Using Laboratory CNC Milling Machine for Tensile Testing of PP Pipes According to ISO 15874

Description

First lets take a look at the tests need to be done on the pipe itself according to this norm:

5 General characteristics
5.1 Appearance
When viewed without magnification the internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities, and other surface defects to an extent that would prevent conformity to this standard.
The material shall not contain visible impurities. Slight variations in appearance of the colour are permitted. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.
5.2 Opacity
Polypropylene pipes that are declared to be opaque shall not transmit more than 0,2 % of visible light, when tested in accordance with ISO 7686.

6 Geometrical characteristics

Besides above specification for general characteristics and geometrical characteristics we have below mechanical, physical and chemical characteristics:

7 Mechanical characteristics
When tested in accordance with the test methods as specified in Table 10 using the indicated parameters, the pipe shall withstand the hydrostatic (hoop) stress without bursting. In the case of pipes with (a) barrier layer(s) the test shall be carried out on test pieces produced without the barrier layer(s).

Table 10 — Mechanical characteristics of pipes

Characteristic	Requirement	Test parameters for the individual tests				Test method
		PP-H				
Resistance to internal pressure	No failure during the test period	Hydrostatic (hoop) stress MPa	Test temp. °C	Test period h	Number of test pieces	ISO 1167-1, ISO 1167-2
		21,0	20	1	3	
		5,1	95	22	3	
		4,2	95	165	3	
		3,6	95	1000	3	
		PP-B				
		Hydrostatic (hoop) stress MPa	Test temp. °C	Test period h	Number of test pieces	
		16,0	20	1	3	
		3,5	95	22	3	
		3,0	95	165	3	
		2,6	95	1000	3	
		PP-R				
		Hydrostatic (hoop) stress MPa	Test temp. °C	Test period h	Number of test pieces	
		16,0	20	1	3	
		4,3	95	22	3	
		3,8	95	165	3	
		3,5	95	1000	3	
		PP-RCT				
		Hydrostatic (hoop) stress MPa	Test temp. °C	Test period h	Number of test pieces	
		15,0	20	1	3	
		4,2	95	22	3	
		4,0	95	165	3	
		3,8	95	1000	3	
		Test parameters for all tests				
		Sampling procedure	[a]			
		Type of end cap	Type A			
		Orientation of test piece	Not specified			
		Type of test	Water-in-water			

[a] The sampling procedure is not specified. For guidance see ISO/TS 15874-7 [3].

8 Physical and chemical characteristics

When tested in accordance with the test methods as specified in Table 11 using the indicated parameters, the pipe shall conform to the requirements given in this table.

Table 11 — Physical and chemical characteristics of pipes

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Longitudinal reversion	≤ 2 %	Test temperature		Method B of ISO 2505 (oven test)
		PP-H	150 °C	
		PP-B	150 °C	
		PP-R	135 °C	
		PP-RCT	135 °C	
		Duration of exposure for:		
		$e_n \leq 8$ mm	1 h	
		8 mm < $e_n \leq 16$ mm	2 h	
		$e_n > 16$ mm	4 h	
		Number of test pieces	3	
Thermal stability by hydrostatic pressure testing	No bursting during the test period	Sampling procedure	[a]	ISO 1167-1, ISO 1167-2
		Hydrostatic (hoop) stress		
		PP-H	1,9 MPa	
		PP-B	1,4 MPa	
		PP-R	1,9 MPa	
		PP-RCT	2,6 MPa	
		Test temperature	110 °C	
		Type of test	Water-in-air	
		End cap	Type A	
		Orientation	Not specified	
		Test period	8760 h	
		Number of test pieces	1	
Impact resistance	≤ 10 %	Sampling procedure	[a]	ISO 9854-1, ISO 9854-2
		Test temperature PP-H	23 °C	
		PP-B	0 °C	
		PP-R	0 °C	
		PP-RCT	0 °C	
		Number of test pieces	10	
Melt flow rate (compound)	≤ 0,5 g/10 min	Test temperature	230 °C	ISO 1133-1
		Mass	2,16 kg	
		Number of test pieces	3	
Melt flow rate (pipe)	30 % maximum difference compared with compound from the same batch.	Test temperature	230 °C	ISO 1133-1
		Mass	2,16 kg	
		Number of test pieces	3	

[a] The sampling procedure is not specified. For guidance see ISO/TS 15874-7 [3].

Above writings from ISO 15874 shows there is no tensile testing defined for performance of the pipes according to this norm.

Customer wants to do tensile testing according to ISO 6259 for his own reserach purposes. Lets see what it tells us:

This standards has 3 parts:

Thermoplastics pipes — Determination of tensile properties — **Part 1:General test method**

Thermoplastics pipes — Determination of tensile properties — **Part 2: Pipes made of unplasticized poly(vinyl chloride) (PVC-U), oriented unplasticized poly(vinyl chloride) (PVC-O), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI)**

Thermoplastics pipes — Determination of tensile properties — **Part 3: Polyolefin pipes**

Then we are going to check part 3 for "**Polyolefin pipes**".

1 Scope
This part of ISO6259 specifies a method of determining the tensile properties of polyolefin (polyethylene,
cross-linked polyethylene, polypropylene, and polybutene) pipes, and the following properties:
— the stress at yield;
— the elongation at break.

This part of ISO 6259 also gives the corresponding basic specifications in Annexes A to D for information
purposes only.

5 Apparatus
See ISO 6259-1:2015, Clause 5, applicable to thermoplastics materials covered by this part of ISO 6259.
6 Test pieces
6.1 Selection of the test pieces
6.1.1 General
The test pieces shall be obtained by die cutting or machining.
NOTE 1 When the thickness of the pipe is less than or equal to 12 mm, the test pieces are to be die cut preferably.

NOTE 2 Care ought to be taken when using die cutting to avoid damaging the test specimen or producing non parallel sides.

6.1.2 Dimensions of test pieces
Test pieces shall be either of Type 1, the shape and dimensions of which are given in Figure 1 and Table 1,
Type 2, the shape and dimensions of which are given in Figure 2 and Table 2, or Type 3, the shape and
dimensions of which are given in Figure 3 and Table 3. The choice of test piece is dependent on the wall
thickness of the pipe from which it is taken (see 6.2).
NOTE 1 The Type 1 test piece is identical to the Type 1B specified in ISO 527-2 [1]. The Type 2 test piece is
identical to the Type 2 specified in ISO 6259-2 [2]. The Type 3 test piece is identical to the Type B test piece in ISO 13953 [3].

NOTE 2 In order to avoid slippage in the grips, it is recommended that the width of the ends of the test piece (B) be increased in proportion to the thickness (en) in accordance with Formula (1):
B = en + 15 (mm) (1)

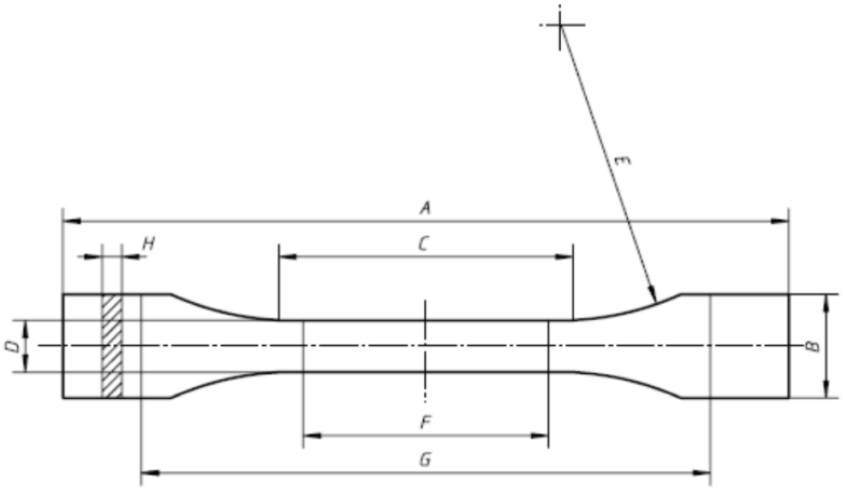


Figure 1 — Type 1 test piece

Table 1 — Dimensions of Type 1 test pieces

Symbol	Description	Dimensions mm
A	Overall length (min.)	150
B	Width of ends[a]	20 ± 1
C	Length of narrow, parallel-sided portion	60 ± 1
D	Width of narrow, parallel-sided portion	10 ± 0,2
E	Radius	60 ± 1
F	Gauge length	50 ± 1
G	Initial distance between grips	115 ± 5
H	Thickness	that of the pipe

[a] This dimension can be larger in accordance with Note 2 of 6.1.2.

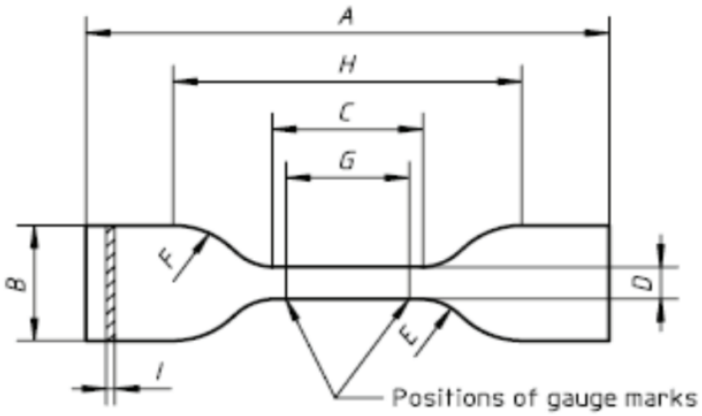


Figure 2 — Type 2 test piece

Table 2 — Dimensions of Type 2 test pieces

Symbol	Description	Dimensions mm
A	Overall length (min.)	115
B	Width of ends	25 ± 1
C	Length of narrow, parallel-sided portion	33 ± 2
D	Width of narrow, parallel-sided portion	6+0,4 0
E	Small radius	14 ± 1
F	Large radius	25 ± 2
G	Gauge length	25 ± 1
H	Initial distance between grips	80 ± 5
I	Thickness	that of the pipe

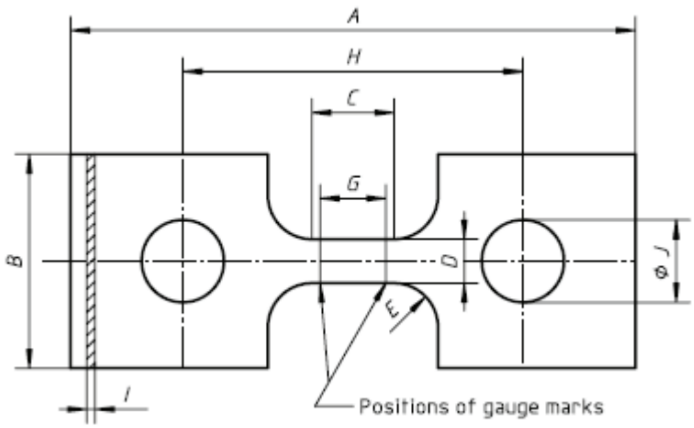


Figure 3 — Type 3 test piece

Table 3 — Dimensions of Type 3 test pieces

Symbol	Description	Dimensions mm
A	Overall length (min.)	250
B	Width of ends	100 ± 3
C	Length of narrow, parallel-sided portion	25 ± 1
D	Width of narrow, parallel-sided portion	25 ± 1
E	Radius	25 ± 1
G	Gauge length	20 ± 1
H	Initial distance between centres of loading pins	165 ± 5
I	Thickness	that of the pipe[a]
J	Diameter of hole	30 ± 5

[a] The thickness of specimens taken from pipe of >50 mm thickness can be reduced by machining so that the reduced thickness of the parallel gauge portion of the specimen shall be at least twice the width, .i.e. ≥50 mm. It is recommended to machine from both sides of the test specimens of >50 mm wall thickness so that the test piece originates from the centre of the pipe wall.

6.2 Preparation of test pieces

The test pieces shall be taken from the centre of strips cut from the length of pipe in accordance with ISO 6259-1:2015, 6.2.1. The type of test piece shall be selected according to the thickness of the pipe as
shown in Table 4.

Table 4 — Type of test piece to be used

Nominal wall thickness of pipe e_n mm	Type of test piece
$e_n \leq 5$	Type 2
$5 < e_n \leq 12$	Type 1
$12 < e_n \leq 25$	Type 1 or Type 3
$e_n > 25$	Type 3

6.3 Cutting method

Use a cutting die with a profile corresponding to that of the Type 1 or Type 2 test piece, depending on thickness of the pipe, see ISO 6259-1:2015, 5.6.
Cut out the test piece at ambient temperature, applying the die cutter to the inner surface of the strip and exerting a continuous uniform pressure.

Customer has 32mm outer diameter pipe and need to do tensile testing according to ISO 6259-2. According the above comments if the thickness of pipe is between 5 and 12mm then we need to choose sample type 1. the thickness of pipe he choose is 5.4 mm, then we need to cut samples according to type 1. Lets take a look at ISO 6259-1 general test method about how to cut this sample type 1 from a pipe that has 32mm outer diameter and 5.4mm thickness.

6 Test Pieces

6.1 Type of the test piece

The test pieces shall conform to the relevant type specified in ISO 6259-2:1997 or ISO 6259-3:2015 or the relevant product standard, as applicable.

6.2 Preparation of test pieces

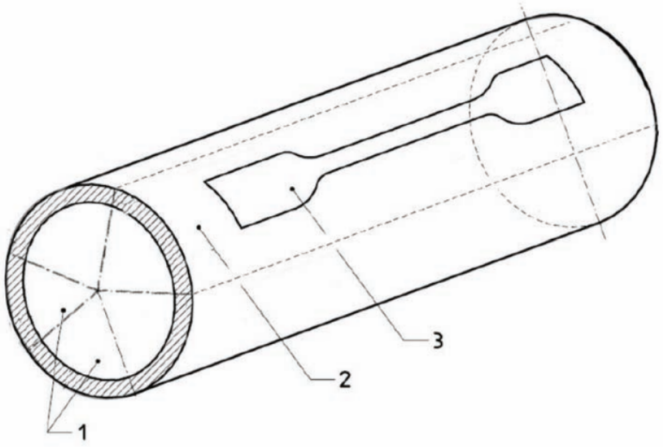
6.2.1 Sampling from the pipe

Take sections of pipe of the appropriate length according to the type of test piece to be used.
Cut strips from the pipe section as supplied, i.e. which has not been heated or flattened, so that their axes are parallel to the axis of the pipe. Small diameter pipes might need to be cut and opened to allow the strips to be cut.
Cut strips from the pipe section in such a way that they are equally distributed around the circumference
of the pipe as shown in Figure 1, starting from a reference line drawn along the pipe. Cut out one test piece per strip.

The minimum number of test pieces is given in Table 1. When it is not possible to obtain the required number of strips from around the circumference of one pipe section, additional strips shall be taken from another section of the pipe.

Table 1 — Minimum number of test pieces

Nominal outside diameter, d_n mm	$15 < d_n \leq 32$	$32 < d_n \leq 63$	>63
Number of strips	2	3	5



Key
1 sectors
2 strip
3 test piece

Figure 1 — Preparation of test pieces

6.2.2 Selection of test pieces

6.2.2.1 Selection

Select the test pieces from the centre of the strips taken from the length of pipe either by die cutting or machining, in accordance with ISO 6259-2:1997 or ISO 6259-3:2015 or relevant product standard, or in accordance with the appropriate product standard for the pipe material.

6.2.2.2 Cutting method

Use the cutting die (5.6) with clean cutting edges, free from notches, with the profile shown in ISO 6259-2:1997 or ISO 6259-3:2015, as applicable.

Cut the test piece from the strip (see 6.2.1).

Care should be taken when using die cutting to avoid damaging the test piece or producing non-parallel sides.

6.2.2.3 Machining method

Produce the specimen by milling, where necessary, using a milling jig.

The shape of the milling cutter and the machining conditions (speed of rotation and advance) are at the discretion of the operator. They shall, however, be chosen so as to avoid excessive heating of the test piece and deterioration of its surface such as cracks, scratches, or other visible flaws.

For the machining procedure, it is recommended that the user consult ISO 2818[3].

Based on above comments i am proposing our valued customer to cut the 32mm pipe in two pieces (according to table 1-ISO 6259-1) in length. pointing him to section 6.2.1 of ISO 6259-1 “Small diameter pipes might need to be cut and opened to allow the strips to be cut“. After cutting, need to open two pieces so that we can cut sample pieces of width 20mm (that is for type 1) from those opened pieces.

CNC Milling for Tensile Sample Preparation-Max40mm

Category

1. Equipment for Standards
2. Standards