International Standard 1642

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Plastics — Industrial laminated sheets based on thermosetting resins — Specification

Plastiques — Stratifiés industriels en planches à base de résines thermodurcissables — Spécification

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Plastics — Industrial laminated sheets based on thermosetting resins — Specification

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the characteristics of industrial laminated sheets made with any one of the following resins as the binder : epoxide (epoxy), melamine, phenolic, polyester (unsaturated), and silicone. The sheets covered are flat and the preferred nominal thicknesses are listed in table 3.

NOTE – The scope of this International Standard may subsequently be extended to cover additional, commercially established types of industrial laminated sheets of similar basic composition.

2 REFERENCES

ISO 62, *Plastics — Determination of water absorption.*[1]

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

ISO/R 179, *Plastics — Determination of the Charpy impact resistance of rigid plastics (Charpy impact flexural test).*

ISO/R 180, *Plastics — Determination of the Izod impact resistance of rigid plastics (Izod impact flexural tests).*

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

IEC Publication 112, *Recommended method for determining the comparative tracking index of solid insulating materials under moist conditions.*

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

IEC Publication 243, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

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

IEC Publication 587, *Test method for evaluating resistance to tracking and erosion of electrical insulating materials used under severe ambient conditions.*

3 CLASSIFICATION

3.1 Designation

The sheets covered by this specification are classified into types which differ in the resin and reinforcement employed and in the distinguishing properties.

Individual types are designated by

– a two-letter abbreviation denoting the resin;

– a second two-letter abbreviation, denoting the reinforcement;

– a serial number.

The abbreviations are given in 3.2.

Example : Type EP GC 3 is the third type in the group of types based on epoxide resin reinforced with woven glass fabric.

3.2 Abbreviations

Resins	Abbreviation
Epoxide (epoxy)	EP
Melamine	MF
Phenolic	PF
Polyester (unsaturated)	UP
Silicone	SI

Reinforcements	Abbreviation
Cellulose paper	CP
Woven cotton fabric	CC
Wood veneer	WV
Asbestos paper	AP
Woven asbestos fabric	AC
Asbestos felt (mat)	AM
Woven glass fabric	GC
Glass mat	GM

3.3 Type

The combinations of resins and reinforcements which constitute the types covered by this International Standard, together with applications and distinguishing properties, are given in table 1.

1) At present at the stage of draft. (Revision of ISO/R 62 and ISO/R 117.)

4 DEFINITIONS

For the purpose of this International Standard the following definitions apply :

4.1 laminates : Products made by bonding together two or more layers of material or materials. Industrial laminated sheets based on thermosetting resins consist of superimposed layers of paper, fabric, veneer, or felt (mat) that have been substantially impregnated with a thermosetting or curable resin and bonded together under pressure, with or without heat, to form a single piece. Other ingredients, for example colouring matter, may be incorporated.

4.2 epoxide (epoxy) resin : Synthetic resin containing epoxide groups and capable of crosslinking.

4.3 melamine resin : An amino resin made by polycondensation of melamine with formaldehyde or a compound that is capable of providing methylene bridges.

4.4 phenolic resin : Generically a class of resins made by the polycondensation of phenol, its homologues and/or derivatives, with aldehydes or ketones.

4.5 polyester resin (unsaturated) : A crosslinked polymer in which the repeated structural unit in the chain is of the ester type and which is crosslinked through polymerization of double bonds.

4.6 silicone resin : Resin in which the main polymer chain consists of alternating silicon and oxygen atoms, with carbon-containing side groups and capable of crosslinking.

5 APPEARANCE

Sheets shall be free from blisters, wrinkles and cracks and reasonably free from other defects, for example scratches, dents, and discoloration. A small amount of mottle is permissible.

6 FLATNESS

When any sheet of nominal thickness 3 mm or more is placed without restraint, concave side up, on a flat surface, the departure at any point of the upper surface of the sheet from a light straightedge laid in any direction upon it shall not exceed either of the appropriate values given in table 2.

TABLE 2 — **Maximum permissible departure of surface of sheet from straightedge**

Values in millimetres

Material	Thickness	Length of straight edge	
		1 000	500
PF AC 1 SI GC 1 SI GC 2	3 to 6 inclusive	15	4
	> 6 to 8 inclusive	12	3
	> 8	10	2,5
PF WV 1 PF WV 2	12 and over	9	2
All other types	3 to 6 inclusive	10	2,5
	> 6 to 8 inclusive	8	2,0
	> 8	6	1,5

7 TOLERANCES ON THICKNESS

The deviation from nominal thickness of a sheet at any point shall not exceed the value shown in table 3 for the appropriate type and thickness. The diameter of the anvil of the measuring device shall be 6 to 8 mm.

8 PHYSICAL PROPERTIES

When determined by the appropriate test methods, the physical properties shall be as given in table 4. In all cases, test results shall be rounded to the same degree of precision as the limiting values.

TABLE 4 — **Physical properties**

A. Epoxide resin EP									
Property	**Method of test**	**Unit**	**Max. or min.**	**Max. or min. nominal thickness of sheet to which test is applied**	**Types**				
					EP CP 1	EP GC 1	EP GC 2	EP GC 3	EP GC 4
Flexural stress at rupture perpendicular to laminations	Annex A	MPa	min.	1,5 mm min.	110	340	340	340[1]	340[1]
Impact strength (notched specimen tested parallel to laminations) a) Charpy[2] b) Izod[2]	Annex B Annex C	kJ/m² J per mm of notch	min. min.	5 mm min. 5 mm min.	– –	37 0,40	37 0,40	37 0,40	37 0,40
Electric strength at 90 °C in oil, perpendicular to laminations	Annex D	MV/m	min.	3 mm max.[3]	See table 6				
Electric strength at 90 °C in oil, parallel to laminations[4] a) 20 s step-by-step test b) 1 min proof test	Annex D Annex D	kV kV	min. min.	3 mm min.[5] 3 mm min.[5]	20 20	35 35	35 35	35 35	35 35
Insulation resistance after immersion in water	Annex E	MΩ	min.	3 mm max.[3]	1×10^4	5×10^4	5×10^4	5×10^4	5×10^4
Dissipation factor at 1 MHz after immersion in water	Annex F	–	max.	3 mm max.	0,05	0,04	0,04	0,04	0,04
Relative permittivity at 1 MHz after immersion in water	Annex F	–	max.	3 mm max.	5,0	5,5	5,5	5,5	5,5
Flammability	Under consideration								
Water absorption	ISO 62 Method 1[9]	mg	max.		See table 5				

See notes at the end of the table (page 10).

TABLE 4 (*continued*)

C. Phenolic resin PF													
Property	**Method of test**	**Unit**	**Max. or min.**	**Max. or min. nominal thickness of sheet to which test is applied**	**Types**											
					PF CP 1	PF CP 2	PF CP 3	PF CP 4	PF CP 5	PF CP 6	PF CP 7	PF CC 1	PF CC 2	PF CC 3	PF CC 4
Flexural stress at rupture, perpendicular to laminations	Annex A	MPa	min.	1,5 mm min.	135	120	120	75	75	85	80	100	90	110	100
Impact strength (notched specimen tested parallel to laminations) a) Charpy[2)] b) Izod[2)]	 Annex B Annex C	 kJ/m^2 J per mm of notch	 min. min.	 5 mm min. 5 mm min.	 – –	 – –	 – –	 – –	 – –	 – –	 – –	 8,8 0,10	 7,8 0,060	 7,0 0,060	 6,0 0,050
Electric strength at 90 °C in oil, perpendicular to laminations	Annex D	MV/m	min.	3 mm max.[3)]	–	See table 6					–	–	–	–	–
Electric strength at 90 °C in oil, parallel to laminations[4)] a) 20 s step-by-step test b) 1 min proof test	 Annex D Annex D	 kV kV	 min. min.	 3 mm min.[5)] 3 mm min.[5)]	 – –	 40 40	 20 20	 25 25	 – –	 25 25	 – –	 – –	 15 15	 – –	 20 20
Insulation resistance after immersion in water	Annex E	MΩ	min.	3 mm max.[3)]	–	–	5×10^1	1×10^4	1×10^4	1×10^3	–	–	1×10^1	–	1×10^1
Dissipation factor at 1 MHz after immersion in water	Annex F	–	max.	3 mm max.	–	–	–	0,05	0,05	0,055	–	–	–	–	–
Relative permittivity at 1 MHz after immersion in water	Annex F	–	max.	3 mm max.	–	–	–	5,5	5,5	6,0	–	–	–	–	–
Dissipation factor at 50 Hz after heating	Annex G	–	max.	3 mm max.	–	0,05	–	–	–	–	–	–	–	–	–
Relative permittivity at 50 Hz after heating	Annex G	–	max.	3 mm max.	–	5,5	–	–	–	–	–	–	–	–	–
Flammability	Under consideration														
Water absorption	ISO 62 Method 1[9)]	mg	max.		See table 5										

See notes at the end of the table (page 10).

TABLE 4 (*continued*)

D. Polyester resin (unsaturated) UP							
Property	**Method of test**	**Unit**	**Max. or min.**	**Max. or min. nominal thickness of sheet to which test is applied**	**Types**		
					UP GM 1	UP GM 2	UP GM 3
Flexural stress at rupture, perpendicular to laminations	Annex A	MPa	min.	1,5 mm min.	130[7]	130[7]	130[7]
Impact strength (notched specimen tested parallel to laminations) a) Charpy[2] b) Izod[2]	 Annex B Annex C	 kJ/m² J per mm of notch	 min. min.	 5 mm min. 5 mm min.	 50 0,40	 50 0,40	 50 0,40
Electric strength at 90 °C in oil, perpendicular to laminations	Annex D	MV/m	min.	3 mm max.[3]	See table 6		
Electric strength at 90 °C in oil, parallel to laminations[4] a) 20 s step-by-step test b) 1 min proof test	 Annex D Annex D	 kV kV	 min. min.	 3 mm min.[5] 3 mm min.[5]	 35 35	 35 35	 35 35
Insulation resistance after immersion in water	Annex E	MΩ	min.	3 mm max.[3]	5×10^2	5×10^2	5×10^2
Tracking resistance a) IEC 112 test b) Inclined plane test	 IEC Publication 112 (proof test) IEC Publication 587	 V –	 proof min.	 All thicknesses 3 mm min.	 Pass at 500 –	 Pass at 500 –	 – Under consider-ation
Flammability	Under consideration				–	Under consideration	
Water absorption	ISO 62 Method 1[9]	mg	max.		See table 5		

See notes at the end of the table (page 10).

TABLE 5 — **Limits for water absorption**, mg

Type	Mean measured thickness of test specimens, mm																				
	0,4	0,5	0,6	0,8	1,0	1,2	1,6	2,0	2,5	3	4	5	6	8	10	12	14	16	20	25	22,5 with one face machined[1]
EP CP 1	30	31	31	33	35	37	41	45	50	55	60	68	76	90	--	—	—	—	—	—	—
EP GC 1	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	45	52	61	73
EP GC 2	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	45	52	61	73
EP GC 3	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	45	52	61	73
EP GC 4	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	45	52	61	73
MF GC 1	103	107	110	116	123	129	142	155	172	188	220	252	285	350	414	479	544	609	738	900	1 080
PF CP 1	410	417	423	437	450	460	480	500	525	550	600	650	700	810	920	1 020	1 130	1 230	1 440	1 700	2 040
PF CP 2	165	167	168	173	180	188	204	220	240	260	300	342	382	470	550	630	720	800	970	1 150	1 380
PF CP 3	160	162	163	167	170	174	182	190	195	200	220	235	250	285	320	350	390	420	490	570	684
PF CP 4	44	45	45	47	48	50	53	56	59	63	70	77	84	99	113	128	142	157	186	222	266
PF CP 5	44	45	45	47	48	50	53	56	59	63	—	—	—	—	—	—	—	—	—	—	—
PF CP 6	62	63	65	67	69	71	76	80	85	90	100	110	118	135	149	162	175	186	202	219	263
PF CP 7	410	417	423	437	450	460	480	500	525	550	—	—	—	—	—	—	—	—	—	—	—
PF CC 1	—	—	—	201	206	211	220	229	239	249	262	275	284	301	319	336	354	371	406	450	540
PF CC 2	—	—	—	133	136	139	145	151	157	162	169	175	182	195	209	223	236	250	277	311	373
PF CC 3	186	190	194	201	206	211	220	229	239	249	262	275	284	301	319	336	354	371	406	450	540
PF CC 4	125	127	129	133	136	139	145	151	157	162	169	175	182	195	209	223	236	250	277	311	373
PF WV 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2 500	2 650	2 810	3 110	3 500	4 200
PF WV 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	600	630	660	720	800	960
PF AP 1	—	231	232	234	236	238	242	246	252	257	268	278	289	310	332	353	374	395	437	490	588
PF AC 1	—	—	—	—	—	305	318	331	347	363	396	428	461	526	590	655	720	784	913	1 075	1 290
PF AM 1	—	—	—	—	—	430	460	490	530	575	660	750	840	1 010	1 190	1 360	1 540	1 710	2 060	2 500	3 000
PF GC 1	107	110	114	121	128	136	152	168	188	208	249	289	330	411	491	570	652	733	895	1 096	1 314
UP GM 1	—	—	—	—	—	—	60	63	67	70	78	85	92	107	120	135	150	165	195	230	276
UP GM 2	—	—	—	—	—	—	60	63	67	70	78	85	92	107	120	135	150	165	195	230	276
UP GM 3	—	—	—	—	—	—	60	63	67	70	78	85	92	107	120	135	150	165	195	230	—
SI GC 1	7	7	8	8	9	9	10	11	12	13	15	17	19	23	27	31	35	39	47	57	68
SI GC 2	28	29	29	31	32	33	35	36	38	40	45	50	55	65	75	85	95	105	125	150	180

1) Sheets of nominal thicknesses greater than 25 mm shall be machined to a relatively smooth surface on one face to a thickness of 22,5 mm, as specified in ISO 62, method 1.

NOTE — If the mean of the measured values of thickness of the test specimens lies between two values of thickness shown in the above table, the limit shall be obtained by interpolation. If the mean of the measured values of thickness is below the minimum thickness for which a limit is given, the water absorption limit appropriate to the minimum thickness shall apply. If the nominal thickness is 25 mm and the mean measured thickness exceeds 25 mm, the limit for 25 mm shall apply.

ANNEX A

DETERMINATION OF FLEXURAL STRESS AT RUPTURE, PERPENDICULAR TO LAMINATIONS

Flexural stress at rupture shall be determined by the method specified in ISO 178.

Cut the test specimens from the sheet to be tested with their major axes in the directions indicated at A and B in figure 1 of ISO 178. Take at least five specimens in each direction. If the sheet to be tested is more than 10 mm thick (20 mm in the case of Type WV), reduce the thickness of the test specimens to 10 mm (20 mm in the case of Type WV), leaving one face of the sheet intact.

Condition the test specimens for at least 24 h in a controlled atmosphere of 50 ± 5 % relative humidity at a temperature of 23 ± 2 °C. Commence the test within 3 min of removal of each test specimen from the controlled atmosphere. Load the specimens perpendicular to the laminations.

Calculate the average of the results for each direction and take the lower of the two averages as the flexural stress at rupture of the sheet under test. However, for Type WV sheets with the veneers arranged with their grain mainly in the same direction, take the higher of the two averages. (See note 6 to table 4.)

ANNEX B

DETERMINATION OF IMPACT STRENGTH, CHARPY (NOTCHED SPECIMEN)

Impact strength, Charpy, shall be determined with notched specimens as specified in ISO/R 179.

Cut the test specimens from the sheet to be tested with their major axes in the directions indicated at A and B in figure 1. Take five specimens in each direction.

Condition the test specimens for at least 24 h in a controlled atmosphere of 50 ± 5 % relative humidity at a temperature of 23 ± 2 °C. Commence the test within 3 min of removal of each test specimen from the controlled atmosphere. Strike the specimens parallel to the laminations.

Calculate the average of the results for each direction and take the lower of the two averages as the impact strength, Charpy, of the sheet under test. However, for Type WV sheets with the veneers arranged with their grain mainly in the same direction, take the higher of the two averages. (See note 6 to table 4.)

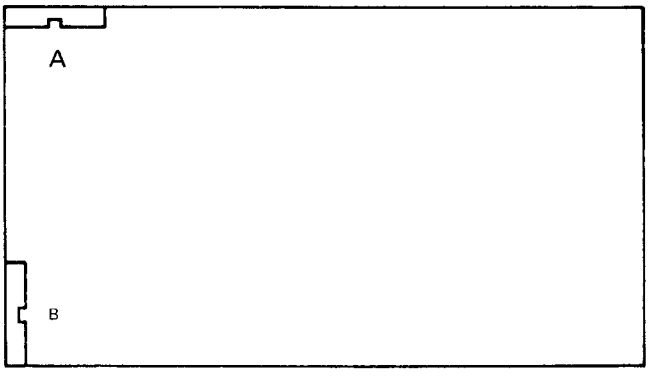

FIGURE 1 – **Determination of impact strength – Direction of test specimens**