Designation: D1305 – 16 (Reapproved 2022)

Standard Specification for Electrical Insulating Paper and Paperboard—Sulfate (Kraft) Layer Type[1]

This standard is issued under the fixed designation D1305; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers electrical grade unsized, unbleached sulfate paper and paperboard for use as layer insulation in coils, transformers, and similar apparatus. Other applications include, but are not limited to, turn insulation, slot liners, wedges, phase insulation, and separator papers in stranded wire/cable constructions. Tissue for the manufacture of capacitors is not included in this specification. Other commonly used designations include:

1.1.1 *Soft Coil Wrap,*

1.1.2 *Dense Coil Wrap,*

1.1.3 *Kraft Coil Insulation,*

1.1.4 *Dry-Finished Kraft,* and

1.1.5 *Water-Finished Kraft.*

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D202 Test Methods for Sampling and Testing Untreated Paper Used for Electrical Insulation

D1711 Terminology Relating to Electrical Insulation

3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard, refer to Terminology D1711.

4. Classification

4.1 Four types of paper and paperboard are covered by this specification, as shown in Table 1. The material is available in sheets, pads, or rolls.

5. Ordering Information

5.1 Orders shall specify the type, including whether water finish or not (see Note 1), nominal thickness, form, width, length (for sheets), nominal outside diameter, and core inside diameter (for rolls).

NOTE 1—Water finish is not available with certain combinations of Kraft type and thickness. In general, water finish is restricted to paper and paperboard in the higher density ranges, that is, Types III and IV.

6. Materials

6.1 The material shall be natural unbleached sulfate paper or paperboard, free of dyes, pigments, fillers, or sizing. It is furnished either with water-finish or without.

7. Detail Requirements

7.1 The material shall conform to the chemical, physical, and electrical requirements specified in Tables 1-4, when tested in accordance with the methods prescribed in Section 11.

8. Interpretation of Numerical Requirements

8.1 Unless otherwise stated, all specified limits in this specification apply to the average of determinations applicable to a sample as defined.

9. Workmanship, Finish, and Appearance

9.1 The material shall be uniform in thickness, density, formation, and texture. The material shall be as free of welts, wrinkles, creases, holes, slime spots, stains, shives, weak spots, blisters, tears, cuts, and other defects; and from resin, dirt, carbon, rubber, metal particles, corrosive substances, or other foreign material, as consistent with good manufacturing processes and in keeping with the requirements of this specification. Rolls and pads shall be compactly wound. Splices shall be

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

TABLE 1 Types of Untreated Kraft Insulating Tissue, Paper, and Paperboard

Type	Density Range, g/cm^3	Nominal Thickness, mil (μm)
I	less than 0.77	1 (25) to 30 (760)
II	0.77 to 0.86	0.5 (12) to 30 (760)
III	0.86 to 0.95	0.4 (10) to 30 (760)
IV	over 0.95	0.2 (5) to 30 (760)

TABLE 2 Chemical Requirements

Property	min	max
Ash, %	...	0.5
Alcohol-soluble material, %	...	1.0
Aqueous extract conductivity, mS/m[A]	...	1.0
Water-soluble chlorides, ppm	...	32
Fiber composition: unbleached sulfate, %	100	...
Moisture, as received, %	4	7
Moisture, as received, for water finished paper, %	4	9
Hydrogen ion concentration, pH	6.5	8.0

[A] 1 mS/m = 10 μΩ/cm.

kept to a minimum. Splicing compounds shall be noncorrosive and shall have no deleterious effect on the insulating or dielectric values of the paper.

10. Sampling

10.1 Sample the paper in accordance with Test Methods D202.

11. Test Methods

11.1 The properties of the paper shall be determined in accordance with Test Methods D202, except workmanship and appearance shall be visually judged.

12. Packaging and Package Marking

12.1 *Packaging*—The material shall be wound on a one-piece substantial core with inside diameter as specified. Ends of rolls shall be protected with suitable caps or roll end protectors to ensure against edge damage. The material shall be packed in moisture-proof wrappers, boxes, or cartons so constructed as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

12.2 *Package Marking*—Each container shall be marked on the side or on one end of the package, or on both the side and end, with the name and type of material, specification number, purchase order number, manufacturer's name or trade mark, or both, manufacturer's roll number, lot number, and the date of manufacture. Each roll or pad shall be marked on one side with the manufacturer's name and lot number and the customer's purchase order number.

13. Retest and Rejection

13.1 If the results of any test do not conform to the requirements prescribed in this specification, at the option of the manufacturer that test shall be repeated on two additional sets of specimens from the same batch or shipment, each of which shall conform to the requirements specified. If either of these two additional sets of specimens fails, it is acceptable to reject the material at the option of the purchaser.

13.2 Notice of failure of material based on tests made in accordance with this specification shall be reported to the manufacturer within three weeks from receipt of the material by the purchaser. Any portion of an accepted shipment of material that is subsequently shown not to have been in accordance with this specification at the time of receipt it is acceptable to reject, provided the manufacturer is notified within 90 days from the date of receipt of the material by the purchaser.

14. Keywords

14.1 alcohol-soluble material; aqueous extract conductivity; ash; chlorides; conducting paths; density; dielectric breakdown voltage; paper; paperboard; pH; tensile strength; unbleached sulfate kraft

TABLE 3 Physical and Electrical Requirements

Nominal Thickness, mils (μm)	Tensile Strength, machine direction min, lbf/in. (N/mm) width	Conducting Paths, max, number per ft² (per 929 cm²)[A]	Dielectric Breakdown Voltage per Sheet, min, avg V rms
Type I[B]			
1.0 (25)	8.0 (1.40)	1	350
1.5 (38)	12.5 (2.19)	1	400
1.7 (43)	15.0 (2.63)	5×10^{-2}	435
2.0 (51)	17.0 (2.98)	4×10^{-2}	495
2.5 (64)	21.0 (3.68)	3×10^{-2}	575
3.0 (76)	26.0 (4.56)	2.0×10^{-2}	650
4.0 (100)	34.5 (6.04)	2.0×10^{-2}	735
5.0 (130)	43.0 (7.53)	1.5×10^{-2}	900
6.0 (150)	52.0 (9.11)	1.5×10^{-2}	1000
7.0 (180)	60.0 (10.51)	1.3×10^{-2}	1100
10.0 (250)	81.0 (14.18)	1.0×10^{-2}	1500
15.0 (380)	115 (20.14)	0.5×10^{-2}	2000
20.0 (510)	144 (25.22)	0.5×10^{-2}	2500
30.0 (760)	180 (31.52)	0.5×10^{-2}	3000
Type II[C]			
0.5 (13)	4.6 (0.80)	4	225
0.55 (14)	5.2 (0.91)	4	230
0.6 (15)	5.8 (1.01)	3	240
0.75 (19)	7.2 (1.26)	2	260
1.0 (25)	10.0 (1.75)	1	360
1.5 (38)	15.0 (2.63)	1	470
1.7 (43)	20.0 (3.50)	5×10^{-2}	510
2.0 (51)	23.0 (4.03)	4×10^{-2}	575
2.5 (64)	24.5 (4.29)	3×10^{-2}	640
3.0 (76)	29.0 (5.08)	2×10^{-2}	690
4.0 (100)	38.5 (6.74)	2×10^{-2}	790
5.0 (130)	48.0 (8.41)	1.5×10^{-2}	900
6.0 (150)	58.0 (10.16)	1.5×10^{-2}	1000
7.0 (180)	67.0 (11.73)	1.3×10^{-2}	1100
10.0 (250)	90.0 (15.76)	1.0×10^{-2}	1500
15.0 (380)	128 (22.42)	0.5×10^{-2}	2000
20.0 (510)	160 (28.02)	0.5×10^{-2}	2500
30.0 (760)	200 (35.02)	0.5×10^{-2}	3000
Type III[D]			
0.4 (10)	4.1 (0.72)	6	340
0.45 (11)	4.9 (0.85)	5	345
0.5 (13)	5.6 (0.98)	4	350
0.55 (14)	6.3 (1.10)	4	355
0.6 (15)	6.9 (1.21)	3	360
0.75 (19)	9.1 (1.59)	2	375
1.0 (25)	12.6 (2.21)	1	430
1.5 (38)	17.1 (2.99)	1	570
1.7 (43)	18.9 (3.31)	5×10^{-2}	630
2.0 (51)	22.1 (3.81)	4×10^{-2}	720
2.5 (64)	26.1 (4.57)	3×10^{-2}	780
3.0 (76)	30.6 (5.36)	2×10^{-2}	800
4.0 (100)	39.6 (6.94)	2×10^{-2}	1000
5.0 (130)	49.5 (8.67)	1.5×10^{-2}	1200
6.0 (150)	58.5 (10.24)	1.5×10^{-2}	1350
7.0 (180)	67.0 (11.73)	1.3×10^{-2}	1500
10.0 (250)	90.0 (15.76)	1.0×10^{-2}	2000
15.0 (380)	135 (23.64)	0.5×10^{-2}	2500
20.0 (510)	180 (31.52)	0.5×10^{-2}	3000
30.0 (760)	225 (39.40)	0.5×10^{-2}	3750
Type IV[D]			
0.20 (5)	1.5 (0.26)	9	250
0.25 (6)	2.3 (0.40)	7	300
0.3 (8)	3.1 (0.54)	7	320
0.35 (9)	3.8 (0.66)	7	330
0.4 (10)	4.6 (0.80)	6	340
0.45 (11)	5.4 (0.94)	5	350
0.5 (13)	6.2 (1.08)	4	355
0.55 (14)	7.0 (1.22)	4	360
0.6 (15)	7.7 (1.35)	3	365
0.75 (19)	10.1 (1.77)	2	380
1.0 (25)	14.0 (2.45)	1	430
1.5 (38)	19.0 (3.33)	1	600
1.7 (43)	21.0 (3.68)	5×10^{-2}	660
2.0 (51)	24.5 (4.29)	4×10^{-2}	750
2.5 (64)	29.0 (5.08)	3×10^{-2}	780
3.0 (76)	34.0 (5.95)	2×10^{-2}	800
4.0 (100)	44.0 (7.70)	2×10^{-2}	1000
5.0 (130)	55.0 (9.63)	1.5×10^{-2}	1200
6.0 (150)	65.0 (11.38)	1.5×10^{-2}	1350
7.0 (180)	74.0 (12.96)	1.3×10^{-2}	1600
10.0 (250)	100 (17.51)	1.0×10^{-2}	2000
15.0 (380)	150 (26.27)	0.5×10^{-2}	2500
20.0 (510)	200 (35.02)	0.5×10^{-2}	3000
30.0 (760)	250 (43.78)	0.5×10^{-2}	3750

[A] Note change in test method between 1.5 and 1.7 mils in thickness.
[B] Thickness tolerance for Type I shall be ±10 % on all thicknesses.
[C] Thickness tolerances for Type II shall be as follows:
2.0 mils and less ±7 %.
Over 2.0 mils ±10 %.
[D] Thickness tolerances for Types III and IV shall be as follows:
2.0 mils and less ±5 %.
Over 2.0 mils ±10 %.

TABLE 4 Dimensional Tolerances

Property	Types	Tolerances ± in. (mm)
Width (cross-machine direction)		
less than 2 in. (50 mm)	all	1/64 (0.4)
2 to 10 in. (51 to 254 mm), incl	all	1/32 (0.8)
over 10 in. (254 mm)	all	1/16 (1.6)
Length (sheets, machine direction)		
less than 18 in. (457 mm)	all	1/16 (1.6)
18 to 36 in. (457 to 915 mm), incl.	all	1/8 (3.2)
over 36 in. (915 mm)	all	3/16 (4.8)
Diameter (outer, of roll)	all	1/2 (13)