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Plastics — Extruded sheets of poly(vinylidene fluoride) (PVDF) — Requirements and test methods

Plastiques — Plaques extrudées en poly(fluorure de vinylidène) (PVDF) — Exigences et méthodes d'essai

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Foreword

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 15014 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*, in collaboration with Technical Committee CEN/TC 249, *Plastics*, of the European Committee for Standardization (CEN).

Plastics — Extruded sheets of poly(vinylidene fluoride) (PVDF) — Requirements and test methods

1 Scope

This International Standard specifies the requirements and test methods for solid flat extruded sheets of poly(vinylidene fluoride) homopolymers and poly(vinylidene fluoride) copolymers without fillers or reinforcing materials. This International Standard also applies to PVDF sheet in rolled form. It applies only to thicknesses from 1 mm to 15 mm.

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 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

ISO 2818, *Plastics — Preparation of test specimens by machining*

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

ISO 11501, *Plastics — Film and sheeting — Determination of dimensional change on heating*

ISO 12086-1, *Plastics — Fluoropolymer dispersions and moulding and extrusion materials — Part 1: Designation system and basis for specification*

3 Material

Sheets shall consist of PVDF extrusion materials as defined in ISO 12086-1, without fillers or reinforcing materials. The extrusion materials can contain additives such as processing aids, stabilizers and colorants. Materials and additives of unknown identity shall not be used.

NOTE Legal conditions may necessitate a specific choice of extrusion material (see 4.3.3).

4 Requirements

4.1 Appearance

Sheets shall be substantially free from bubbles, voids, cracks, visible impurities and other defects which would make them unfit for the intended use. Surfaces shall be substantially smooth and free from sharp grooves, sink marks or damage. Colorants shall be homogeneously distributed throughout the material. Slight colour variations due to variations in the extrusion compound or processing conditions are admissible. The exact extent of variations in any of the above shall be agreed between the interested parties. Sheets shall be examined in accordance with 5.3.

4.2 Dimensional tolerances

4.2.1 Thickness

For any individual sheet, the thickness tolerance with reference to the nominal thickness shall be as given by

$$|\Delta h| \leqslant (0{,}08\ \text{mm} + 0{,}03 \times h_n) \quad (1)$$

where

Δh is the tolerance on the thickness, in millimetres;

h_n is the nominal thickness, in millimetres.

Testing shall be in accordance with 5.4.1.

4.2.2 Length and width

The nominal length, l_n, and nominal width, b_n, of sheets shall be as agreed between the interested parties. Unless agreed differently, the length shall be in the direction of extrusion.

For any individual sheet selected at random from any delivery, the tolerances on length and width shall be in accordance with Table 1. Testing shall be in accordance with 5.4.2.

Table 1 — Tolerances on length and width of sheet

Dimensions in millimetres

Nominal dimension D_n	Tolerances	
	Length	Width
$D_n \leqslant 500$	$^{+2}_{-1}$	$^{+2}_{-1}$
$500 < D_n \leqslant 1\,000$	$^{+3}_{-1}$	$^{+3}_{-1}$
$1\,000 < D_n \leqslant 1\,500$	$^{+4}_{-1}$	$^{+4}_{-1}$
$1\,500 < D_n \leqslant 2\,000$	$^{+6}_{-1}$	$^{+4}_{-1}$
$2\,000 < D_n \leqslant 3\,000$	$^{+8}_{-1}$	$^{+6}_{-1}$
$3\,000 < D_n \leqslant 4\,000$	$^{+11}_{-1}$	$^{+7}_{-1}$

For rolled sheets, the minimum length shall be the nominal length.

4.2.3 Rectangularity

For any individual sheet selected at random from any delivery, the rectangularity tolerance, expressed as the difference in length of the diagonals, $|d_1 - d_2|$ (see Figure 1), shall be in accordance with Table A.1.

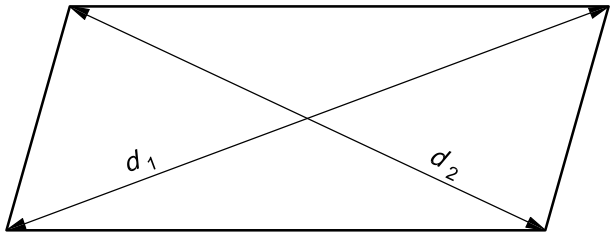


Figure 1 — Difference between lengths of diagonals, $|d_1 - d_2|$

Testing shall be in accordance with 5.4.3.

4.3 Properties

4.3.1 Mechanical and thermal properties

Requirements for mechanical and thermal properties are given in Table 2.

Table 2 — Mechanical and thermal properties

Property	Unit	Requirements (average values)			
		PVDF homopolymer group		PVDF copolymer group	Test method subclause
		1.1 [a]	1.2	2.1	
Tensile stress at yield	MPa	⩾ 50	⩾ 40	⩾ 20	5.5
Tensile strain at break	%	⩾ 20	⩾ 6	⩾ 8	5.5
Modulus of elasticity in tension	MPa	⩾ 1 700	⩾ 1 500	⩾ 400	5.6
Charpy impact strength of notched specimens [b]	kJ/m^2	⩾ 10	⩾ 10	⩾ 20	5.7
MFR (230 °C/5 kg)	g/10 min	0,4 to 3,0	1,0 to 7,0	0,2 to 6,0	5.8

[a] Sheets of group 1.1 shall be manufactured from extrusion compounds complying with specific requirements for creep rupture strength (see ISO 9080) and shall be approved by all interested parties.

[b] Only valid for nominal sheet thicknesses $h_n \geqslant 4$ mm.

4.3.2 Behaviour on heating

4.3.2.1 Maximum shrinkage for general applications

For sheets for general applications, the maximum shrinkage in the direction of extrusion shall be less than 3 % after heating. Testing shall be in accordance with 5.9 and Table 5.

4.3.2.2 Maximum shrinkage for thermoforming applications

For sheets for thermoforming applications, the maximum shrinkage in the direction of extrusion shall not exceed the values given in Table 3 when measured using the method in 5.9 under the conditions given in Table 6.

Table 3 — Maximum shrinkage for thermoforming applications

Nominal thickness, h_n (mm)	1	2	4	6	8	10	> 10
Maximum shrinkage in the direction of extrusion (%)	50	40	30	20	15	10	Not applicable

4.3.3 Physiological behaviour

Relevant legislation concerning physiological behaviour shall be taken into consideration.

5 Test methods

5.1 Test specimens

5.1.1 Preparation of test specimens

Representative test specimens shall be cut both longitudinally and transversely from locations evenly distributed over the length and width of the sheet. With sheets in rolled form, a 2 m sample shall be cut from the end of the roll to prepare test specimens. The extrusion direction shall be marked on the test specimens. The surfaces of the test specimens shall be free from damage and faults in order to avoid notch effects. Should any burrs occur on the test specimens during preparation, these shall be eliminated without damaging the surfaces of the specimens. If required, the cut edges shall be finished with abrasive paper (grain size 220 or finer), the direction of abrasion being along the length of the test specimens. If it is necessary to machine the sheet to reduce it to the thickness required, one original surface shall be left intact. In particular, test specimens over 4,2 mm thick intended to be used in the tests described in 5.5 to 5.7 shall be machined down on one side to a thickness of 4,0 mm $\pm$ 0,2 mm in accordance with ISO 2818.

5.1.2 Conditioning

Any production quality control test specimens shall be conditioned for at least 16 h in accordance with ISO 291 or as specified in the appropriate material standard. Shorter conditioning times may be used by agreement between the interested parties when it can be shown that there is no significant difference in the results obtained.

5.1.3 Testing

Testing shall be carried out under conditions which are in accordance with ISO 291 or as specified in the appropriate material standard unless otherwise agreed between the interested parties or specified in the individual test standards.

5.2 Delivery condition

Sheets shall be visually examined when delivered to ensure freedom from mechanical damage or other obvious defects. Sheets can be inspected by ultrasonic or X-ray methods where required.

5.3 Appearance

Where possible, sheets shall be examined for visual defects by transmitted light using a suitable light source. Otherwise, sufficiently bright reflected light shall be used. Any defects thus identified shall be compared with the agreed specification (which may be either a written specification or in the form of reference samples) and classified accordingly.

5.4 Dimensions

5.4.1 Thickness, h

The thickness, h, shall be measured using suitable calibrated equipment meeting the specifications of Table 4.

Table 4 — Error limits of equipment

Values in millimetres

Nominal thickness, h_n	Error limit
$1{,}00 < h_n \leqslant 10{,}00$	$\leqslant +0{,}05$
$10{,}00 < h_n \leqslant 15{,}00$	$\leqslant +0{,}10$

5.4.2 Length, l, and width, b

The length, l, and width, b, shall be measured to the nearest 1 mm using suitable equipment. Measurements shall be made directly across the surface of the sheet and along the cut edge.

5.4.3 Rectangularity

For flat sheets, the rectangularity, expressed as the difference between the lengths of the diagonals, $|d_1 - d_2|$, as shown in Figure 1, shall be measured to the nearest 1 mm using a graduated ruler or tape measure.

5.5 Tensile stress at yield, σ_y, and tensile strain at break, ε_B

The tensile stress at yield, σ_y, and tensile strain at break, ε_B, shall be determined using at least five type 1B test specimens in each direction in accordance with ISO 527-2, using a test speed of 50 mm/min $\pm$ 5 mm/min.

5.6 Modulus of elasticity in tension, E_t

The modulus of elasticity in tension, E_t, shall be determined using at least five type 1B test specimens in each direction in accordance with ISO 527-2, using a test speed of 1 mm/min $\pm$ 0,2 mm/min.

5.7 Charpy impact strength of notched specimens, a_{cn}

For nominal sheet thicknesses $h_n \geqslant 4$ mm, the Charpy impact strength of notched specimens, a_{cn}, shall be determined edgewise in accordance with ISO 179-1/1eA or ISO 179-2/1eA, using at least 10 test specimens cut in each direction.

5.8 Melt mass-flow rate (MFR)

The melt mass-flow rate shall be determined in accordance with ISO 1133, using a temperature of 230 °C and load of 5 kg.

5.9 Determination of shrinkage on heating

The shrinkage on heating shall be determined in accordance with the principles of ISO 11501. The principle of the test procedure is as follows:

a) a tray containing a kaolin or talc bed is placed in a circulating-air oven and the temperature controlled such that the bed is within the specified temperature limits;

b) the initial length between the reference marks on each test specimen is measured in the longitudinal direction;

c) the test specimens are heated for a specified period of time at a specified temperature on the kaolin or talc bed in the circulating-air oven;

d) the distance between the longitudinal reference marks is measured again after cooling, and the change in the length of each specimen calculated.

Cut at least three test specimens with dimensions of 100 mm × 100 mm from the centre and both sides of the sheet. The side test specimens shall be taken at least 50 mm from the edge of the sheet. Make one or more pairs of reference marks on the specimens in the extrusion direction. Measure the initial length, L_0, between the pairs of marks with an accuracy of 0,1 mm at room temperature. Dust the specimens with kaolin or talc and place them flat on the kaolin or talc bed in the circulating-air oven. The temperature and duration of the test shall be as given in Table 5 and Table 6.

Table 5 — Test conditions for general applications

Nominal thickness, h_n mm	**Test temperature** °C		**Duration of test** [a] min
	PVDF homopolymer groups 1.1 and 1.2	**PVDF copolymer group 2.1**	
$1 \leqslant h_n \leqslant 2$	150 ± 2	135 ± 2	45 ± 1
$2 < h_n \leqslant 10$	150 ± 2	135 ± 2	60 ± 1
$10 < h_n \leqslant 15$	150 ± 2	135 ± 2	90 ± 1
[a] The heating period until the test temperature is reached is not included.			

Table 6 — Test conditions for thermoforming applications

Nominal thickness, h_n mm	**Test temperature** °C		**Duration of test** [a] min
	PVDF homopolymer groups 1.1 and 1.2	**PVDF copolymer group 2.1**	
$1 \leqslant h_n \leqslant 2$	200 ± 2	185 ± 2	45 ± 1
$2 < h_n \leqslant 10$	200 ± 2	185 ± 2	60 ± 1
$10 < h_n \leqslant 15$	200 ± 2	185 ± 2	90 ± 1
[a] The heating period until the test temperature is reached is not included.			

Remove the tray with the test specimens from the circulating-air oven. Allow to cool down to room temperature. Measure the length, L, of each specimen between the pairs of reference marks. Calculate the shrinkage, ΔL, for each pair of reference marks using Equation (2):

$$\Delta L = \frac{L_0 - L}{L_0} \times 100 \qquad (2)$$

where

ΔL is the shrinkage on heating, in percent;

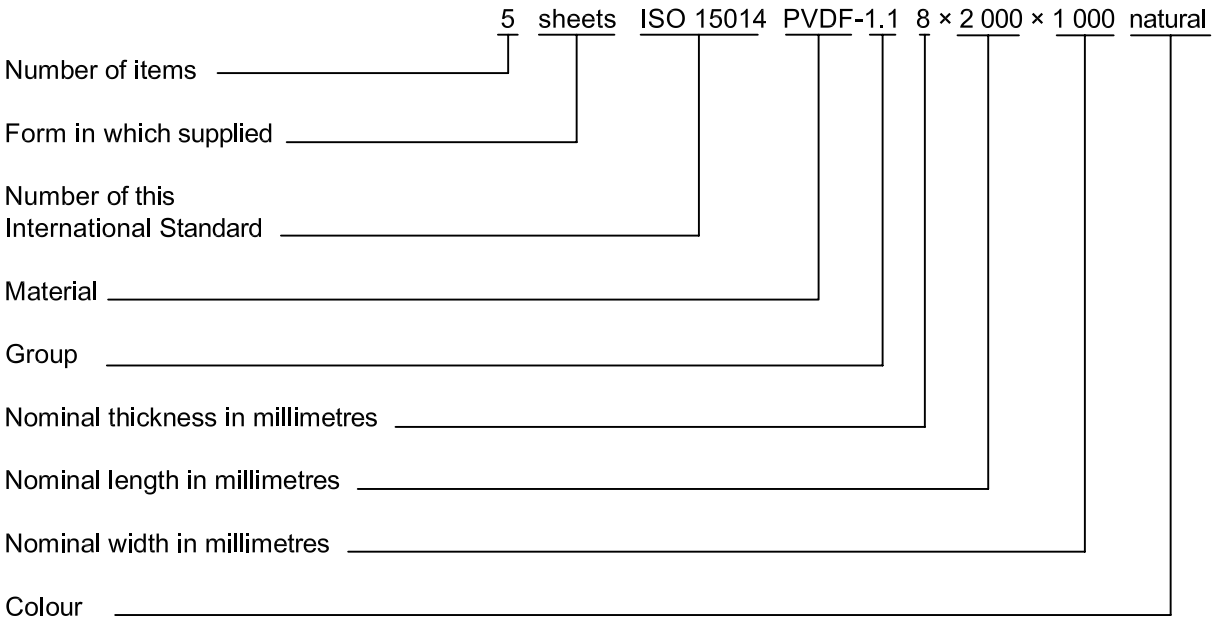
L_0 is the initial length in the direction of extrusion before heating, in millimetres;

L is the length in the direction of extrusion after heating, in millimetres.

Calculate the arithmetic mean of all the ΔL values for all the specimens.

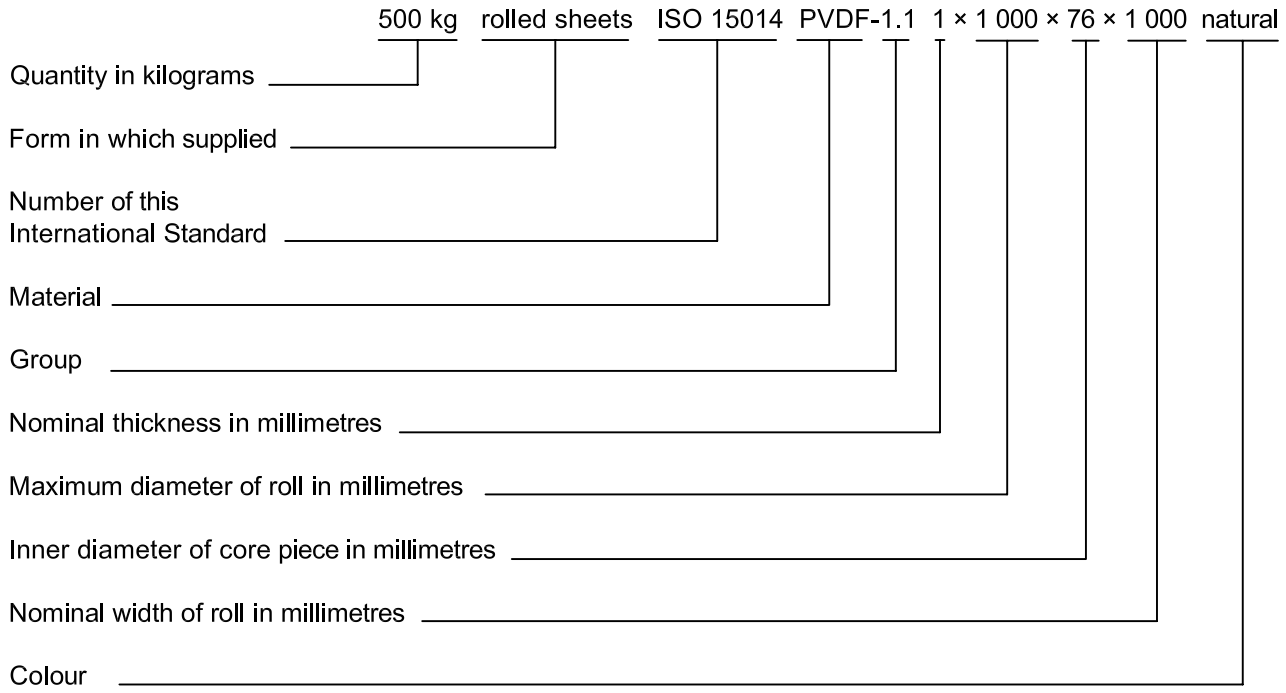
6 Designation

6.1 Example for sheets



Designation: 5/sheets/ISO 15014/PVDF-1.1/8 × 2 000 × 1 000/natural

6.2 Example for sheets in rolled form



Designation: 500 kg/rolled sheets/ISO 15014/PVDF-1.1/1 × 1 000 × 76 × 1 000/natural

7 Marking

Sheets or rolls that conform to this International Standard may be marked with the following information:

a) the manufacturer's name, trade mark or identification mark;

b) the reference number of this International Standard, ISO 15014;

c) the date of manufacture/batch number.

Annex A
(normative)

Requirements for rectangularity

Table A.1 — Maximum limits of deviation from rectangularity (see 4.2.3)

Values in millimetres

Nominal sheet dimensions (length × width)	Maximum limit of deviation from rectangularity $\lvert d_1 - d_2 \rvert$
⩽ 550 × 1 000	3
(> 550 to 900) × 1 000	4
(> 900 to 1 500) × 1 000	5
(> 1 500 to 4 000) × 1 000	6
⩽ 550 × 1 220	3
(> 550 to 800) × 1 220	4
(> 800 to 1 100) × 1 220	5
(> 1 100 to 1 750) × 1 220	6
(> 1 750 to 4 000) × 1 220	7
⩽ 550 × 1 500	3
(> 550 to 750) × 1 500	4
(> 750 to 1 000) × 1 500	5
(> 1 000 to 1 350) × 1 500	6
(> 1 350 to 1 850) × 1 500	7
(> 1 850 to 3 000) × 1 500	8
(> 3 000 to 4 000) × 1 500	9
⩽ 500 × 2 000	3
(> 500 to 700) × 2 000	4
(> 700 to 900) × 2 000	5
(> 900 to 1 150) × 2 000	6
(> 1 150 to 1 450) × 2 000	7
(> 1 450 to 1 800) × 2 000	8
(> 1 800 to 2 300) × 2 000	9
(> 2 300 to 3 000) × 2 000	10
(> 3 000 to 4 000) × 2 000	11

Table A.1 (*continued*)

Nominal sheet dimensions (length × width)	Maximum limit of deviation from rectangularity $\lvert d_1 - d_2 \rvert$
⩽ 500 × 3 000	3
(> 500 to 700) × 3 000	4
(> 700 to 850) × 3 000	5
(> 850 to 1 050) × 3 000	6
(> 1 050 to 1 250) × 3 000	7
(> 1 250 to 1 500) × 3 000	8
(> 1 500 to 1 700) × 3 000	9
(> 1 700 to 2 000) × 3 000	10
(> 2 000 to 2 300) × 3 000	11
(> 2 300 to 2 700) × 3 000	12
(> 2 700 to 3 100) × 3 000	13
(> 3 100 to 3 700) × 3 000	14
(> 3 700 to 4 000) × 3 000	15

ICS 83.140.10

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