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Termoplastiļ ni polimeri za drsne leģaje - Razvrstitev in poimenovanje

Thermoplastic polymers for plain bearings -- Classification and designation

Polymères thermoplastiques pour paliers lisses -- Classification et désignation

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Thermoplastic polymers for plain bearings — Classification and designation

Polymères thermoplastiques pour paliers lisses — Classification et désignation

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6691 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

This second edition cancels and replaces the first edition (ISO 6691:1989), of which has been technically revised.

Annexes A and B of this International Standard are for information only.

Thermoplastic polymers for plain bearings — Classification and designation

1 Scope

This International Standard specifies a classification and designation system for a selection of the most common unfilled thermoplastic polymers for plain bearings.

The unfilled thermoplastic polymers are classified on the basis of appropriate levels of distinctive properties, additives and information about their application for plain bearings. The designation system does not include all properties; thermoplastic polymers having the same designation cannot therefore be interchanged in all cases.

It also provides an outline of the properties and applications of the most common unfilled thermoplastic polymers as well as listing some of the fundamental parameters that influence the selection of thermoplastic polymers for use for plain bearings.

NOTE In the further course of the work it is intended to prepare standards on "thermosetting polymers" and "mixed polymers" for plain bearings.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 307, *Plastics — Polyamides — Determination of viscosity number*.

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles.*

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

ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets.*

ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites.*

ISO 527-5, *Plastics — Determination of tensile properties — Part 5: Test conditions for unidirectional fibre-reinforced plastic composites.*

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

ISO 1183, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

ISO 1628-5, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 5: Thermoplastic polyester (TP) homopolymers and copolymers*.

ISO 1872-2, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*.

ISO 1874-2, *Plastics — Polyamide (PA) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*.

ISO 7148-2, *Plain bearings — Testing of the tribological behaviour of bearing materials — Part 2: Testing of polymer-based bearing materials*.

3 Classification and designation system

3.1 General

The classification and designation are based on a block system consisting of a "description block" and "identity block". The "identity block" comprises an "International Standard number block" and an "individual item block". For unambiguous coding of all thermoplastic polymers, the "individual item block" is subdivided into five data blocks.

Designation						
Description block	Identity block					
	International Standard number block	Individual item block				
		Data block 1	Data block 2	Data block 3	Data block 4	Data block 5

The "individual item block" starts with a dash. The data blocks are separated by commas.

Data blocks 1 to 5 include the following information:

data block 1: material symbol (see 3.2)

data block 2: intended application or method of processing (see 3.3)

data block 3: distinctive properties (see 3.4)

data block 4: type and content of fillers or reinforcing materials (see 3.5)

data block 5: information about tribological properties for plain bearings (see 3.6)

The meaning of the letters and digits is different for each data block (see 3.2 to 3.6).

Data block 2 comprises up to 4 positions. If at least one of positions 2 to 4 is used, but no information is given in position 1, then the letter "X" shall be placed in position 1. The letters in positions 2 to 4 shall be arranged in alphabetical order.

If a data block is not used, this shall be indicated by consecutive data block separators, i.e. two commas (,,).

Designation examples are given in clause 4.

3.2 Data block 1

The chemical nature of the thermoplastic polymer is designated by its symbol in accordance with ISO 1043-1.

Table 1 — Symbols for the chemical structure of the materials

Thermoplastic polymers		Name and chemical structure
Group/Name	Symbol	
Polyamide	PA 6	Polyamide 6; homopolymer based on ε-caprolactam
	PA 6 cast	Polyamide 6, cast; homopolymer based on ε-caprolactam
	PA 66	Polyamide 66; homopolycondensate based on hexamethylenediamine and adipic acid
	PA 12	Polyamide 12; homopolymer based on ω-laurinlactam or ω-aminododecanoic acid
	PA 12 cast	Polyamide 12, cast; homopolymer based on ω-laurinlactam or ω-aminododecanoic acid
	PA 46	Polyamide 46; a co-condensate based on 1,4-diaminabutane and adipic acid
Polyoxymethylene	POM	Polyacetal (homopolymer) Polyacetal (copolymer)
Polyalkyleneterephthalate	PET	Polyethylene terephthalate
	PBT	Polybutylene terephthalate
Polyethylene	PE-UHMW	Polyethylene with ultra high molecular weight
	PE-HD	High density polyethylene
Polyfluorocarbon	PTFE	Polytetrafluoroethylene
Polyimide	PI	Polyimides from polyaddition reactions are available as thermo-setting plastics. Polyimides from polycondensation reactions are available as thermoplastics and thermosetting plastics, as well as copolymers of the imide group. Some thermoplastic polyimides are "apparent thermosetting plastics" because their thermoplastic range lies above the decomposition temperature. Because of their intermediate position, polyimides and imide copolymers are only treated marginally in this International Standard.
Polyetheretherketone	PEEK	Polyaryletherketone
Polyvinylidene fluoride	PVDF	Homopolymer based on difluorodichloroethane
Polyphenylene sulfide	PPS	Polyphenylene sulfide, linearly structured phenyl ring and sulfur atoms (tribologically modified material)
Poly(amide-imide)	PAI	Poly(amide-imide) reacted by polycondensation is a hard/tough, amorphous thermoplastic. After postcuring the PAI parts cannot be used for re-processing ("pseudo-thermoset plastics").

3.3 Data block 2

Position 1 gives the code for the intended application (see Table 2).

Table 2 — Data block 2 — Position 1

Code	Intended application
E	Extrusion
G	General use
M	Injection moulding
Q	Compression moulding
R	Rotational moulding
X	No indication

Up to three important properties and/or additives can be indicated in positions 2 to 4 (see Table 3).

Table 3 — Data block 2 — Positions 2 to 4

Code	Intended application
A	Processing stabilized
F	Special burning characteristics
H	Heat ageing stabilized
L	Light and weather stabilized
R	Release agent
S	Slip agent, lubricated

3.4 Data block 3

3.4.1 General

The levels of distinctive properties are coded by letters and numbers.

The properties used for the designation are different for every thermoplastic polymer.

Owing to manufacturing tolerances, single property values can lie on, or to either side of, two intervals. It is up to the manufacturer to state which interval will designate the thermoplastic polymer.

3.4.2 Polyamides

Polyamides are designated in data block 3 by their viscosity number, represented by two digits (see Table 4) in accordance with ISO 1874-1 and, separated by a dash, their modulus of elasticity represented by three digits (see Table 5).

In the last position, rapid-setting products may be indicated with the letter N.

The viscosity number shall be determined in accordance with ISO 307 using the solvents given in Table 4. The modulus of elasticity shall be determined in the dry state in accordance with ISO 527-1, ISO 527-2, ISO 527-3, ISO 527-4 and ISO 527-5, under the conditions specified in ISO 1874-2.

Table 4 — Viscosity number for polyamides

Polyamide	Code	Viscosity number, ml/g			
		Solvent			
		Sulfuric acid 96 % (*m*/*m*)		*m*-cresol	
		>	⩽	>	⩽
PA 6 PA 6 cast PA 66	**09**	—	90	—	
	10	90	110		
	12	110	130		
	14	130	160		
	18	160	200		
	22	200	240		
	27	240	290		
	32	290	340		
	34	340	—		
PA 12 PA 12 cast	**11**	—		—	110
	12			110	130
	14			130	150
	16			150	170
	18			170	200
	22			200	240
	24			240	—

Table 5 — Modulus of elasticity

Code	Modulus of elasticity N/mm^2	
	>	⩽
001	50	150
002	150	250
003	250	350
004	350	450
005	450	600
007	600	800
010	800	1 500
020	1 500	2 500
030	2 500	3 500
040	3 500	4 500
050	4 500	5 500
060	5 500	6 500
070	6 500	7 500
080	7 500	8 500
090	8 500	9 500
100	9 500	10 500
110	10 500	11 500
120	11 500	13 000
140	13 000	15 000
160	15 000	17 000
190	17 000	20 000
220	20 000	23 000
250	23 000	—

3.4.3 Polyethylenes

Polyethylenes are designated by their density represented by two digits (see Table 6) in accordance with ISO 1872-1 and, separated by a dash, their melt flow rate (MFR) represented by one letter and three digits (see Table 7).

The density of the base material shall be determined in accordance with ISO 1183 under the conditions specified in ISO 1872-2.

The melt flow rate shall be determined in accordance with ISO 1133 at 190 °C with a load of 2,16 kg (symbol D). For thermoplastic polymers with a melt flow rate < 0,1 g/10 min, a test under a load of 5 kg (symbol T) is recommended. If the melt flow rate is still < 0,1 g/10 min, the test should then be carried out under a load of 21,6 kg (symbol G).

The symbols D, T and G shall precede the code for melt flow rate given in Table 7.

Table 6 — Density

Code	**Density** [a] g/cm^3	
	>	⩽
15	—	0,917
20	0,917	0,922
25	0,922	0,927
30	0,927	0,932
35	0,932	0,937
40	0,937	0,942
45	0,942	0,947
50	0,947	0,952
55	0,952	0,957
60	0,957	0,962
65	0,962	—

[a] Density ranges for uncoloured and unfilled polyethylene materials.

Table 7 — Melt flow rate (MFR)

Code	**Melt flow rate** g/10 min	
	>	⩽
000	—	0,1
001	0,1	0,2
003	0,2	0,4
006	0,4	0,8
012	0,8	1,5
022	1,5	3
045	3	6
090	6	12
200	12	25
400	25	50
700	50	100

3.4.4 Polyalkyleneterephthalates

The distinctive property of polyalkyleneterephthalates is the viscosity number according to ISO 7792-1, determined in accordance with ISO 1628-5, and designated by two digits (see Table 8).