

3M Science.
Applied to Life.™

3M™ Flexible Insulations

Product Selection Guide

**Effective,
efficient,
sustainable.**



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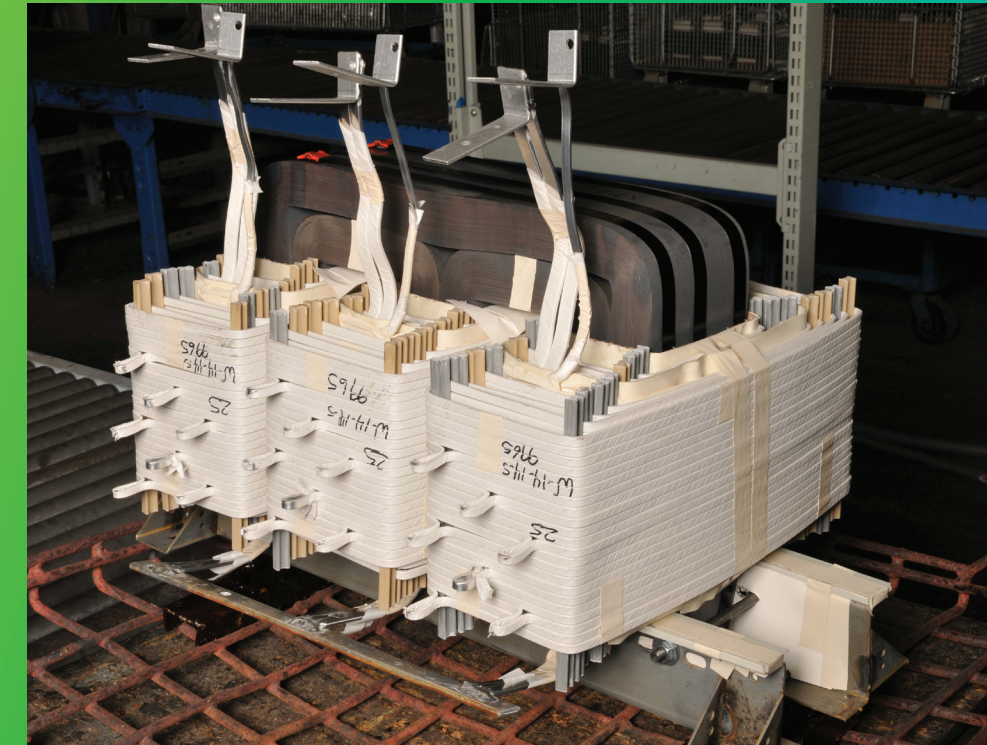
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As the demands on electrical components increase, 3M offers insulating and protecting products that are performance engineered to meet the most rigorous applications. These state-of-the-art materials have been refined, tested and proven in a wide variety of applications.



Use 3M™ Flexible Insulation for:

- Ground, phase and interwinding insulation for dry-type transformers
- Slot, phase and wedge insulation for electric motors and generators
- Flame barrier insulation for appliances
- Collars for voice coils used in speakers
- Wire and cable wrap
- Layer insulation used in cast coil transformers

Inorganic paper technology offers:

Voltage endurance

3M Flexible Insulation retains a high percentage of dielectric strength even after extended exposure to high operating temperatures while its inorganic content helps reduce damage caused by partial discharge.

Varnish absorption

The good varnish absorption characteristics of flexible insulation can enhance its already high thermal conductivity, helping equipment to run cooler, quieter, and last longer.

Thermal conductivity

The high thermal conductivity of flexible insulation helps achieve the heat dissipation required in today's electrical apparatus, allowing more efficient operation or the design of smaller, more cost-effective equipment.

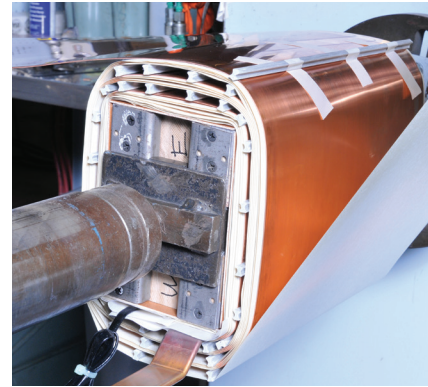
Low moisture absorption

Manufactured with less than 1% moisture content, flexible insulation papers exhibit dimensional stability even in humid environments and do not require extended drying time prior to varnish saturation.

Inorganic-Based Insulating Papers

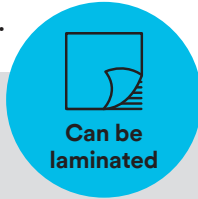
3M™ ThermaVolt Calendered Inorganic Insulating Paper

For high-temperature electrical insulation applications up to Class 220(R), the high thermal conductivity of 3M ThermaVolt Electrical Insulation Paper helps achieve the heat dissipation required in today's electrical apparatus, allowing more efficient operation or the design of smaller, more cost-effective equipment. 3M ThermaVolt AR (TVAR) paper combines the long-recognized advantages of 3M ThermaVolt paper with improved mechanical properties.



3M ThermaVolt Calendered Inorganic Insulating Paper Average Properties

	ASTM Test Method	3M ThermaVolt paper					
Nominal Thickness	D-645	0.08 mm 3 mil	0.10 mm 4 mil	0.13 mm 5 mil	0.18 mm 7 mil	0.25 mm 10 mil	0.38 mm 15 mil
Basis Weight	D-202	103 g/m ² 0.19 lb/yd ²	156 g/m ² 0.29 lb/yd ²	195 g/m ² 0.36 lb/yd ²	274 g/m ² 0.49 lb/yd ²	410 g/m ² 0.76 lb/yd ²	561 g/m ² 1.04 lb/yd ²
Tensile Strength, MD	D-828	11 lb/inch 19 N/cm	22 lb/inch 39 N/cm	31 lb/inch 54 N/cm	41 lb/inch 72 N/cm	53 lb/inch 93 N/cm	100 lb/inch 175 N/cm
Elongation to Break, MD	D-828	1.0%	1.2%	1.3%	1.2%	1.7%	1.7%
Elmendorf Tear, CD	D-689	60 g 0.6 N	132 g 1.3 N	142 g 1.4 N	302 g 3.0 N	354 g 3.5 N	734 g 7.2 N
Dielectric Breakdown Strength	D-149	1.1 kV	2.2 kV	2.7 kV	3.0 kV	5.0 kV	8.0 kV
Thermal Conductivity	E-1530 (@ 180°C)	0.15	0.21	0.21	0.21	0.25	0.25
Flame Rating UL File E65069	UL94	V-0, 5VA	V-0, 5VA	V-0, 5VA	V-0, 5VA	V-0, 5VA	V-0, 5VA



Features and benefits

- UL systems recognition through Class 220(R)
- Excellent thermal conductivity
- Good dielectric breakdown resistance
- Thicknesses: 3 mils (0.08 mm) to 30 mils (0.76 mm)

Applications

High temperature electrical insulation for:

- Dry-type transformers, coils and reactors
 - Ground insulation
 - Phase insulation
 - Layer insulation
 - Interwinding insulation
 - Electromagnet layer insulation

3M ThermaVolt AR paper after 2 weeks aging at 260°C

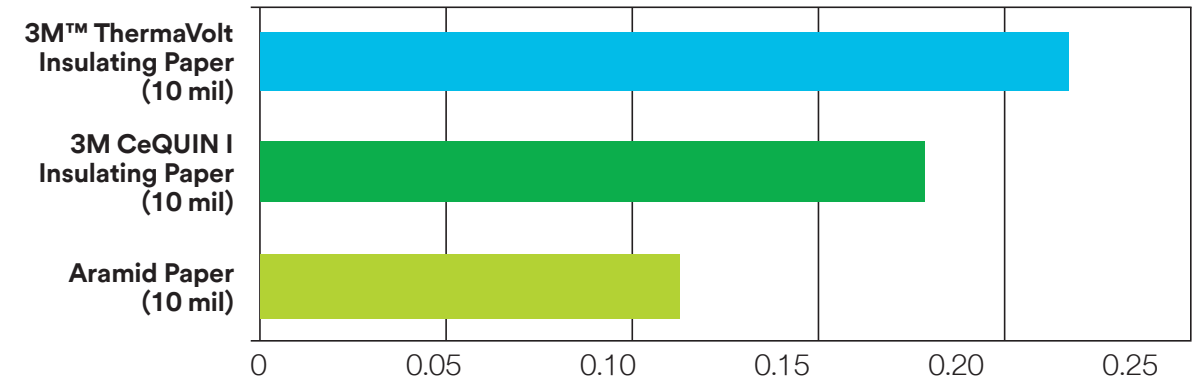


3M ThermaVolt AR Calendered Inorganic Insulating Paper Average Properties

	ASTM Test Method	3M ThermaVolt paper						
Nominal Thickness	D-645	0.10 mm 4 mil	0.13 mm 5 mil	0.18 mm 7 mil	0.25 mm 10 mil	0.38 mm 15 mil	0.51 mm 20 mil	0.76 mm 30 mil
Basis Weight	D-202	105 g/m ² 0.19 lb/yd ²	168 g/m ² 0.31 lb/yd ²	244 g/m ² 0.45 lb/yd ²	326 g/m ² 0.60 lb/yd ²	501 g/m ² 0.94 lb/yd ²	668 g/m ²	1032 g/m ² 1.9 lb/yd ²
Tensile Strength, MD	D-828	52 lb/inch 91 N/cm	72 lb/inch 126 N/cm	81 lb/inch 142 N/cm	98 lb/inch 172 N/cm	190 lb/inch 333 N/cm	234 lb/inch 410 N/cm	319 lb/inch 559 N/cm
Elongation to Break, MD	D-828	2.5%	2.3%	2.9%	2.5%	4.7%	4.5%	3.9%
Elmendorf Tear, CD	D-689	530 g 5.2 N	780 g 7.7 N	1050 g 10.3 N	1110 g 10.9 N	2184 g 21.4 N	2752 g 27.0 N	>3200 g >31.4 N
Dielectric Breakdown Strength	D-149	0.98 kV	1.5 kV	2.8 kV	6.5 kV	7.4 kV	8.6 kV	14.8 kV
Thermal Conductivity	E-1530 (@ 180°C)	0.13	0.16	0.17	0.20	0.21	0.21	0.23

* DS = Data Sheet, SDS = Safety Data Sheet

Thermal Conductivity



Thermal conductivity (W/mK) tested per ASTM E-1530 @ 180° C

3M ThermaVolt Laminates

3M ThermaVolt TvF Calendered Inorganic Insulating Paper

A two-ply composite of 3M ThermaVolt calendered inorganic paper bonded to polyester film.

3M ThermaVolt TvFTv Calendered Inorganic Insulating Paper

A three-ply composite of 3M ThermaVolt paper bonded to both sides of a polyester film.

3M ThermaVolt FTvF Calendered Inorganic Insulating Paper

A three-ply composite of polyester film bonded to both sides of 3M ThermaVolt paper.

3M ThermaVolt Calendered Inorganic Insulating Laminates Average Properties

	ASTM Test Method	3M TvF paper 3+2	3M TvF paper 5+2	3M TvF paper 7+1	3M TvF paper 7+2	3M TvFTv paper 4+2+4	3M TvFTv paper 7+1+7	3M TvFTv paper 5+5+5	3M TvFTv paper 5-7.5-5
Nominal Thickness	D-645	0.13 mm 5 mil	0.18 mm 7 mil	0.20 mm 8 mil	0.23 mm 9 mil	0.25 mm 10 mil	0.38 mm 15 mil	0.38 mm 15 mil	0.45 mm 17.5 mil
Basis Weight	D-202	180 g/m ² 0.33 lb/yd ²	727 g/m ² 0.50 lb/yd ²	314 g/m ² 0.58 lb/yd ²	351 g/m ² 0.65 lb/yd ²	388 g/m ² 0.71 lb/yd ²	600 g/m ² 1.11 lb/yd ²	570 g/m ² 1.05 lb/yd ²	664 g/m ² 1.22 lb/yd ²
Tensile Strength, MD	D-828	53 lb/inch 93 N/cm	63 lb/inch 285 N/cm	60 lb/inch 105 N/cm	68 lb/inch 119 N/cm	87 lb/inch 152 N/cm	95 lb/inch 166 N/cm	142 lb/inch 249 N/cm	220 lb/inch 835 N/cm
Elongation to Break, MD	D-828	9%	3%	4%	4%	3%	2%	3%	3%
Elmendorf Tear, CD	D-689	157 g 1.5 N	232 g 1.9 N	232 g 2.3 N	256 g 2.5 N	498 g 4.9 N	540 g 5.3 N	648 g 6.4 N	896 g 8.9 N
Dielectric Breakdown Strength	D-149	8 kV	9 kV	6 kV	9 kV	11 kV	11 kV	15 kV	18 kV
Thermal Conductivity	E-1530 (@ 180°C)	**	**	**	**	0.22	**	0.21	0.21

* DS = Data Sheet, SDS = Safety Data Sheet

** Data not available at this time

Inorganic-Based Insulating Papers

3M™ CeQUIN Inorganic Insulating Paper, Laminates and Boards

3M CeQUIN Inorganic Insulating Paper is for high-temperature electrical insulation applications up to Class 220(R).

3M CeQUIN 3000 Inorganic Insulating Paper

3M Inorganic Insulating Paper CeQUIN 3000 is a modified version of 3M CeQUIN I paper designed with higher mechanical strength. Available in 3-mil thickness.



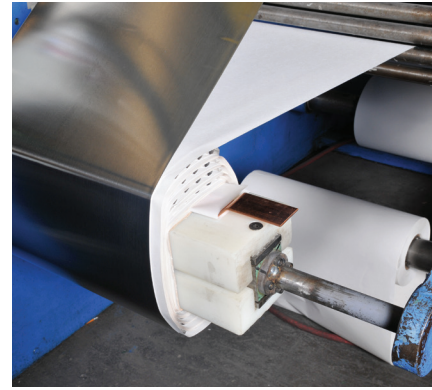
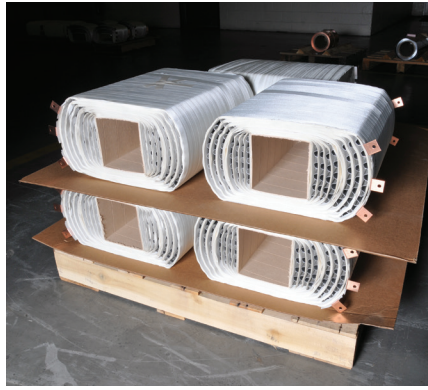
Features and benefits

- UL systems recognition through Class 220(R)
- CSA Component Acceptance: Temperature Class 220
- Very good thermal conductivity

Applications

High temperature electrical insulation for:

- Dry-type transformers, coils and reactors
 - Ground insulation
 - Phase insulation
 - Layer insulation
 - Interwinding insulation
 - Barrier insulation
 - Core wrap
 - End Fill
- Electromagnet layer insulation
- Switchgear insulation
- Spiral and convolute tubing



3M CeQUIN Inorganic Insulating Paper Average Properties

ASTM Test Method	3M CeQUIN I paper						
	0.13 mm 5 mil	0.18 mm 7 mil	0.25 mm 10 mil	0.38 mm 15 mil	0.51 mm 20 mil	0.76 mm 30 mil	
Nominal Thickness	D-645	0.13 mm 5 mil	0.18 mm 7 mil	0.25 mm 10 mil	0.38 mm 15 mil	0.51 mm 20 mil	0.76 mm 30 mil
Basis Weight	D-202	125 g/m ² 0.23 lb/yd ²	175 g/m ² 0.32 lb/yd ²	270 g/m ² 0.50 lb/yd ²	410 g/m ² 0.75 lb/yd ²	540 g/m ² 1.0 lb/yd ²	810 g/m ² 1.5 lb/yd ²
Tensile Strength, MD	D-828	6 lb/inch 11 N/cm	9 lb/inch 16 N/cm	12 lb/inch 21 N/cm	16 lb/inch 28 N/cm	20 lb/inch 35 N/cm	23 lb/inch 40 N/cm
Elongation to Break, MD	D-828	<2%	<2%	<2%	<2%	<2%	<2%
Elongation to Break, CD	D-689	<2%	<2%	<2%	<2%	<2%	<2%
Dielectric Breakdown Strength	D-149	1.0 kV	1.3 kV	1.8 kV	2.6 kV	3.2 kV	3.8 kV
Thermal Conductivity	E-1530 (@ 180°C)	0.14	**	0.17	**	0.17	0.17

** Data not available at this time

ASTM Test Method	3M CeQUIN II paper			
	0.76 mm 30 mil	1.00 mm 40 mil	1.50 mm 60 mil	
Nominal Thickness	D-645	0.76 mm 30 mil	1.00 mm 40 mil	1.50 mm 60 mil
Basis Weight	D-202	865 g/m ² 1.6 lb/yd ²	1140 g/m ² 2.1 lb/yd ²	1640 g/m ² 3.0 lb/yd ²
Tensile Strength, MD	D-828	51 lb/inch 79 N/cm	55 lb/inch 96 N/cm	65 lb/inch 114 N/cm
Elongation to Break, MD	D-828	<2%	<2%	<2%
Elongation to Break, CD	D-689	<2%	<2%	<2%
Dielectric Breakdown Strength	D-149	6.5 kV	7.5 kV	9.0 kV
Thermal Conductivity	E-1530 (@ 180°C)	**	0.21	**

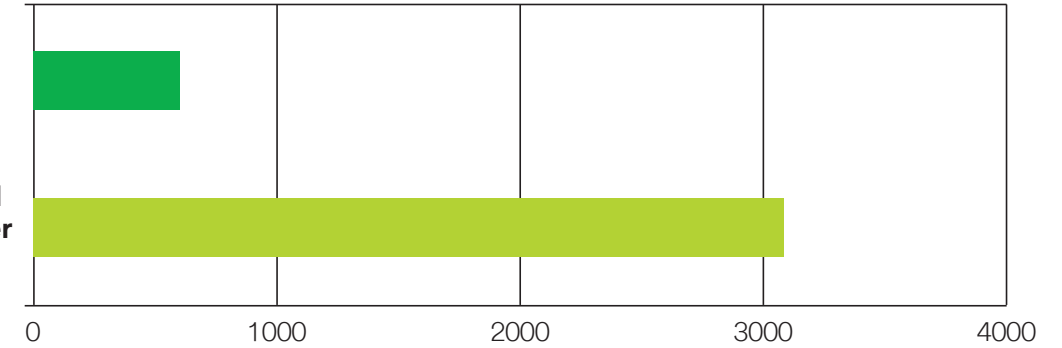
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Voltage Endurance Comparison ASTM D2275-89

Calendered
Aramid Paper
(10 mils)

3M™ CeQUIN I
Insulating Paper
(10 mils)

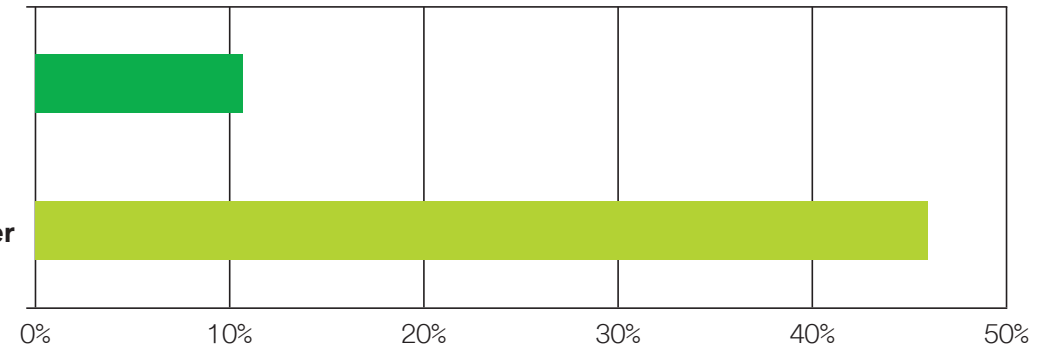


Tested per ASTM D-2275: average of 5 data points.
60Hz, 20° C, 50% RH

Varnish Absorption

Calendered
Aramid Paper
(10 mils)

3M CeQUIN I
Insulating Paper
(10 mils)



3M test method reflects percent weight absorption.
(10-min dip in polyester resin (250 cps). Excess varnish removed with steel rod.)

3M CeQUIN 3000 Inorganic Insulating Paper Average Properties

ASTM Test Method	3M CeQUIN 3000 paper			
	0.08 mm 3 mil	0.13 mm 5 mil	0.25 mm 10 mil	
Nominal Thickness	D-645	0.08 mm 3 mil	0.13 mm 5 mil	0.25 mm 10 mil
Basis Weight	D-202	72 g/m ² 0.13 lb/yd ²	106 g/m ² 0.19 lb/yd ²	228 g/m ² 0.42 lb/yd ²
Tensile Strength, MD	D-828	7 lb/inch 12 N/cm	13 lb/inch 23 N/cm	35 lb/inch 61 N/cm
Elongation to Break, MD	D-828	<2%	<2%	<2%
Dielectric Breakdown Strength	D-149	0.8 kV	1.0 kV	1.5 kV
Thermal Conductivity	ASTM E-1530 (@ 180° C)	0.11	0.11	**

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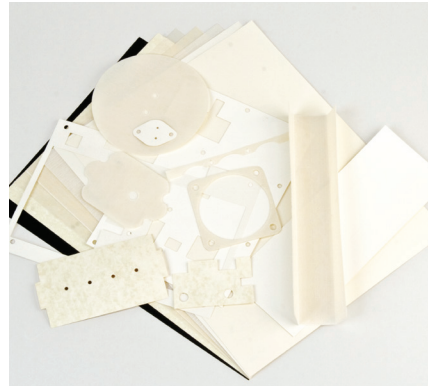
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Inorganic-Based Insulating Papers

3M™ CeQUIN Inorganic Insulating Laminates

Features and benefits

- UL Systems Recognition from Class 130(B) through Class 220(R)
- CSA Component Acceptance: Temperature Class 220
- High temperature capabilities
- Long-term dielectric strength
- Good thermal conductivity
- Low moisture absorption
- Cost effective
...Combined with the added benefits of polyester film
- Improved cut-through resistance
- Good Stiffness and snap back
- Higher mechanical strength
- Improved resistance to tear
- High initial dielectric strength



3M CeQUIN IF Inorganic Insulating Paper

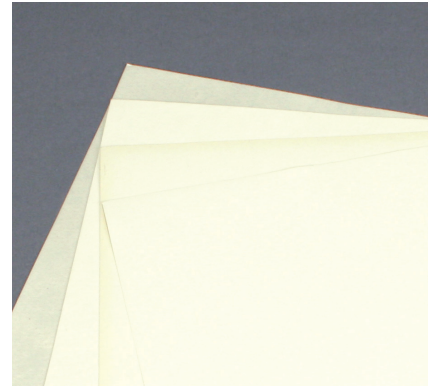
A two-ply composite of 3M CeQUIN I inorganic paper bonded to polyester film.

3M CeQUIN IFI Inorganic Insulating Paper

A three-ply composite of 3M CeQUIN I paper bonded to both sides of a polyester film.

3M CeQUIN FIF Inorganic Insulating Paper

A three-ply composite of polyester film bonded to both sides of 3M CeQUIN I paper.



3M CeQUIN 30F Inorganic Insulating Paper

A two-ply composite of 3M CeQUIN 3000 inorganic paper bonded to polyester film.

3M CeQUIN 30F30 Inorganic Insulating Paper

A three-ply composite of 3M CeQUIN 3000 paper bonded to both sides of a polyester film.

3M CeQUIN IG, CeQUIN IGI, and CeQUIN GIG Inorganic Insulating Papers

3M CeQUIN papers also can be laminated to glass fabric for extreme high-temperature applications

3M CeQUIN Inorganic Insulating Laminates Average Properties

	ASTM Test Method	3M CeQUIN paper 30F 3+2	3M CeQUIN paper IF 5+1	3M CeQUIN paper IF 5+2	3M CeQUIN paper IF 10+1	3M CeQUIN paper IF 15+1	3M CeQUIN paper IFI 5-3-5
Nominal Thickness	D-645	0.13 mm 5 mil	0.15 mm 6 mil	0.18 mm 7 mil	0.28 mm 11 mil	0.41 mm 16 mil	0.33 mm 13 mil
Basis Weight	D-202	154 g/m ² 0.28 lb/yd ²	172 g/m ² 0.32 lb/yd ²	210 g/m ² 0.39 lb/yd ²	310 g/m ² 0.57 lb/yd ²	454 g/m ² 0.84 lb/yd ²	386 g/m ² 0.71 lb/yd ²
Tensile Strength, MD	D-828	44 lb/inch 77 N/cm	23 lb/inch 40 N/cm	42 lb/inch 74 N/cm	30 lb/inch 53 N/cm	40 lb/inch 70 N/cm	64 lb/inch 112 N/cm
Dielectric Breakdown Strength	D-149	8 kV	5.5 kV	8 kV	5.5 kV	5.5 kV	11 kV
Thermal Conductivity	E-1530 (@ 180°C)	**	0.14	**	0.19	**	0.14

* DS = Data Sheet, SDS = Safety Data Sheet

** Data not available at this time

Insulating Papers



3M™ Thermal Shield Insulating Paper

3M™ Thermal Shield Insulating Paper is a calendered, non-woven insulating paper designed for high-temperature electrical insulation applications, including ground and layer insulation in dry-type transformers and electromagnet coils.

3M™ Thermal Shield available options and typical product properties

Nominal Thickness mil (mm)	Basis Weight g/m ² (lb/yd ²)	Tensile Strength, MD N/cm (lb/inch)	Tensile Strength, CD N/cm (lb/inch)	Elongation, MD %	Elongation, CD %	Dielectric Strength V
2.5 (0.064)	45 (0.08)	16 (9)	5 (3)	18	7	350
3 (0.08)	66 (0.12)	21 (12)	9 (5)	14	5	450
4 (0.10)	90 (0.17)	28 (16)	12 (7)	12	5	500
5 (0.13)	116 (0.21)	42 (24)	19 (11)	15	6	600
ASTM Test Method						
D-374	D-202	D-828	D-828	D-828	D-828	D-149

Data is not for specifications. Values are typical and should not be considered minimum or maximum. Properties measured at room temperature 73°F (-23°C) unless otherwise stated.



Features and benefits

- UL systems recognition through Class 220(R)
- Longer fibers that increase the tear and mechanical toughness
- Excellent varnish absorption
- Excellent chemical resistance
- Low moisture absorption
- Widths up to 72"*

* For more information on laminated versions over 36", please reach out to your 3M sales representative.

Applications

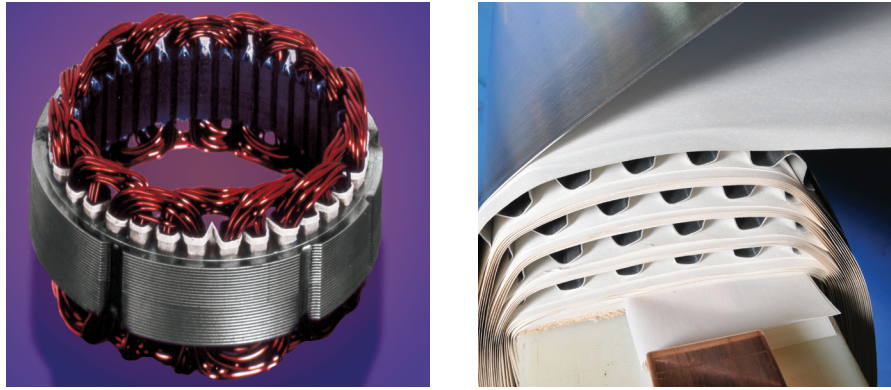
- **Dry-type transformers, coils, and reactors**
 - Ground or interwinding insulation
 - Layer or turn insulation
- **Electromagnetic coils**

3M™ Hybrid Insulating Papers

3M™ TufQUIN 110 and TufQUIN 120 Hybrid Insulating Papers

For high-temperature insulation applications up to Class 200(N), 3M TufQUIN 110 Hybrid Insulating Paper is a tough, flexible and conformable paper with good dielectric characteristics and thermal conductivity.

3M TufQUIN 120 Hybrid Insulating Paper is similar to 3M TufQUIN 110 paper, but uses a modified manufacturing process that maintains conformability at high thickness.



3M TufQUIN Hybrid Insulating Paper Average Properties

ASTM Test Method	3M TufQUIN 110 paper					
	0.05 mm 2 mil	0.08 mm 3 mil	0.13 mm 5 mil	0.18 mm 7 mil	0.25 mm 10 mil	
Nominal Thickness	D-645	0.05 mm 2 mil	0.08 mm 3 mil	0.13 mm 5 mil	0.18 mm 7 mil	0.25 mm 10 mil
Basis Weight	D-202	50 g/m ² 0.092 lb/yd ²	94 g/m ² 0.173 lb/yd ²	148 g/m ² 0.273 lb/yd ²	202 g/m ² 0.37 lb/yd ²	304 g/m ² 0.56 lb/yd ²
Tensile Strength, MD	D-828	12 lb/inch 21 N/cm	20 lb/inch 35 N/cm	27 lb/inch 47 N/cm	45 lb/inch 79 N/cm	50 lb/inch 88 N/cm
Elongation to Break, MD	D-828	10%	15%	19%	14%	18%
Elmendorf Tear, CD	D-689	145 g 1.4 N	200 g 2.0 N	525 g 5.1 N	705 g 6.9 N	1335 g 13.1 N
Dielectric Breakdown Strength	D-149	0.4 kV	0.7 kV	0.9 kV	1.0 kV	2.5 kV
Thermal Conductivity	E-1530 (@ 180°C)	0.16	0.18	0.18	0.17	0.18

ASTM Test Method	3M TufQUIN 120 paper		
	0.19 mm 7.5 mil	0.38 mm 15 mil	
Nominal Thickness	D-645	0.19 mm 7.5 mil	0.38 mm 15 mil
Basis Weight	D-202	208 g/m ² 0.38 lb/yd ²	422 g/m ² 0.78 lb/yd ²
Tensile Strength, MD	D-828	45 lb/inch 79 N/cm	90 lb/inch 158 N/cm
Elongation to Break, MD	D-828	14%	14%
Elmendorf Tear, CD	D-689	705 g 6.9 N	1620 g 15.9 N
Dielectric Breakdown Strength	D-149	1.0 kV	2.7 kV
Thermal Conductivity	E-1530 (@ 180°C)	0.17	**

* DS = Data Sheet, SDS = Safety Data Sheet
** Data not available at this time

Features and benefits

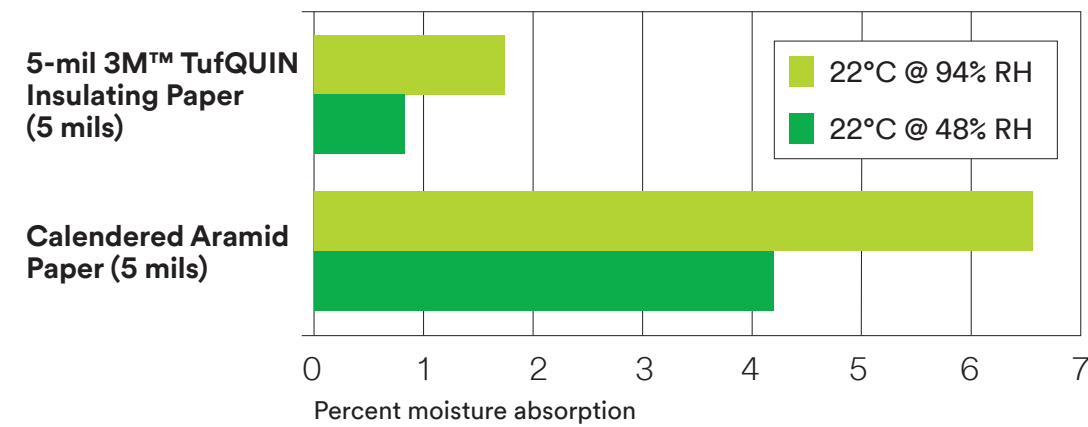


- UL systems recognition through Class 200(N)
- CSA Component Acceptance: Temperature Class 200
- Tough and conformable
- Good dielectric strength
- Excellent stiffness and tear resistance
- Very good thermal conductivity

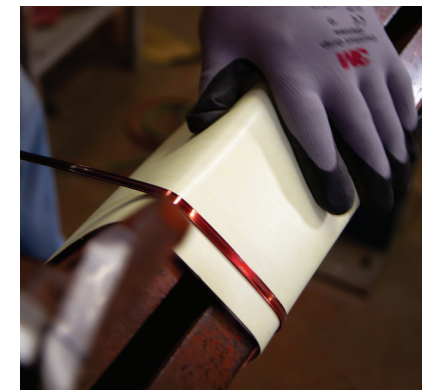
Applications

- **Motors and generators**
 - Slot liner
 - Wedge
 - Phase insulation
- **Dry-Type Transformers, coils and reactors**
 - Ground/interwinding insulation
 - Phase insulation
 - Layer insulation
 - Barrier insulation
 - Wire wrap
- **Spiral- and convolute-wound tubing**
- **Switchgear insulation**
- **Pressure-sensitive tapes**

Moisture Absorption***



***Tested for percent moisture absorption per ASTM D-644



3M TufQUIN Laminates

3M TufQUIN TF Hybrid Insulating Paper

A two-ply composite of 3M TufQUIN 110 Hybrid paper bonded to polyester film.

3M TFT Hybrid Insulating Paper

A three-ply composite of 3M TufQUIN 110 paper bonded to both sides of a polyester film.

With 3M TufQUIN TF and TFT Hybrid Insulating Papers, the polyester film provides an excellent dielectric barrier and adds stiffness and snapback characteristics to the composite, uniquely suited for motor/generator slot liner, wedge and phase insulation applications.

3M TufQUIN Hybrid Insulating Laminate Average Properties

ASTM Test Method	3M TufQUIN Hybrid Insulating Laminate Average Properties									
	3M TFT paper 2-1-2	3M TFT paper 2-2-2	3M TFT paper 3-3-3	3M TFT paper 3-5-3	3M TFT paper 3-7.5-3	3M TFT paper 5-5-5	3M TFT paper 5-10-5	3M TFT paper 5+7.5		
Nominal Thickness	D-645	0.13 mm 5 mil	0.15 mm 6 mil	0.23 mm 9 mil	0.28 mm 11 mil	0.34 mm 13.5 mil	0.38 mm 15 mil	0.51 mm 20 mil	0.32 mm 12.5 mil	
Basis Weight	D-202	144 g/m ² 0.265 lb/yd ²	180 g/m ² 0.33 lb/yd ²	306 g/m ² 0.56 lb/yd ²	376 g/m ² 0.69 lb/yd ²	470 g/m ² 0.87 lb/yd ²	484 g/m ² 0.89 lb/yd ²	659 g/m ² 1.22 lb/yd ²	423 g/m ² 0.78 lb/yd ²	
Tensile Strength, MD	D-828	52 lb/inch 91 N/cm	71 lb/inch 124 N/cm	96 lb/inch 168 N/cm	128 lb/inch 224 N/cm	161 lb/inch 282 N/cm	127 lb/inch 222 N/cm	212 lb/inch 371 N/cm	141 lb/inch 247 N/cm	
Elongation to Break, MD	D-828	27%	26%	28%	30%	30%	17%	29%	33%	
Elmendorf Tear, CD	D-689	600 g 5.9 N	625 g 6.1 N	1190 g 11.7 N	1260 g 12.3 N	1430 g 14.0 N	2700 g 26.5 N	3050 g 29.9 N	1300 g 12.7 N	
Dielectric Breakdown Strength	D-149	6 kV	8 kV	11 kV	15 kV	18 kV	15 kV	22 kV	18 kV	
Thermal Conductivity	E-1530 (@ 180°C)	0.17	0.17	0.18	0.17	0.17	0.18	0.18	**	

* DS = Data Sheet, SDS = Safety Data Sheet
** Data not available at this time

3M™ Flexible Laminates DMD

3M Flexible Laminates DMD is a family of tough, formable insulation designed for high reliability for such common uses as slot liner, wedge and phase insulation. It has UL Systems recognition through Class 155 (F).

Applications

- **Motors and Generators**
 - Slot Liner
 - Wedge
 - Phase Insulation



Why use a polyester film laminate?

Polyester film can provide mechanical support for inorganic insulating paper. However, considering the thermal, mechanical, electrical, and UL factors together can be complex.

What are the thermal capabilities of polyester film?

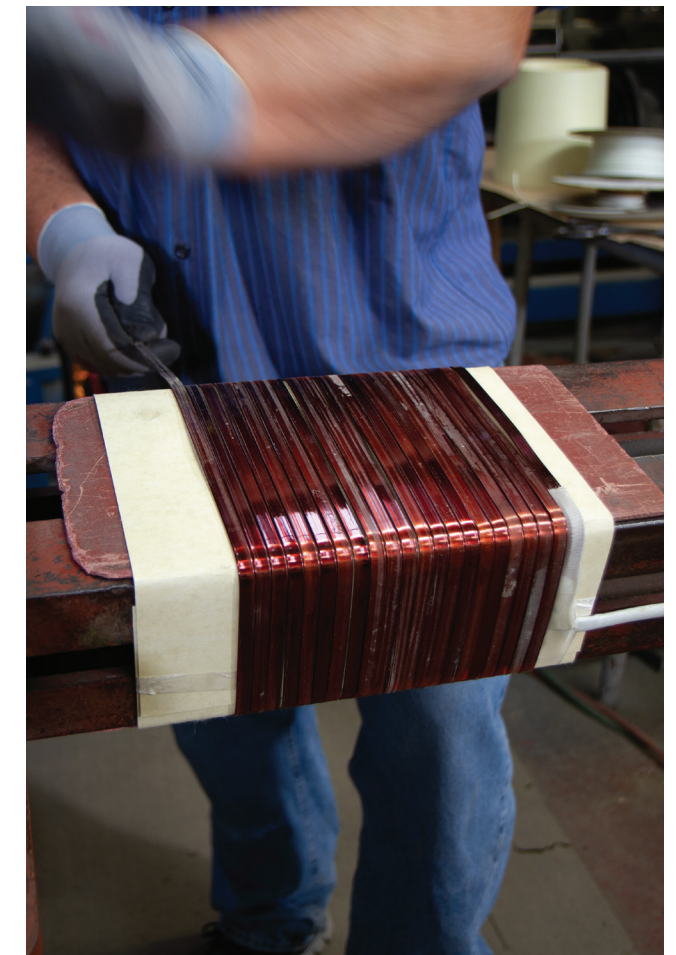
Polyester film is a component rated as a 130°C material; it will shrink and embrittle when aged at high temperatures. The primary mode of this degradation is oxidation. However, Lamination will help slow this process as will properly applied varnish or impregnation. As the film slowly oxidizes, it breaks down into its constituent chemicals which do not attack other components nor carbonize the film. This “friendly” degradation is one of the reasons that polyethyleneterephthalate (PET) polyester film is so widely used in electrical insulation applications. Despite the concern of some that this 130°C material will melt, the actual melting point of PET polyester film is over 240°C. Although it will begin to lose mechanical strength at high temperatures, polyester film can withstand short-term thermal excursions if protected from oxidation.

Won't polyester film shrink and embrittle at high temperatures?

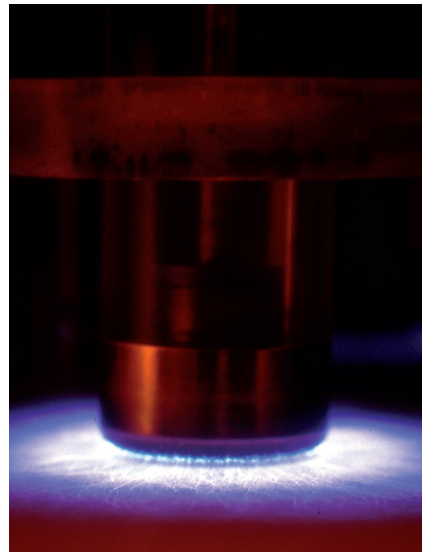
Shrinkage and embrittlement due to thermal aging can be addressed through equipment design. For example, in a tightly wound unit a 3M™ CeQUIN Inorganic Insulating Laminates (paper/polyester) will be held in place, greatly reducing shrinkage. Likewise, a tightly wound, well-varnished coil will significantly reduce mechanical stress and vibration that could affect the polyester film portion of the laminate as it ages.

How long have polyester film laminates been used?

From a historical perspective, inorganic papers laminated with polyester film have been used successfully for more than 40 years in Class 220(R) coil applications, ranging from small H.I.D. ballast transformers to medium size dry-type distribution transformers. For example, 3M CeQUIN IF inorganic insulating paper laminate is used as a wire wrap in the manufacture of a 250°C-rated appliance wiring material (UL Style 5288/CSA Class 1, Group A/B) for use in high-temperature, severe environments. The acceptance of inorganic insulating paper paper-polyester film laminates for use in these high performance applications speaks for itself.



For more information about these products, including data sheets, go to www.3M.com/oem.



UL recognition

3M™ Flexible Insulations have undergone extensive thermal aging evaluation per UL 1446, “Standard for Systems of Insulating Materials – General.” As a result they are UL Recognized for use as major insulation in electrical insulation systems as listed under 3M Innovative Paper Technologies File No. E65007 and may be found on UL’s Electrical Insulation Systems Database at <http://data.ul.com/systems/>. All systems listed on this database are available for use by any electrical apparatus manufacturer by contacting the nearest UL office UL 1446 systems with 3M Flexible Insulations also comply with IEC Publication 85.

Recommended usage

Optimum performance of an electrical insulation system is dependent upon many factors including proper choice of materials, acceptable design criteria, and good manufacturing procedures. Varnishing is recommended for construction of equipment that may be exposed to the elements. For design purposes, it is recommended that operating electrical stresses in electrical apparatus not exceed 40 V/mil (1.6 kV/mm) in order to minimize the risk of partial discharge.

Insulating & Conductive Tapes

3M offers a wide variety of electrical and electronic insulating tapes for insulating, holding, protecting, bonding, resin impregnation, harnessing and electromagnetic compatibility. Most of these tapes feature industry component recognition, such as UL, as well as excellent mechanical, electrical and physical properties.

3M™ Insulating and Conductive Tapes are designed to provide a high level of protection for electrical and electronic components. All 3M tapes and related products feature exceptionally high quality backed by experienced technical support.



Liquid Insulating Resins

3M Scotchcast™ Electrical Liquid Resins are 100-percent solid, thermosetting, electrical-grade insulating resins. These two-part liquids are classified chemically as either epoxies or polyurethanes. These resins have electrical and physical properties that make them excellent for insulating and protecting electrical and electronic parts and assemblies.



Powder Resins

3M Scotchcast Powder Resins are a series of one-part, 100-percent solid electrical-grade systems offering fast curing, excellent thermal and mechanical shock resistance, significant cut-through resistance, high adhesion, excellent chemical and moisture resistance, high-to-low flow characteristics, and excellent electrostatic coating capability. Insulation systems established per UL 1446 and IEC 85 requirements are available in this family of resins up to Class H (180°C).

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