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Plastics — Phenolic moulding materials — Specification

Plastiques — Matières à mouler phénoplastes — Spécification

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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.

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.

International Standard ISO 800 was prepared by Technical Committee ISO/TC 61, *Plastics*, Sub-Committee SC 12, *Thermosetting materials*.

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Plastics — Phenolic moulding materials — Specification

1 Scope

1.1 General

This International Standard specifies requirements for the physical and chemical properties of phenolic moulding materials, classified by type and grade according to their use and properties.

1.2 Types

Four types of phenolic moulding material are specified, as follows:

— Type A: General purpose

— Type C: Heat resistant

— Type D: Impact resistant

— Type E: Electrical applications

1.3 Filler

The type of filler to be used in each type of phenolic moulding material is not specified but is usually as shown in the following examples:

Type of moulding material	Filler
A	Wood flour
C	Mineral filler
D	Cotton
E	Mica

1.4 Resin

Abbreviations are used to indicate the type of phenolic resin, as follows:

— One-step phenolic resin: PF 1

— Two-step phenolic resin: PF 2

1.5 Grades

The various types of material are further sub-divided into grades based on the property levels and requirements.

EXAMPLE

PF 2A1 is a phenolic moulding material made from two-step resin, intended for general applications. The last digit indicates a particular grade of one type of material.

1.6 Classification

Table 1 shows the types and the grades of phenolic moulding material covered by this International Standard, together with their applications and distinguishing properties.

Table 1 — Classification of phenolic moulding materials

Type and grade	Applications and distinguishing properties
PF 2A1	General-purpose applications
PF 2A2	Similar to type PF 2A1 but with improved electrical properties
PF 1A1	General-purpose applications, ammonia-free
PF 1A2	General-purpose applications, ammonia-free, with improved electrical properties
PF 2C1	Heat resistant
PF 2C2	Heat resistant, impact strength higher than that of type PF 2C1
PF 2C3	Heat resistant, similar to type PF 2C1 but with improved electrical properties
PF 2C4	Heat resistant, asbestos-free
PF 2C5	Heat resistant, asbestos-free, with improved electrical properties
PF 2D1	Impact resistant
PF 2D2	Impact resistant (impact strength higher than that of type PF 2D1)
PF 2D3	Impact resistant (impact strength higher than that of type PF 2D2)
PF 2D4	Impact resistant (impact strength higher than that of type PF 2D3)
PF 2E1	Electrical low loss applications

It shall not be inferred from the classification given in table 1 that materials of any particular grade are necessarily unsuitable for applications other than those indicated, or that specific material will be suitable for all applications within the wide description given.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 62:1980, *Plastics — Determination of water absorption.*

ISO 75:1987, *Plastics and ebonite — Determination of temperature of deflection under load.*

ISO 120:1977, *Plastics — Phenol-formaldehyde mouldings — Determination of free ammonia and ammonium compounds — Colorimetric comparison method.*

ISO 171:1980, *Plastics — Determination of bulk factor of moulding materials.*

ISO 178:1975, *Plastics — Determination of flexural properties of rigid plastics.*

ISO 179:1982, *Plastics — Determination of Charpy impact strength of rigid materials.*

ISO 180:1982, *Plastics — Determination of Izod impact strength of rigid materials.*

ISO 181:1981, *Plastics — Determination of flammability characteristics of rigid plastics in the form of small specimens in contact with an incandescent rod.*

ISO 291:1977, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 295:1991, *Plastics — Compression moulding of test specimens of thermosetting materials.*

ISO 308:1981, *Plastics — Phenolic moulding materials — Determination of acetone-soluble matter (apparent resin content of material in the unmoulded state).*

ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

ISO 2577:1984, *Plastics — Thermosetting moulding materials — Determination of shrinkage.*

ISO 2818:1980, *Plastics — Preparation of test specimens by machining.*

IEC 112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC 167:1964, *Methods of test for the determination of the insulation resistance of solid insulating materials.*

IEC 243-1:1988, *Methods of test for electric strength of solid insulating materials — Part 1: Tests at power frequencies.*

IEC 250:1969, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelength.*

IEC 296:1982, *Specification for unused mineral insulating oils for transformers and switchgear.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 phenolic moulding material: Thermosetting material based on a phenolic resin and used in the manufacture of thermoset-moulded articles. Other ingredients such as fillers, plasticizers, catalysts and colorants may be incorporated.

3.2 phenolic resin: Generic term for a class of resins made by the polycondensation of phenol, and/or its homologues and/or derivatives of phenol or its homologues, with aldehydes or ketones. These thermosetting resins can be either novolaks (two-step PF 2) or resols (one-step PF 1).

NOTE 1 Novolak resins require a crosslinking agent, generally hexamethylenetetramine.

4 Requirements

Phenolic moulding materials complying with this specification shall meet the appropriate property requirements shown in table 2.

Though no specific limits are placed on the flow rate in table 2, a suitable flow rate is essential for the satisfactory use of a phenolic moulding material and the flow rate shall therefore be specified in any contract.

The method of test and the flow rate value shall be as agreed by the interested parties.

In addition, for some applications, it may be desirable for information to be made available on other properties of the moulding material, for example curing time, particle size or moisture content. If this is so, these properties and the method to be used shall be agreed by the interested parties.

5 Test specimens

Bulk factor, moisture content, flow and particle size shall be measured on the moulding material itself. Other properties shall be determined on moulded test specimens prepared in accordance with ISO 295. It is permissible to machine test specimens from sheet (see ISO 2818) moulded under the moulding conditions of ISO 295, as long as it can be shown that the test specimens give results which do not differ significantly from those with moulded test specimens.

Test specimens to be used for determining the properties given in section B of table 2 shall be conditioned under prevailing atmospheric conditions as indicated in ISO 291, unless otherwise stated in the method of the test or agreed by the interested parties.

Tests shall comence not less than 16 h and not more than 72 h after the test specimens have been moulded, unless otherwise specified in the methods.

When test specimens have been moulded from powder which has been preheated or dried, then this fact shall be stated in the test report. The preheating or drying conditions shall also be given.

6 Methods of test

6.1 Determination of specific gravity

See ISO 1183, method A. Test specimens may be prepared from any moulded plate or bar. At least two test specimens shall be used for the determination.

6.2 Determination of flexural stress at rupture

See ISO 178. Five test specimens of length not less than 80 mm, of width 10 mm and of thickness 4 mm shall be used.

For both moulded bars and test specimens machined from material moulded in the form of a plate, the load shall be applied parallel to the direction of moulding pressure. The testing speed shall be 2,0 mm/ min ± 0,2 mm/ min.

6.3 Determination of Charpy impact strength

See ISO 179. For both moulded bars and test specimens machined from material moulded in the form of a plate, the load shall be applied parallel to the direction of moulding pressure.

6.3.1 Charpy notched impact strength

See ISO 179, method 3C. Five test specimens shall be used for the determination.

6.3.2 Charpy unnotched impact strength

See ISO 179, method 3D. Five test specimens shall be used for the determination.

6.4 Determination of Izod impact strength

See ISO 180, method 2A. Five test specimens shall be used for the determination.

6.5 Determination of temperature of deflection under load

See ISO 75, method A. Two test specimens of length not less than 110 mm, of width 10 mm and of thickness 4 mm shall be used.

6.6 Determination of flammability characteristics

Use three test specimens, each measuring 120 mm × 10 mm × 4 mm, for the determination. The test shall be carried out in accordance with ISO 181, except for the following details: after 3 min, remove the incandescent rod from the specimen and note whether there is any flame on the specimen during the next 30 s.

6.7 Determination of insulation resistance

See IEC 167. The test specimen shall be in the form of a flat plate moulded to a thickness of 3,0 mm ± 0,25 mm. Taper pin electrodes shall be used. Before carrying out the test, the test specimens shall be conditioned (without electrodes) in an oven at 50 °C ± 2 °C for 24 h ± 1 h, and then cooled to room temperature in a desiccator. It shall then be immersed in distilled or deionized water maintained at 23 °C ± 2 °C for 24 h ± 1 h. Before the specimen is tested, water on its surface shall be removed with blotting paper or filter paper or with a clean absorbent cloth, and the electrodes then fitted. Measurement of insulation resistance shall be made within 5 min of the end of the immersion. At least two test specimens shall be used for the determination.

6.8 Determination of electric strength at power frequencies

See IEC 243-1. At least three test specimens shall be used for the determination.

It may be necessary to measure the short-time value on an additional test specimen in order to determine the initial voltage to be applied.

Each specimen shall be 3,0 mm ± 0,25 mm thick and not less than 100 mm in diameter. Each test specimen shall be immersed in oil at a temperature of 90 °C ± 2 °C for 15 min to 20 min before the test, and also during the test. The oil should preferably be one complying with the requirements of class II as defined in IEC 296. The 20 s step-by-step method shall be used.

6.9 Determination of dielectric dissipation factor

See IEC 250. The test frequency shall be 1 MHz. Three test specimens shall be used for the determination.

6.10 Determination of comparative tracking index (CTI) under moist conditions

See IEC 112. Test solution A shall be used. For quality-control purposes, the proof test may be used. The numerical value of the applied voltage shall be that of the CTI given in table 2. Two determinations shall be made.

6.11 Determination of free ammonia and ammonium compounds

See ISO 120. The powdered test portion may be prepared from any moulded plate or bar.

6.12 Determination of water absorption

See ISO 62, method 1. Two test specimens measuring 50 mm ± 1 mm in diameter and 3,0 mm ± 0,25 mm thick shall be used.

As an alternative, when agreed by the interested parties, square specimens of side 50 mm ± 1 mm cut from 4,0 mm ± 0,2 mm thick moulded plates may be used. If this alternative type of test specimen is used, the requirements shall also be the subject of agreement by the interested parties.

6.13 Determination of moulding shrinkage

See ISO 2577. Two test specimens measuring 120 mm × 15 mm × 10 mm shall be used for the determination.

For material intended for injection or transfer moulding the method of preparation of the test specimens shall be agreed by the interested parties.

7 Marking

Moulding materials purporting to comply with the requirements of this International Standard shall be supplied in containers marked with the identity of the supplier, the material type and grade, the batch number and the number of this International Standard.

Table 2 — Limits on properties of phenolic moulding materials

Property	Unit	max. or min.	Type A				Type C					Type D				Type E	Method of test
			Grade				Grade					Grade				Grade	
			PF 2A1	PF 2A2	PF 1A1	PF 1A2	PF 2C1	PF 2C2	PF 2C3	PF 2C4	PF 2C5	PF 2D1	PF 2D2	PF 2D3	PF 2D4	PF 2E1	
A) Properties measured on moulding materials																	
Bulk factor	—	max.	3,0	3,0	3,0	3,0	4,0	6,0	4,0	3,0	3,0	5,0	6,0	8,0	15,0	3,5	ISO 171
Flow rate			Values to be agreed between the interested parties														See note 1
B) Properties measured on test specimens (see note 2)																	
Specific gravity	—	max.	1,45	1,45	1,45	1,45	2,0	2,0	2,0	2,0	2,0	1,45	1,45	1,45	1,45	2,0	ISO 1183, method A
Flexural stress at rupture	MPa	min.	70	70	60	60	50	50	50	50	50	55	55	55	55	50	ISO 178
Charpy impact strength (see note 3)																	
notched	kJ/m^2	min.	1,5	1,5	1,3	1,3	2,0	5,0	2,0	1,0	1,0	2,5	3,5	6,0	12,0	1,5	ISO 179/3C
unnotched	kJ/m^2	min.	6,0	6,0	6,0	6,0	3,5	5,0	3,5	3,5	3,5	5,0	5,0	6,0	12,0	3,0	ISO 179/3D
Izod impact strength (see note 3)	kJ/m^2	min.	1,4	1,4	1,4	1,4	Values to be added later									1,4	ISO 180/2A
Temperature of deflection under load	°C	min.	140	140	120	110	155	160	155	150	150	135	140	140	140	160	ISO 75, method A
Flammability characteristics	—	min.	—	—	—	—	(See subclause 6.6)					—	—	—	—	—	ISO 181 (see note 4)
Insulation resistance	Ω	min.	—	10^8	—	10^{10}	—	—	10^8	—	10^8	—	—	—	—	10^{12}	IEC 167
Electric strength at 90 °C	MV/m	min.	—	3,5	—	—	—	—	2,0	—	2,0	—	—	—	—	5,8	IEC 243-1, in oil, 20 s step-by-step method

Property	Unit	max. or min.	Type A				Type C					Type D				Type E	Method of test
			Grade				Grade					Grade				Grade	
			PF 2A1	PF 2A2	PF 1A1	PF 1A2	PF 2C1	PF 2C2	PF 2C3	PF 2C4	PF 2C5	PF 2D1	PF 2D2	PF 2D3	PF 2D4	PF 2E1	
Dielectric dissipation factor (tan δ) at 1 MHz	—	max.	—	0,1	—	—	—	—	—	—	—	—	—	—	—	0,030	IEC 250
Comparative tracking index	V	min.	—	—	—	—	—	—	175	—	175	—	—	—	—	175	IEC 112
Free ammonia	% (m/m)	max.	—	—	0,02	0,02	—	—	—	—	—	—	—	—	—	—	ISO 120
Water absorption	mg	max.	60	60	60	60	40	50	40	30	30	80	150	150	150	20	ISO 62, method 1 (see note 5)
Moulding shrinkage	%	max.	Values to be agreed between the interested parties														ISO 2577 (see note 6)

NOTES

1 The method of test for flow rate shall be agreed between the interested parties. The flow rate will also depend on the resin content. For the determination of the resin content of two-step materials, see ISO 308.

2 The mean result for the number of test specimens used for each method shall be used to determine whether the moulding material is within the limits specified in this table.

3 The Charpy and Izod methods are alternatives, to be used as agreed by the interested parties.

4 As modified by subclause 6.6.

5 See 6.12, second paragraph, regarding the use of an alternative type of test specimen.

6 See 6.13, second paragraph, regarding preparation of test specimens.

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