the relevant methods of test for seamless pipes of circular cross section made from propylene homopolymers (PP-H) (type 1), thermoplastic propylene impact copolymers (PP-B) (type 2) or thermoplastic propylene random copolymers (type 3).

Individual requirements specified in this standard may be omitted or supplemented in technical delivery conditions relating to particular applications.

2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 323-1	Preferred numbers and preferred number series – Basic, calculated and rounded values
DIN 8077	Polypropylene (PP) pipes – Dimensions
DIN 16774-1	Plastic moulding materials – Polypropylene and propylene copolymer thermoplastics –Classification and designation

DIN 16774-2	Plastics moulding materials- Polypropylene (PP) moulding materials – Preparation of specimens and determination of their properties
DIN 16887	Determination of the long-term hydrostatic pressure resistance of thermoplastics pipes
DIN 50011-11	Artificial climates in technical applications- Controlled-atmosphere test installations-General concepts and requirements
DIN 51222	Pendulum impact testing machines with an energy of 50 J or less- Requirements and verification
DIN 53453	Impact testing of plastics by the torsion pendulum test
DIN 53759	Creep testing of plastics hollow bodies
DIN EN 10204	Inspection documents for metallic products (includes Amendment A1:1995)

3 Material

Pipes shall be made from polypropylene (PP) moulding material, stabilized by means of suitable antioxidants. The choice of stabilizers and other additives shall be left to the pipe manufacturer. Moulding material of unknown composition shall not be used.

4 Requirements

4.1 Condition on delivery

Pipe ends shall be cut as square as possible to the pipe axis. Pipes shall be free from blisters, shrink holes and inhomogeneities which would impair their performance in service. They shall be of uniform colour throughout.

4.2 Surface finish

The internal and external pipe surfaces shall be smooth. Slight corrugations, with consequent variations in wall thickness, are acceptable provided that the

thickness of the pipe wall is at no point less than that specified in DIN 8077. Pipes with sharp-edged grooves or sink marks are not permitted.

4.3 Dimensions and limit deviations

The pipe outside diameter and wall thickness shall comply with the specifications of DIN 8077, which also applies by analogy to pipes of sizes deviating from the series of preferred numbers given in DIN 323-1 and from international specifications.

4.4 Creep strength

When tested in accordance with subclause 5.3 using the test conditions specified in table 1, pipes shall neither burst nor leak during the prescribed period of stressing.

Table 1

Test temperature in °C	Exposure medium	PP-H		PP-B		PP-R		
		Proof stress, $\sigma_{0,}$ in N/mm^2	Period of stressing (minimum time to failure), *t*, in hours	Proof stress, $\sigma_{0,}$ in N/mm^2	Period of stressing (minimum time to failure), *t*, in hours	Proof stress, $\sigma_{0,}$ in N/mm^2	Period of stressing (minimum time to failure), *t*, in hours	
20	Air or water	21	1	16	1	16	1	
95	Air or water	3,5	1000	2,6	1000	3,5	1000	Optional
110	Air	1,9	8760*)	1,4	8760*)	1,9	8760*)	Optional
*) For quality control testing performed at the start of production and at any change of material or manufacturing method (valid only temporarily).								

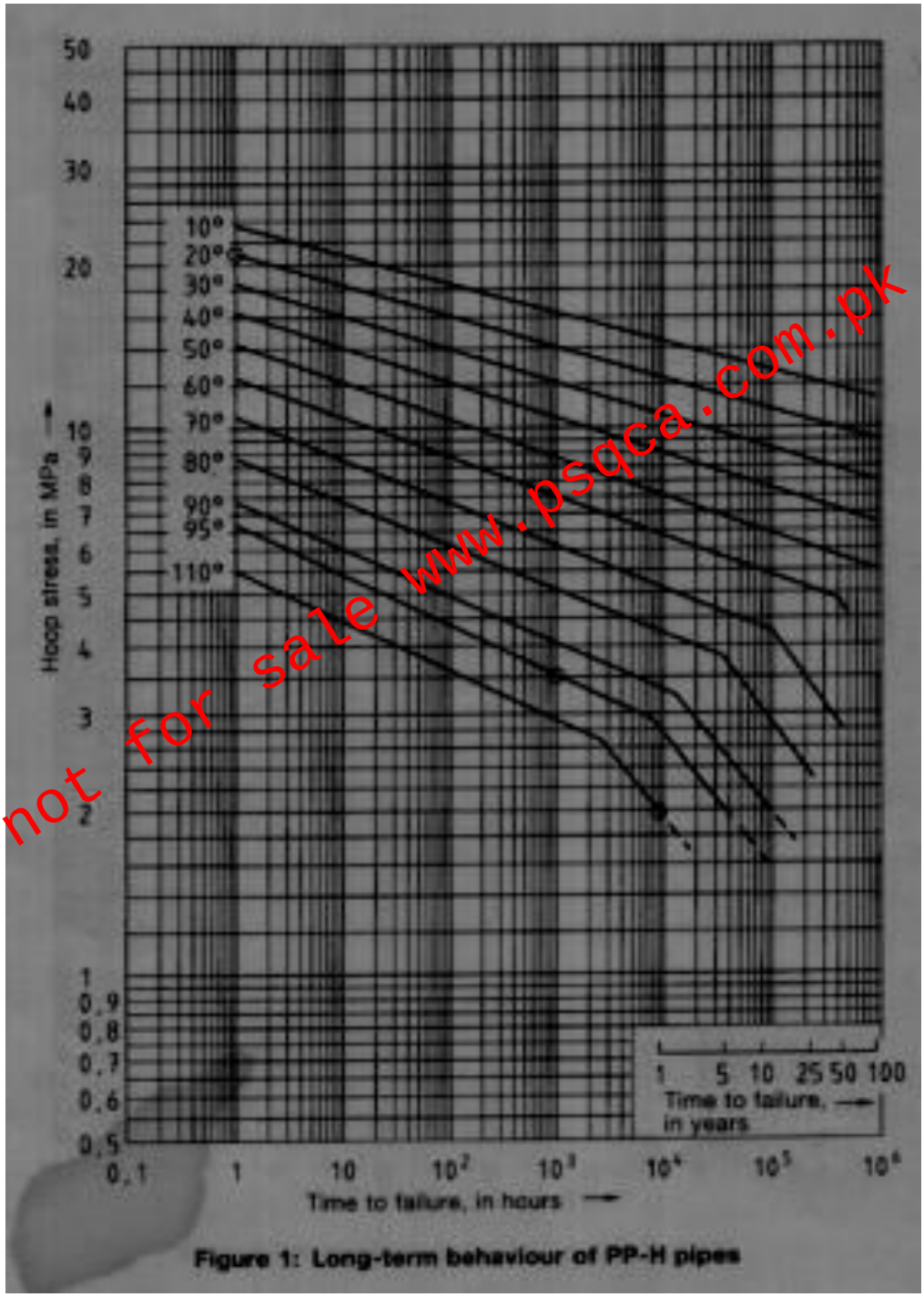


Figure 1: Long-term behaviour of PP-H pipes

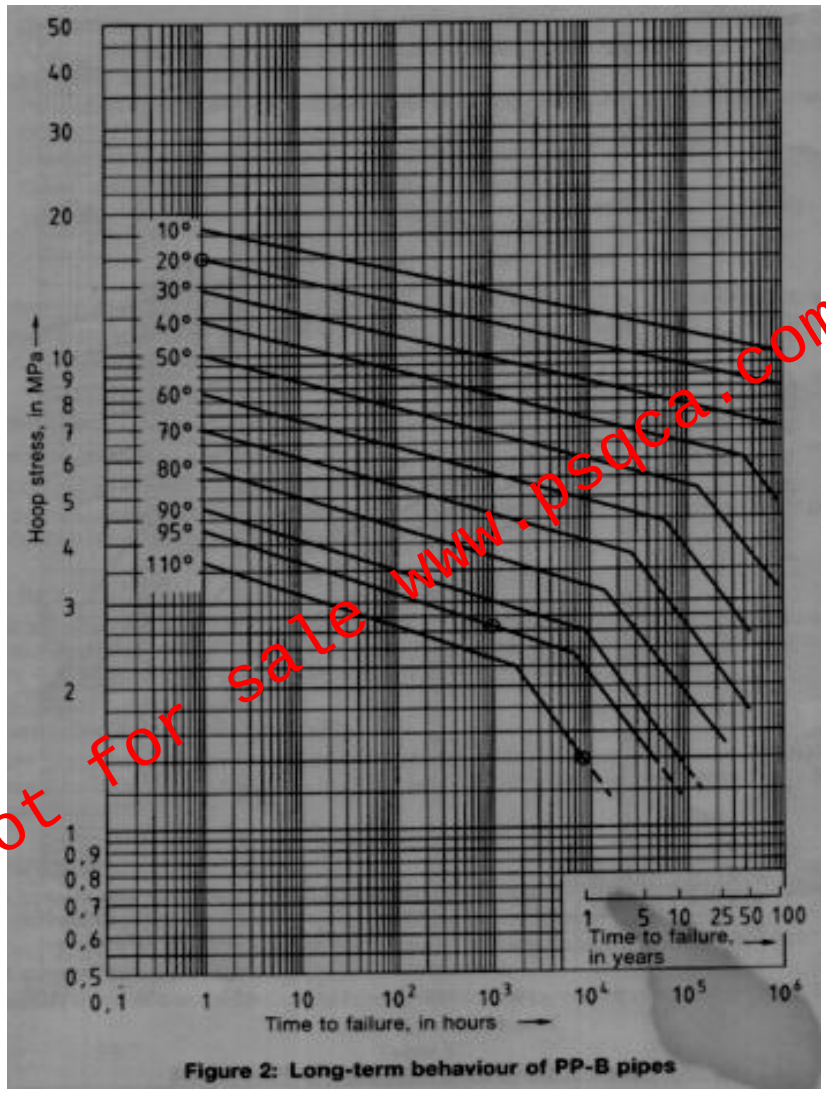


Figure 2: Long-term behaviour of PP-B pipes

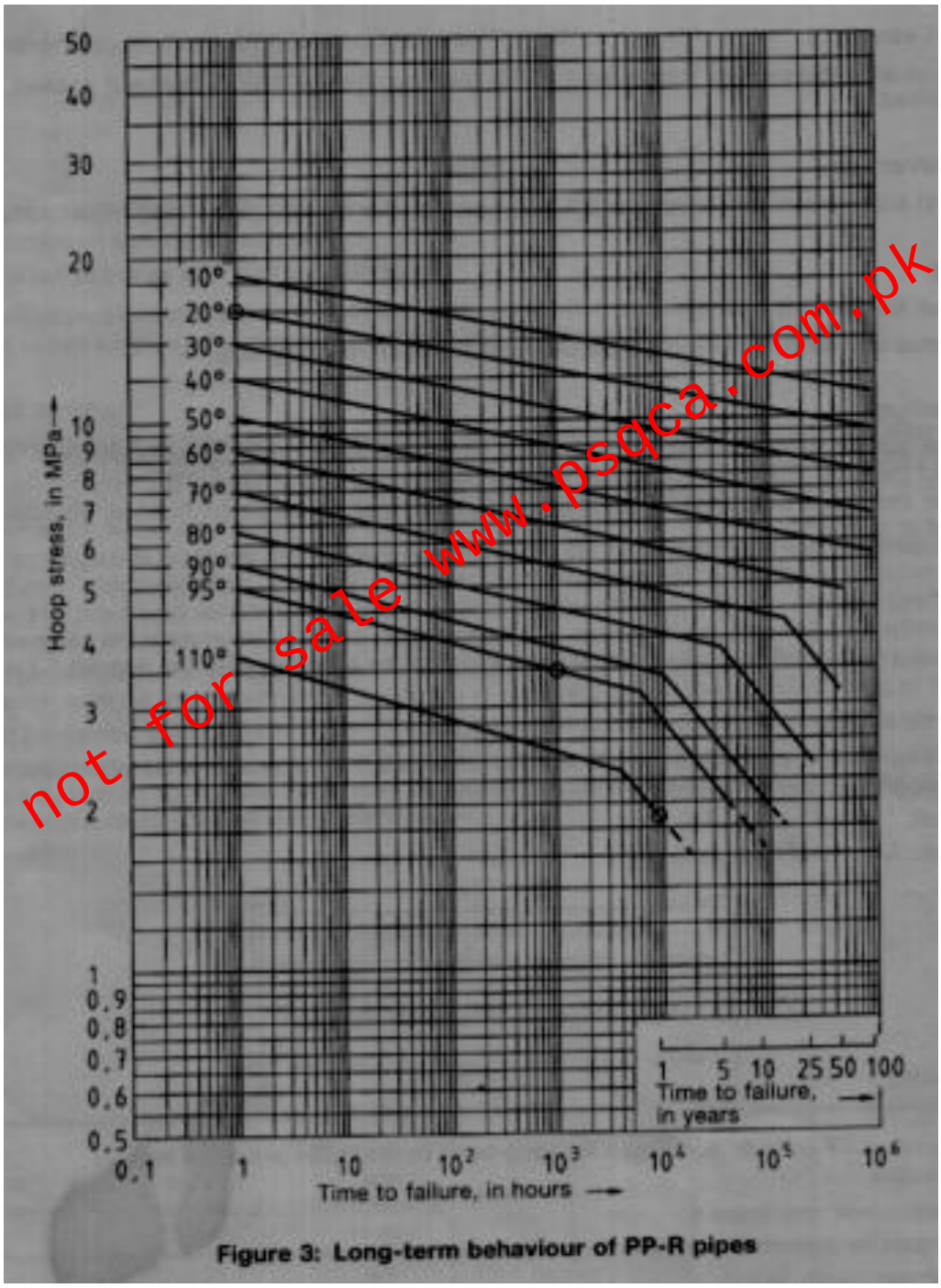


Figure 3: Long-term behaviour of PP-R pipes

4.5 Impact strength

When tested in accordance with subclause 5.4, the total number of failures shall not exceed 10% of the specimens tested.

4.6 Heat reversion

When tested in accordance with subclause 5.5, the mean relative change in pipe length shall not exceed 2%.

5 Testing

5.1 Surface finish

The pipe internal and external surfaces shall be inspected using back lighting.

5.2 Dimensions

The mean pipe outside diameter shall be established, to the nearest 0,1 mm, by circumferential measurement at both ends of the pipe. The wall thicknesses shall be determined, to the nearest 0,1mm, by measurement at four points per end, these being spaced as evenly as possible around the circumference. Measurements shall be carried out at (23±2) ^{o}C.

5.3 Ovality

Ovality is the difference between the maximum and the minimum outside diameters at the same cross section. It shall be measured immediately after manufacture and shall be determined to the nearest 0,1mm.

5.4 Creep strength

See DIN 53759 for general information on this test. For each stress given in table 1, three sections of pipe shall be taken as specimens and be cut to the following lengths:

For $d \leq 250$mm: $l1 \approx 3d + 2l_5 + 250mm$

For $d > 250$mm: $l1 \approx 1000mm + 2l_5$

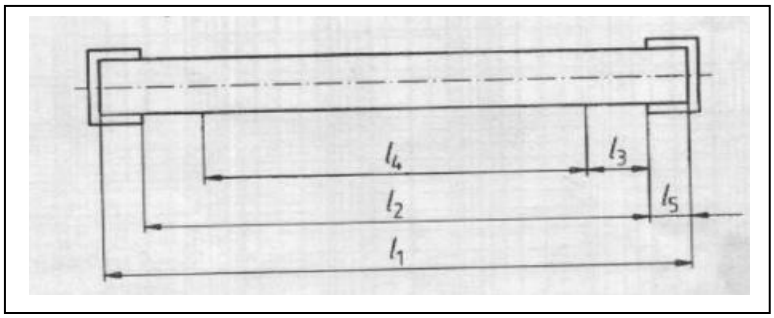


Figure 4: Specimen for long-term hydrostatic pressure test

In the above equations and figure 4,

d is the pipe outside diameter, in mm;

l_1 is the specimen length, in mm;

l_2 is the test length, in mm;

l_3 is the length of pipe zone affected by the end sealing devices being clamped, in mm:

for $d \leq 250mm$: $l_3 = d$,

for $d > 250mm$: $l_3 = 250mm$;

l_4 *is the assessment length, in mm* ($= l_2 - 2\, l_3$);

l_5 *is the length, in mm, required for fixing the end sealing devices*

The wall thickness shall be measured at eight points over l_4 *and the outside diameter at three points, to an accuracy of 0,1mm, and the minimum wall thickness,* S_{min}, and mean outside diameter $\bar{d}$ determined. Sealing devices shall be fitted at both ends of the specimen, which shall remain free to move in the axial direction during the test. The pipe shall be filled with water at the test temperature specified in table 1 (maintained to within ±5 K) through an aperture in one of the sealing devices, then placed in a water bath heated to test temperature (maintained to within ±1K) and kept there for not less than one hour to reach thermal equilibrium. If the pipe is filled with water at a lower temperature, it shall be kept in the bath for 12 hours to ensure thermal equilibrium.

The pressure in the pipe, which is to remain in the bath throughout the test, shall then be steadily increased to reach the specified proof stress within one

minute. This pressure shall be maintained to within±2,5% for the period of stressing specified in table 1.

The proof pressure, p_e, $p = \frac{2 \cdot s_{min} \cdot \sigma_0}{\bar{d} - s_{min}}$

where

$\bar{d}$ is the mean outside diameter over l4 ;

smin is the minimum wall thickness over l4 ;

σ0 is the proof stress as specified in table 1.

It shall be established whether the pipe leaks or bursts during the specified period of stressing. Tests where the pipe fails within length l3 during that period shall not be counted and shall be repeated.

5.5 **Impact strength**

In accordance with the specifications given in table 2, specimens shall be prepared from the pipes either in the form of pipe sections or of bars taken along the pipe axis (cf. figure 5). The latter shall be taken from sections of pipe in lengths of (50±1) mm or (120±2) mm at points spaced as evenly as possible around the circumference. The specimen width specified in table 2 corresponds to dimension b in figure 5.

The internal and external surfaces of the specimens shall not be machined if the wall thickness, s, does not exceed 10,5mm. Otherwise, the external surfaces shall be machined until the specimen thickness is (10±0,5) mm. The machined surfaces shall then be smoothed lengthwise with fine emery paper (of grain size No.220 or finer).

Testing shall be carried out on ten specimens on the lines of DIN53453, using a DIN51222-15 pendulum impact testing machine, with the impact applied either to the external surface or the machined face of the specimen. Testing shall be carried out at (23±2)^{o}C for PP-H pipes and at (0±2) ^{o}C for PP-B and PP-R pipes.

It shall be carried out on ten specimens on the lines of DIN 53453, using a DIN 51222-15 pendulum impact testing machine, with the impact applied either to the external surface or the machined face of the specimen. Testing shall be carried out at (23±2) ^{o}C for PP-H pipes and at (0±2) ^{o}C for PP-B and PP-R pipes.

It shall be established whether the specimens fail. If more than one specimen falls in this test, the test shall be repeated on a further 20 specimens taken from the same pipe. In this case, the total number of failures from the first and second tests shall be evaluated together.

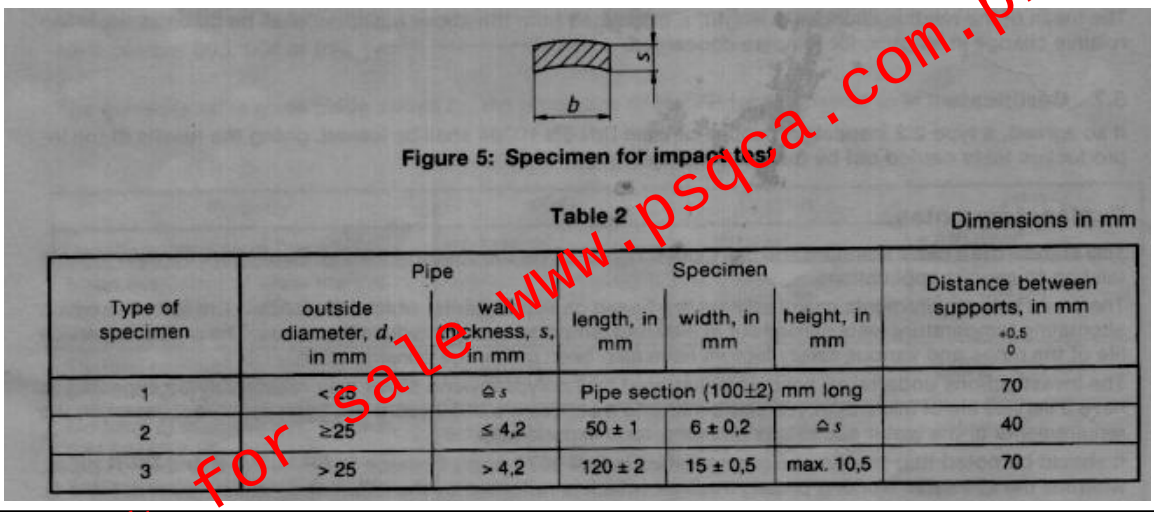


Figure 5: Specimen for impact test

Table 2

Dimensions in mm

Type of specimen	Pipe: outside diameter, d, in mm	Pipe: wall thickness, s, in mm	Specimen: length, in mm	Specimen: width, in mm	Specimen: height, in mm	Distance between supports, in mm $^{+0.5}_{0}$
1	< 25	≙ s	Pipe section (100±2) mm long			70
2	≥25	≤ 4,2	50 ± 1	6 ± 0,2	≙ s	40
3	> 25	> 4,2	120 ± 2	15 ± 0,5	max. 10,5	70

5.6 Heat reversion

Either three complete sections of pipe, each about 200mm long, shall be used as specimens, or, where the pipe diameter is 200mm or more, three pieces of pipe about 200mm long taken along the pipe axis and with an approximate arc length of 200mm shall be cut from the sample pipe. In the latter case, the pipe section shall be divided into pieces measuring approximately 200mm square (e.g. a 200X11.4mm section will be divided into three, and a 1000x38,5mm section, into 15 pieces). The direction of the pipe axis shall be marked on the pieces. All pieces shall be tested.

A mark shall be scribed on the external surface approximately 50mm from each end of the pieces so obtained, in the axial direction of the pipe (for complete pipe sections, the mark shall be scribed around the whole circumference). The distance between the two marks, l_0 (reference length),

shall be approximately 100mm and shall be measured, at (23±2) °C, to an accuracy of 0,25mm.

To ensure that changes in length are not obstructed, the specimens shall be placed concave side up on a glass plate dusted with talcum.

The glass plate with the specimens shall then be placed in an oven with forced air circulation as specified in DIN50011-1 that has been brought to test temperature. The specimen shall be kept in the oven at the temperatures and for the periods specified in table 3.

Table 3

Type of pipe	Test temperature, in °C	Minimum period of stressing, *t*, in mm
PP-H	150 ± 2	120 ± 2
PP-B	150 ± 2	120 ± 2
PP-R	135 ± 2	120 ± 2

After removal of the specimens from the oven, they shall be left as they are on the plate to cool in air down to test temperature. The minimum distance between the gauge marks, $l_{min,}$ shall then be measured. The relative change in length, ε, as a percentage, is to be calculated using equation (2):

$$\varepsilon = \frac{l_0 - l_{min} \cdot 100}{l_0}$$

where

l_0 is the distance between the gauge marks before thermal treatment;

l_{min} is the distance between the gauge marks after thermal treatment and cooling.

The mean of the relative changes in length, ε, calculated from the above equation, shall be taken as the mean relative change in lengt, ε, for the pipe concerned.

5.7 Certificate

If to agreed, a type 2.2 inspection document as in DIN EN 10204 shall be issued, giving the results of the introduction tests carried out by the manufacturer.

Explanatory notes

This standard is a basic standard and therefore does not cover the scope of testing, inspection, or requirements relating to special applications.

The creep test requirements specified here are based on experiments, which have shown the extent to which alternating temperature tests carried out at elevated temperatures can reduce test times. The probable service life of the pipes and various safety factors have also been given due consideration.

The investigations undertaken have demonstrated that polypropylene pipes may reasonably be expected to have a service life of more than 100 years (hitherto a service life of 50 years has been assumed, based on the requirements of the water authorities and long-term experience).

It should be noted that the dimensions specified in DIN 8077 apply likewise to PP-H, PP-B and PP-R pipes, whereas the allowable working pressures differ (which is reflected by the different σ_0 values given in table 1). Specifications with respect to the composition of the pipe material and the methods of manufacture have not been included in order not to impede technical innovation. The specification that moulding material of unknown composition should not be used is intended to prevent the use of unsuitable material, while allowing the manufacturer to derive technical and economic advantages to be

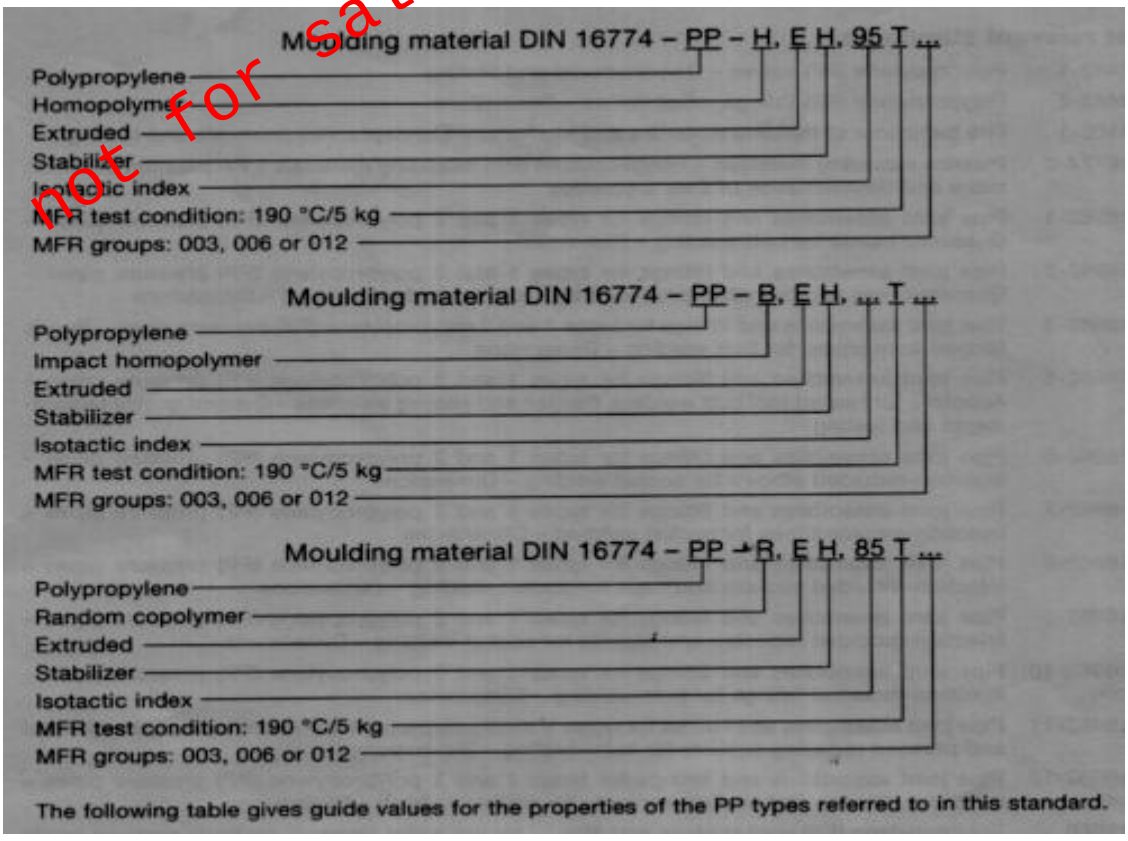
gained from using of his own rework material. The following type of moulding material specified in DIN 16774-1 is generally used for the manufacture of polypropylene (PP) pipes:

Table 4

Property	PP-H	PP-B	PP-R
Density (testing as in DIN 53479)	≈ 0,91 g/cm³	≈ 0,91 g/cm³	≈ 0,91 g/cm³
Mean coefficient of linear thermal expansion (0 to 110 °C; testing as in DIN 53752)	≈ 1,5 · 10^{-4} K^{-1}	≈ 1,5 · 10^{-4} K^{-1}	≈ 1,5 · 10^{-4} K^{-1}
Thermal conductivity (testing as in DIN 52612-1)	≈ 0,23 W · K^{-1} · m^{-1}	≈ 0,23 W · K^{-1} · m^{-1}	≈ 0,23 W · K^{-1} · m^{-1}
Modulus of elasticity (testing as in DIN 53457)[1])	≈ 1200 N/mm²	≈ 1 000 N/mm²	≈ 800 N/mm²
Surface resistance (testing as in DIN 53482	> 10^{12} Ω	> 10^{12} Ω	> 10^{12} Ω

[1]) Specimen preparation as in DIN 16774-2.

Pipes as specified in this standard comply with building material class B 2 (non-readily ignitable) as defined in DIN 4102-1 as long as no flame retardants are used.



Other relevant standards

DIN3442-1	Polypropylene (PP) valves- Requirements and testing
DIN3442-2	Polypropylene (PP) fittings- Ball valves- Dimensions
DIN4102-1	Fire behavior of building materials and elements-Concepts, requirements and testing
DIN 16774-2	Plastics moulding materials-Polypropylene (PP) moulding materials- Preparation of specimens and determination of their properties
DIN 16962-1	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes- Gusseted bends for butt welding-Dimensions
DIN 16962-2	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes-Gusseted tees and branches produced by necking, for butt welding – Dimensions
DIN 16962-3	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes – Bends formed from pipes, for butt welding – Dimensions
DIN 16962-5	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes- Adaptors for heated tool butt welding, flanges and sealing elements- General quality requirements and testing
DIN16962-6	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes- Injection – moulded elbows for socket welding- Dimensions
DIN 16962-7	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes – Injection-moulded tees for socket welding-Dimensions

DIN16962-8	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes- Injection-moulded sockets and caps for socket welding-Dimensions
DIN16962-9	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes-Injection-moulded reducers and nipples for socket welding-Dimensions
DIN16962-10	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes-Injection-moulded fittings for butt welding-Dimensions
DIN 16962-11	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes- Turned and pressed reducing sockets for butt-welding-Dimensions
DIN16962-12	Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes-Adaptors, flanges and sealing elements for socket welding-Dimensions
DIN 19560	Polypropylene (PP) socket pipes and fitting for hot water resistant drainage systems inside buildings- Dimensions and technical delivery conditions
DIN 52612-1	Determination of the thermal conductivity of thermal insulating materials by the guarded hot – plate apparatus-Procedure and evaluation
DIN 53457	Determination of elastic modulus of plastics by tensile, compression and bend testing
DIN 53479	Determination of density of plastics and elastomers
DIN 53482	Testing of materials used in electrical engineering-Measurement of electrical resistance of nonmetallic materials
DIN 53752	Determination of coefficient of linear thermal expansion of plastics