INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Guide

IPT is an organization of specialists who research, design and manufacture high quality Inorganic papers and boards for industrial applications. At the manufacturing and R&D facilities in Tilton, New Hampshire, IPT has pioneered the development and production of a new generation of products which are performance engineered to meet the most rigorous applications at temperatures ranging from sub-zero to more than 250°C.

The mission of IPT is to be an innovative world supplier of paper and board products designed to meet specific applications in specialty markets utilizing expertise in blending inorganic and organic materials.

CERTIFIED QUALITY MANAGEMENT SYSTEM ISO 9001:2000

ANAB ACCREDITED

DNV

Innovative Paper Technologies, LLC
PO Box 739
Tilton, NH, USA 03276-0739
Tel: 866-357-2737
Fax:603-286-4859

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

CeQUIN® I

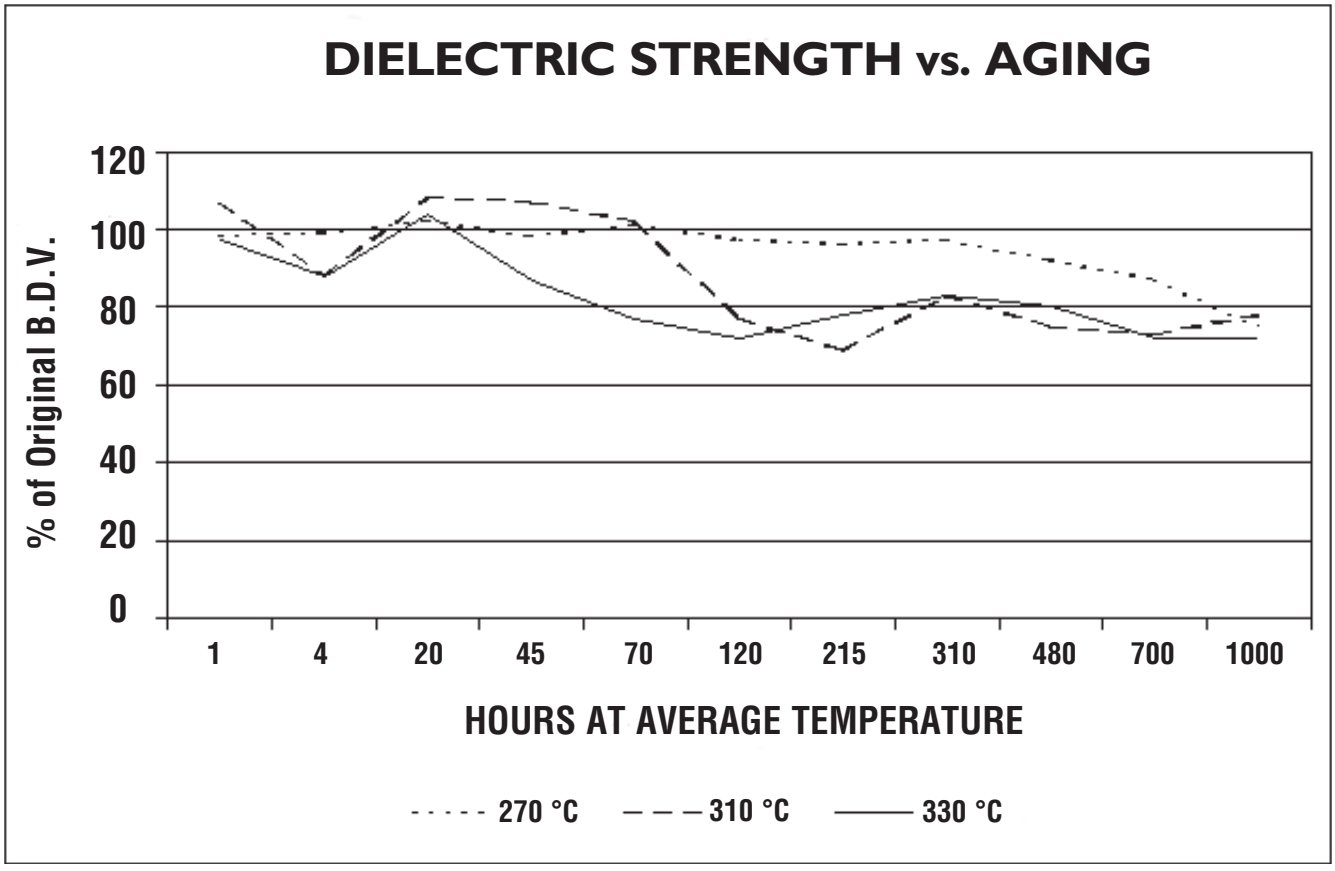
Description

CeQUIN I is IPT's highest inorganic content paper. Composed primarily of glass fibers, micro-fibers, inorganic fillers and less than 10% organic binders. CeQUIN I is capable of long-term performance at operating temperatures up to 250°C. CeQUIN I is a highly flexible paper available in continuous roll stock in thicknesses ranging from .13mm (5 mils) to .76mm (30 mils).

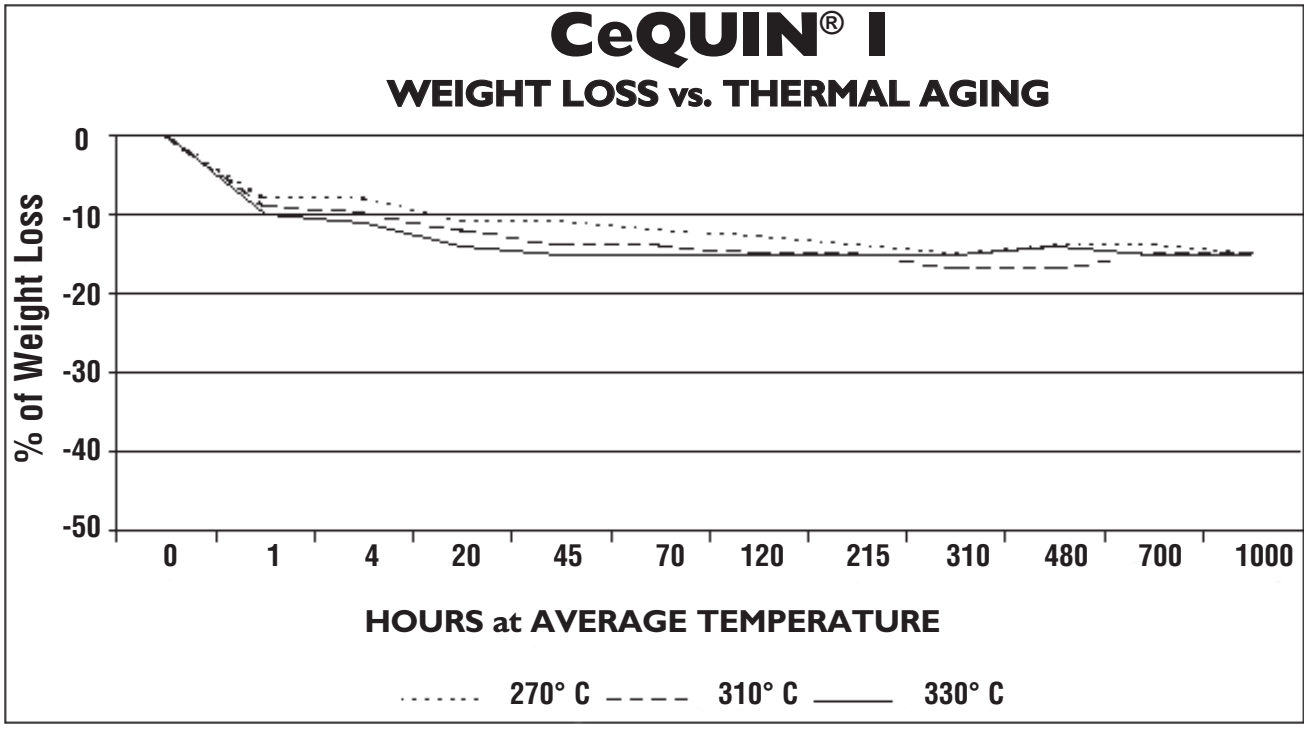
CeQUIN® I*			5 mil	10 mil	30 mil
Typical Thickness		mm	0.13	0.25	0.76
		mil	5	10	30
Basis Weight		kg/m^2	0.12	0.27	0.81
		lb/yd^2	0.23	0.5	1.5
Tensile Strength	kN/m	MD	1	2.1	4
		CD	0.3	0.7	N/A
	lb/in	MD	6	12	23
		CD	2	4	N/A
Elongation to Break		%	1	1	1
Elmendorf Tear	grams	MD	60	160	500
		CD	100	220	530
Mullen Burst		kPa	34	70	160
		psi	5	10	23
Breakdown Voltage		kV	1	1.8	3.8
Dielectric Constant		23°C	2.6	3.1	3
		120°C	3	4	3.7
Dissipation Factor		23°C	3.2	3	3.1
		120°C	12.3	17.8	13.7
Volume Resistivity @ 23°C		ohm-cm	10^{13}	10^{13}	10^{12}
Corona Inception		Volts	N/A	1010	N/A
Corona Extinction		Volts	N/A	1000	N/A
B.I.L Withstand Test**		Withstand	1.39	3.91	N/A
		Breakdown	1.43	4.35	N/A
Thermal Conductivity @ 180°C		W/m-°K	0.14	0.19	0.19
Moisture Content		%	<1	<1	<1

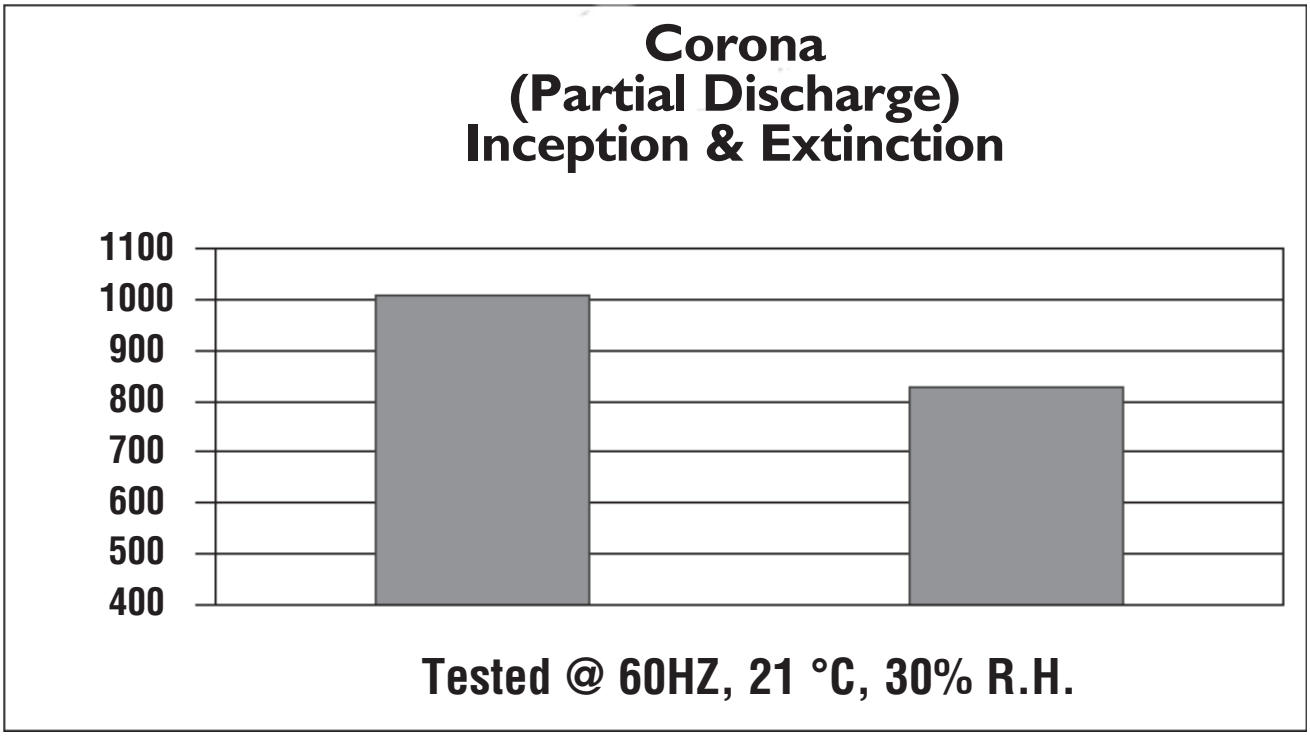
* All data is for nominal product properties and is not for specification purposes.
** The withstand voltage is the average of the five highest voltages the material withstood during valid testing.
The breakdown voltage is the average of five valid test voltage impulses that caused insulation failure.
N/A=Not Available

CeQUIN® I*			7 mil	15 mil	20 mil	25 mil
Typical Thickness		mm	0.18	0.40	0.51	0.63
		mil	7	15	20	25
Basis Weight		kg/m^2	0.18	0.40	0.55	0.70
		lb/yd^2	0.34	0.74	1	1.3
Tensile Strength	kN/m	MD	1.6	2.8	3.1	3.5
		CD	0.5	1.2	N/A	N/A
	lb/in	MD	9	16	18	20
		CD	3	7	N/A	N/A
Elongation to Break		%	1	1	1	1
Elmendorf Tear	grams	MD	100	240	300	450
		CD	60	330	330	500
Mullen Burst		kPa	44	110	140	140
		psi	7	16	20	20
Breakdown Voltage		kV	1.3	2.6	2.8	3.2



* All data is for nominal product properties and is not for specification purposes
N/A=Not Available





* All data is for nominal product properties and is not for specification purposes

INNOVATIVE PAPER TECHNOLOGIES, LLC

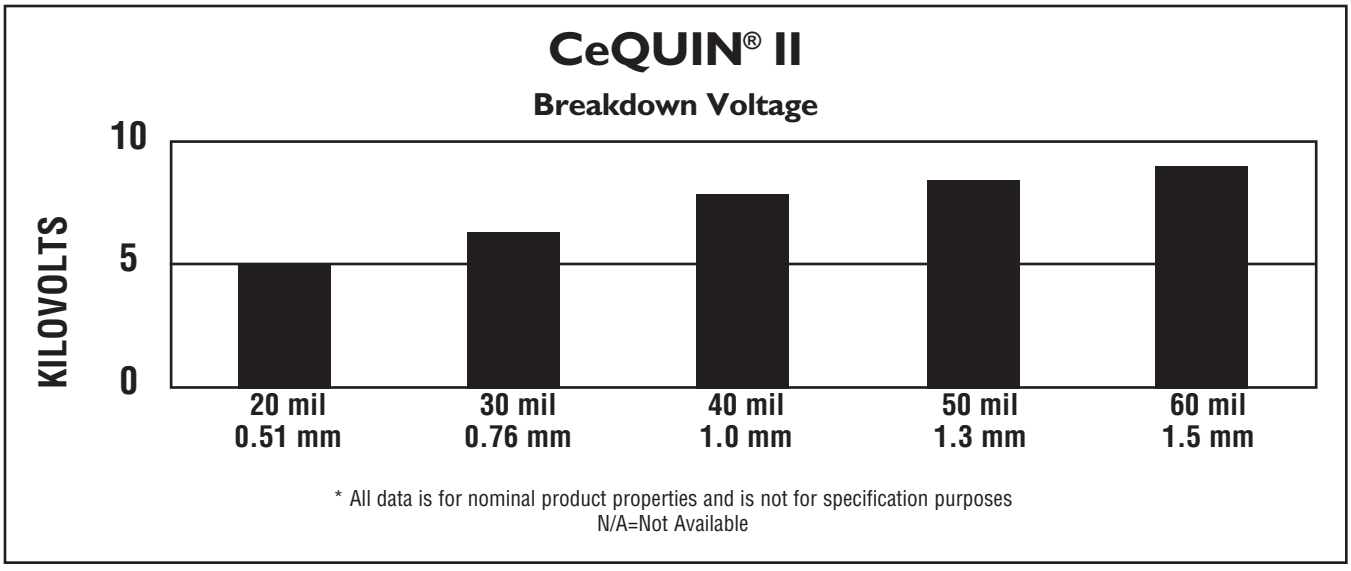
Technical Reference Sheet

CeQUIN® II

Description

CeQUIN II is a two layer composite of CeQUIN I designed to provide thicker roll stock for barrier, end filler, and core wrap insulation applications. CeQUIN II exhibits enhanced physical and dielectric properties and is available in thicknesses ranging from 0.50 to 1.5 mm (20 to 60 mils).

CeQUIN® II*			20 mil	30 mil	40 mil	50 mil	60mil
Typical Thickness		mm	0.5	0.76	1.0	1.3	1.5
		mil	20	30	40	50	60
Basis Weight		kg/m^2	0.55	0.81	1.1	1.4	1.6
		lb/yd^2	1	1.5	2.1	2.6	3
Tensile Strength	kN/m	MD	5.6	N/A	9.6	10	11
		CD	2.6	N/A	N/A	N/A	N/A
	lb/in	MD	32	9.6	55	57	61
		CD	15	N/A	N/A	N/A	N/A
Elongation to Break		%	1.5	N/A	N/A	N/A	N/A
Elmendorf Tear	grams	MD	224	N/A	N/A	N/A	N/A
		CD	384	N/A	N/A	N/A	N/A
Moisture		%	<1	<1	<1	<1	<1



* All data is for nominal product properties and is not for specification purposes
N/A=Not Available

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

CeQUIN® 3000

Description

CeQUIN 3000 is a modified version of CeQUIN I developed by IPT to provide high strength thin papers by introducing a small percentage of organic fiber reinforcement along with a higher strength binder system. CeQUIN 3000 papers are produced in 3 and 5 mil thicknesses.

CeQUIN® 3000*			3 mil	5 mil
Typical Thickness		mm	0.08	0.13
		mil	3.3	5
Basis Weight		kg/m^2	0.06	0.10
		lb/yd^2	0.12	0.19
Tensile Strength	kN/m	MD	1	1.6
	lb/in	MD	5.5	9
Elongation to Break		%	1.4	1.4
Elmendorf Tear	grams	MD	28	40
		CD	48	72
Mullen Burst		kPa	38	38
		psi	5.5	5.5
Breakdown Voltage		kV	0.6	1.0
Dielectric Constant		23 °C	1.9	N/A
		120 °C	2.3	N/A
Dissipation Factor		23 °C	2.3	N/A
		120 °C	4.9	N/A
Corona Inception		volts	N/A	853
Corona Extinction		volts	N/A	746
B.I.L. Withstand Test**		Withstand	N/A	2.4
		Breakdown	N/A	2.55
Thermal Conductivity @ 180 °C		W/m-°K	0.09	N/A
Moisture		%	<1	<1

*All data is for nominal product properties and is not for specification purposes.
** The withstand voltage is the average of the five highest voltages the material withstood during valid testing.
The breakdown voltage is the average of five valid test voltage impulses that caused insulation failure.
N/A=Not Available

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

CeQUIN® X

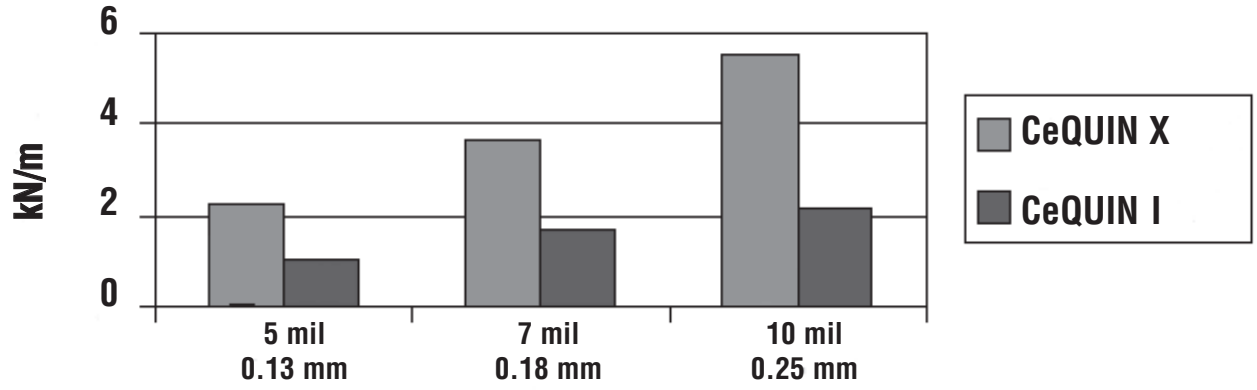
Description

Based on CeQUIN I, CeQUIN X is an inorganic electrical insulation material developed to address the need for greater mechanical strength and extra stiffness. CeQUIN X is ideally suited for impregnation, providing good wet strength during saturating and coating operations to allow better processing capabilities.
Available in 5, 7 and 10 mil thicknesses, CeQUIN X can be supplied in sheets, slit coils, and continuous rolls up to 36" wide.

CeQUIN® X*			5 mil	7 mil	10 mil
Typical Thickness		mm	0.13	0.18	0.25
		mil	5	7	10
Basis Weight		kg/m^2	0.1	0.14	0.21
		lb/yd^2	0.19	0.27	0.39
Tensile Strength	kN/m	MD	2.2	3.6	5.5
		CD	N/A	2.3	3.2
	lb/in	MD	13	21	31
		CD	N/A	13	18
Elongation to Break		%	1.3	1.4	1.4
Elmendorf Tear	grams	MD	100	132	184
		CD	N/A	184	248
Mullen Burst		psi	18	23	33
Breakdown Voltage		kV	0.9	1.3	1.8
Dielectric Constant		23 °C	N/A	N/A	2.1
		120 °C	N/A	N/A	2.5
Dissipation Factor		23 °C	N/A	N/A	1.1
		120 °C	N/A	N/A	9
Thermal Conductivity @ 180 °C		W/m-°K	N/A	N/A	0.11
Moisture		%	<1	<1	<1

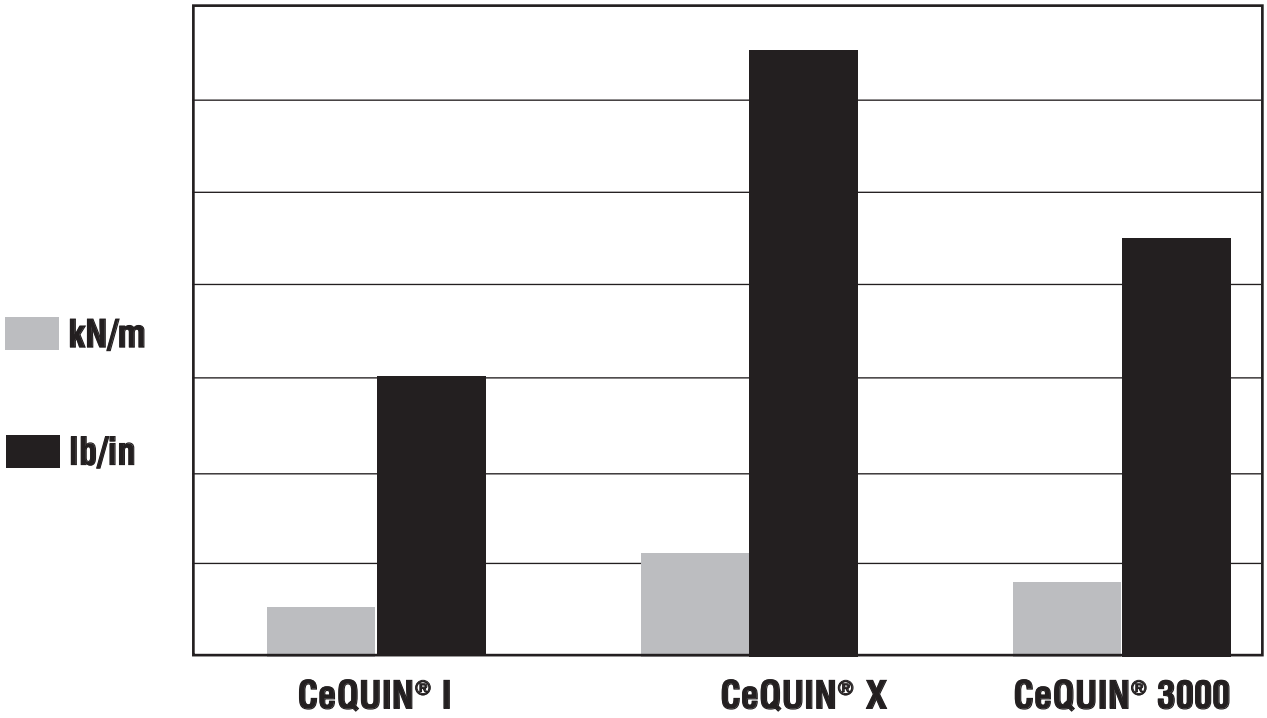
*All data is for nominal product properties and is not for specification purposes.
N/A=Not Available

CeQUIN® X vs. CeQUIN® I
Tensile Strength, MD



* All data is for nominal product properties and is not for specification purposes

Tensile Strength of CeQUIN® Papers
5 mil (0.13 mm) Thickness



* All data is for nominal product properties and is not for specification purposes.

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

CeQUIN® Film Laminates

Description

IPT composites of CeQUIN inorganic-based laminated with polyester film have been developed to provide a balanced blend of electrical, physical, and thermal capabilities on a cost effective basis. The PET polyester film is bonded to either CeQUIN I or CeQUIN 3000 using a high temperature resin system. A variety of two-ply and three-ply products are available.

CeQUIN® IF*		5+0.5	5+1	5+1.5	5+2	5+3	5+5	7+1	7+2
Typical Thickness	mm	0.14	0.15	0.17	0.18	0.20	0.25	0.20	0.23
	mil	5.5	6	6.5	7	8	10	8	9
Basis Weight	kg/m²	0.15	0.17	0.18	0.21	0.23	0.30	0.22	0.26
	lb/yd²	0.28	0.31	0.34	0.38	0.42	0.55	0.41	0.49
Tensile Strength, MD	kN/m	2.6	3.5	5.2	7.0	10.4	17.5	3.5	7.0
	lb/in	15	20	30	40	60	100	20	40
Breakdown Voltage	kV	3	4.5	6	7.5	9	N/A	4.5	7.5
Moisture	%	<1	<1	<1	<1	<1	<1	<1	<1

CeQUIN® IF*		7+3	10+1	10+1.5	10+2	15+1	15+2	15+3	25+2
Typical Thickness	mm	0.25	0.28	0.29	0.30	0.40	0.43	0.46	0.69
	mil	10	11	11.5	12	16	17	18	27
Basis Weight	kg/m²	0.29	0.32	0.33	0.35	0.48	0.49	0.52	0.76
	lb/yd²	0.54	0.58	0.62	0.64	0.88	0.90	0.96	1.4
Tensile Strength, MD	kN/m	10.4	5.2	7.0	8.8	5.2	8.8	12.2	8.8
	lb/in	60	30	40	50	30	50	70	50
Breakdown Voltage	kV	9	5	6	7.5	5	7.5	10	7.5
Moisture	%	<1	<1	<1	<1	<1	<1	<1	<1

CeQUIN® IFI & FIF*		IFI 5-2-5	IFI 5-3-5	IFI 7-2-7	IFI 15-2-15	FIF 1-5-1	FIF 2-5-2	FIF 1-10-1	FIF 2-15-2	FIF 2-20-2
Typical Thickness	mm	0.30	0.33	0.41	0.81	0.18	0.23	0.30	0.48	0.63
	mil	12	13	16	32	7	9	12	19	24
Basis Weight	kg/m^2	0.34	0.37	0.46	0.90	0.22	0.30	0.35	0.57	0.71
	lb/yd^2	0.62	0.69	0.85	1.66	0.41	0.55	0.65	1.05	1.31
Tensile Strength, MD	kN/m	7.9	10.5	8.8	10.5	7.0	14.0	7.0	15.7	17.5
	lb/in	45	60	50	60	40	80	40	90	100
Breakdown Voltage	kV	8	11	8	8.5	12	12	8.5	13	13
Moisture	%	<1	<1	<1	<1	<1	<1	<1	<1	<1

CeQUIN® 30F; XF, 30F30*		30F 3+1	30F 5+1	XF 10+2	30F30 3-1-3	30F30 3-3-3	30F30 5-2-5
Typical Thickness	mm	0.10	0.15	0.30	0.18	0.23	0.30
	mil	4	6	12	7	9	12
Basis Weight	kg/m^2	0.10	0.15	0.29	0.17	0.25	0.31
	lb/yd^2	0.19	0.28	0.54	0.31	0.47	0.56
Tensile Strength, MD	kN/m	3.5	3.5	10.5	5.2	10.5	8.8
	lb/in	20	20	60	30	60	50
Breakdown Voltage	kV	4.5	4.5	8	4.5	9	8
Moisture	%	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5

* All data is for nominal product properties and is not for specification purposes
N/A=Not Available

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

CeQUIN® Glass Laminates

Description

CeQUIN Glass Laminates combine all the benefits of CeQUIN with the strength of glass cloth to produce an economical high temperature electrical insulation for applications where maximum strength is required.

CeQUIN® Glass Laminates*		IG 5+3	IG 7+3	IG 10+3	IG 15+3	IG 30+3	30G 3+3
Typical Thickness	mm	0.2	0.25	0.33	0.46	0.84	0.18
	mil	8	10	13	18	33	7
Basis Weight	kg/m²	0.22	0.27	0.38	0.50	0.92	0.16
	lb/yd²	0.4	0.5	0.7	0.92	1.7	0.3
Tensile Strength, MD	kN/m	24	24	24	24	24	24
	lb/in	140	140	140	140	140	140
Breakdown Voltage	kV	1.2	1.4	2	2.5	4.3	0.9
Moisture	%	<1	<1	<1	<1	<1	<1

CeQUIN® Glass Laminates*		IGI 5-3-5	IGI 7-3-7	GIG 3-10-3	GIG 3-30-3
Typical Thickness	mm	0.33	0.43	0.41	0.91
	mil	13	17	16	36
Basis Weight	kg/m²	0.36	0.47	0.48	1.03
	lb/yd²	0.67	0.87	0.88	1.9
Tensile Strength, MD	kN/m	28	28	28	28
	lb/in	160	160	160	160
Breakdown Voltage	kV	2.6	3.0	2.5	4.7
Moisture	%	<1	<1	<1	<1

* All data is for nominal product properties and is not for specification purposes

INNOVATIVE PAPER TECHNOLOGIES, LLC

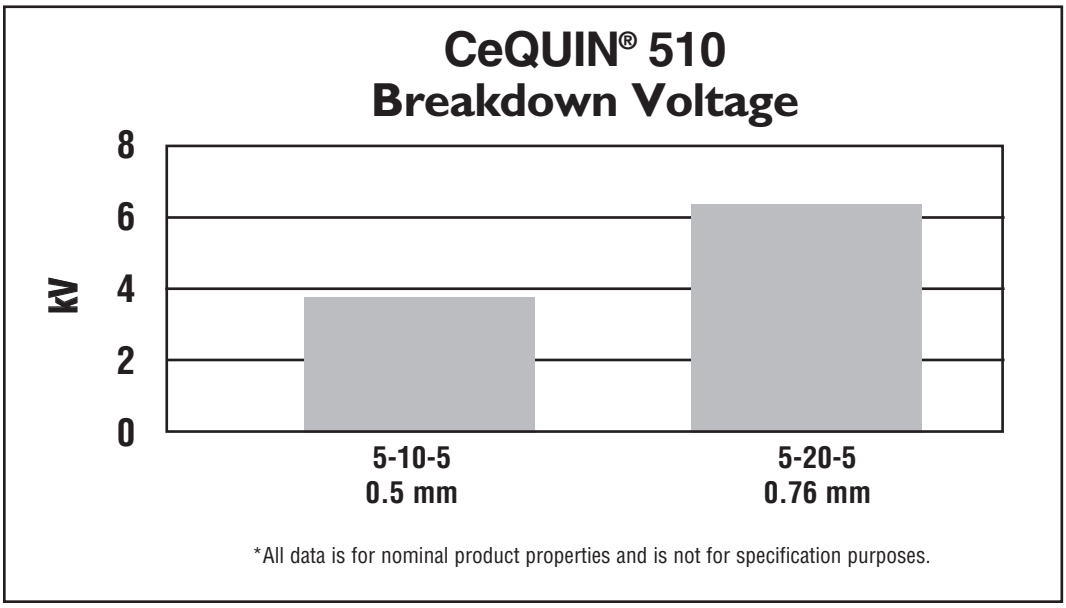
Technical Reference Sheet

CeQUIN® 510

Description

CeQUIN 510 is a three-ply laminate derived from IPT's CeQUIN and TufQUIN® lines to provide maximum strength and cut through resistance.

CeQUIN® 510*			5-10-5	5-20-5
Typical Thickness		mm	0.50	0.76
		mil	20	30
Basis Weight		kg/m²	0.53	0.76
		lb/yd²	0.97	1.4
Tensile Strength	kN/m	MD	11	11.4
	lb/in	MD	63	65
Moisture		%	<1	<1



*All data is for nominal product properties and is not for specification purposes.

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

CeQUINBORD® CGA

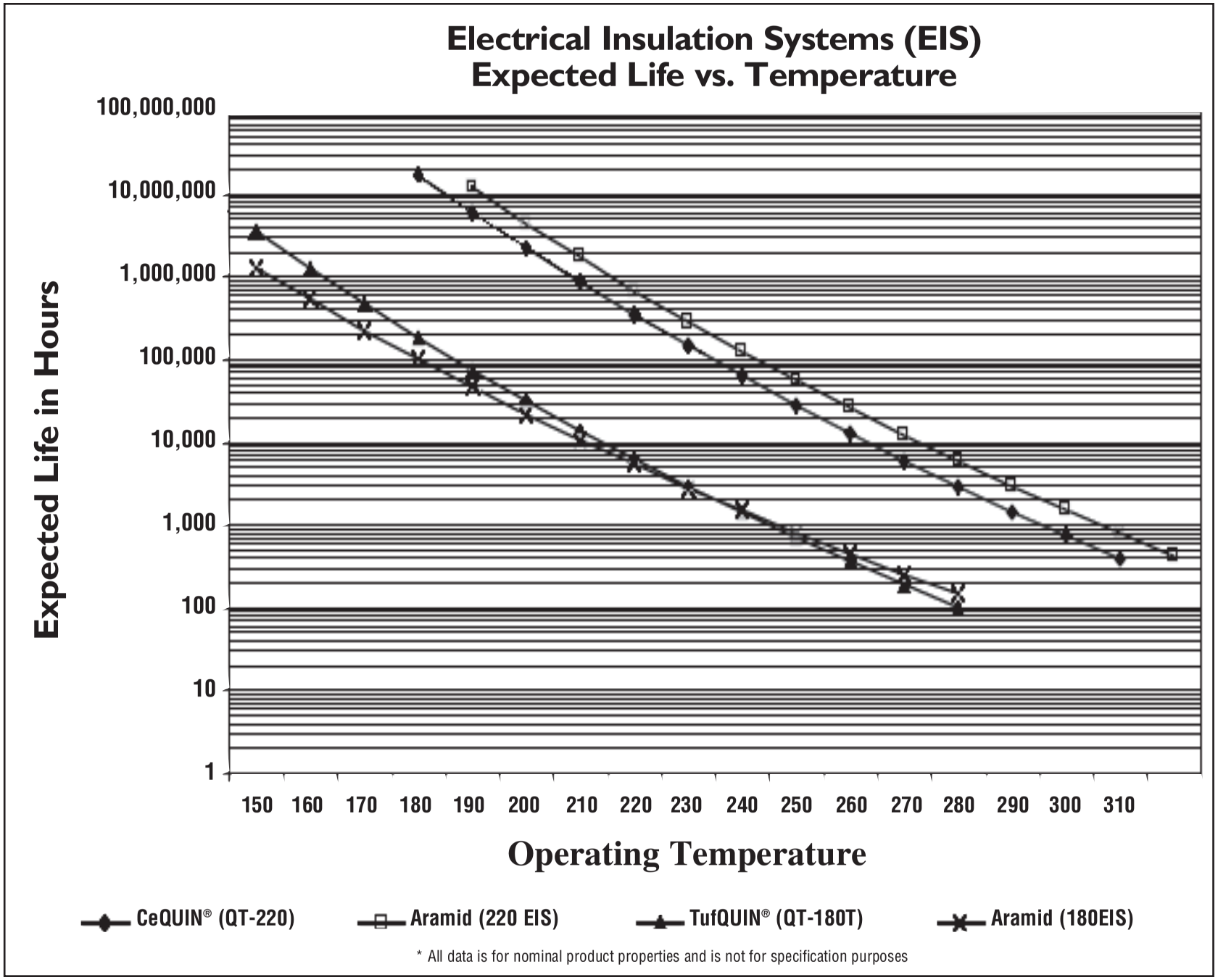
Description

CeQUINBORD is made up of primarily glass fibers and microfibers, inorganic fillers and less than 10% organic binders. Capable of withstanding long term exposure to temperatures in excess of 250° C. CeQUINBORD CGA is UL recognized as suitable for use in electrical insulation systems rated from Class 130(B) through 220(R). CeQUINBORD also carries both 94V-0 and 94-5VA Flame Class Ratings.

CeQUINBORD® CGA*		1/32	1/16	3/32	1/8
Typical Thickness	mm	0.8	1.6	2.4	3.2
	mil	32	62	93	125
Basis Weight	kg/m²	0.9	1.8	2.6	3.5
	lb/yd²	1.6	3.3	4.9	6.5
Tensile Strength, MD	kN/m	10	14	14	14
	lb/in	55	80	80	80
Elongation To Break	%	<2	<2	<2	<2
Breakdown Voltage	kV	4.5	12	14	20
Dielectric Constant @ 23 °C	%	2.9	N/A	N/A	N/A
Dissipation Factor @ 23 °C	%	1.4	N/A	N/A	N/A
B.I.L. Withstand Test**	Withstand	N/A	15.1	N/A	N/A
	Breakdown	N/A	15.4	N/A	N/A
Thermal Conductivity	W/m-°K	0.21	N/A	N/A	N/A
Moisture	%	<1	<1	<1	<1

CeQUINBORD® CGA*		5/32	3/16	1/4	3/8
Typical Thickness	mm	4	4.8	6.4	9.5
	mil	156	188	250	375
Basis Weight	kg/m²	4.5	5.2	6.8	9.3
	lb/yd²	8.1	9.5	12.5	17
Tensile Strength, MD	kN/m	N/A	N/A	35	N/A
	lb/in	N/A	N/A	200	N/A
Elongation to Break	%	<2	<2	<2	<2
Moisture	%	<1	<1	<1	<1

* All data is for nominal product properties and is not for specification purposes.
** The withstand voltage is the average of the five highest voltages the material withstood during valid testing.
The breakdown voltage is the average of five valid test voltage impulses that caused insulation failure.
N/A=Not Available


Electrical Insulation Systems (EIS)
Expected Life vs. Temperature
Expected Life in Hours
100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310
Operating Temperature
CeQUIN® (QT-220)
Aramid (220 EIS)
TufQUIN® (QT-180T)
Aramid (180EIS)
* All data is for nominal product properties and is not for specification purposes

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

TufQUIN® Inorganic-based Papers

Description

TufQUIN products are a hybrid inorganic/organic paper based upon advanced manufacturing techniques. TufQUIN offers the high-temperature capabilities of inorganic materials combined with the high mechanical strength gained by the use of organic fiber. TufQUIN is a flexible, conformable paper exhibiting physical toughness in the form of high tensile strength and excellent tear resistance

TufQUIN® 110 *			2.5 mil	3 mil	5 mil	10 mil
Typical Thickness		mm	0.07	0.08	0.13	0.25
		mil	2.5	3.0	5.0	10
Basis Weight		kg/m^2	0.07	0.08	0.14	0.27
		lb/yd^2	0.13	0.15	0.25	0.5
Tensile Strength	kN/m	MD	2.6	2.6	4.2	8.7
		CD	1	1	2.1	4.2
	lb/in	MD	15	15	24	50
		CD	6	6	12	24
Elongation to Break, MD		%	12	15	19	18
Elongation to Break, CD		%	3	3	8	12
Elmendorf Tear grams		MD	60	110	280	640
Breakdown Voltage		kV	0.6	0.7	0.8	1.5
Dielectric Constant@ 23 °C		%	N/A	2.2	2.2	2.7
Dissipation Factor @ 23 °C		%	N/A	1.1	0.7	1.4
Thermal Conductivity @ 180 °C		W/m-°K	N/A	0.14	0.14	0.17
Moisture		%	<1	<1	<1	<1

* All data is for nominal product properties and is not for specification purposes
N/A=Not Available

TufQUIN® 120 *			7.5 mil	12 mil	15 mil	20 mil
Typical Thickness		mm	0.19	0.30	0.38	0.50
		mil	7.5	12	15	20
Basis Weight		kg/m^2	0.2	0.35	0.42	0.57
		lb/yd^2	0.37	0.64	0.77	1.05
Tensile Strength	kN/m	MD	6.3	9.6	13	19
		CD	2.5	N/A	5	N/A
	lb/in	MD	36	55	75	110
		CD	14	N/A	28	N/A
Elongation to Break, MD		%	14	14	14	15
Elmendorf Tear grams		MD	340	N/A	N/A	N/A
Breakdown Voltage		kV	1	1.9	2.1	3.3
Dielectric Constant@ 23 °C		%	2.6	N/A	N/A	N/A
Dissipation Factor @ 23 °C		%	3.2	N/A	N/A	N/A
Thermal Conductivity @ 180 °C		W/m-°K	0.17	N/A	N/A	N/A
Moisture		%	<1	<1	<1	<1

INNOVATIVE PAPER TECHNOLOGIES, LLC

Technical Reference Sheet

TufQUIN® Film Laminates

Description

TufQUIN TFT composites are a family of laminates based on IPT's advanced high performance TufQUIN inorganic-based papers combined with polyester film.

TufQUIN® TFT*		2-2-2	2-5-2	2.5-7.5-2.5
Typical Thickness	mm	0.15	0.23	0.32
	mil	6	9	12.5
Basis Weight	kg/m²	0.16	0.24	0.42
	lb/yd²	0.29	0.44	0.77
Breakdown Voltage	kV	7	N/A	N/A
Moisture	%	<1	<1	<1

TufQUIN® TFT*			3-1-3	3-3-3	3-5-3	3-7.5-3	3-10-3	3-14-3
Typical Thickness		mm	0.18	0.23	0.28	0.34	0.41	0.5
		mil	7	9	11	13.5	16	20
Basis Weight		kg/m²	0.22	0.28	0.35	0.44	0.51	0.66
		lb/yd²	0.4	0.52	0.64	0.82	0.94	1.22
Tensile Strength	kN/m	MD	12	18	23	30	38	47
		CD	9	15	30	34	51	61
	lb/in	MD	70	100	130	170	215	270
		CD	50	85	170	195	290	350
Elongation to Break		%	22	23	22	23	28	30
Elmendorf tear	grams	MD	160	320	320	990	540	750
		CD	580	960	1280	1180	1020	2100
Breakdown Voltage		kV	5	10	14	16	22	N/A
Moisture		%	<1	<1	<1	<1	<1	<1

* All data is for nominal product properties and is not for specification purposes
N/A=Not Available

TufQUIN® TFT*			5-1-5	5-2-5	5-3-5	5-5-5	5-10-5	5-14-5
Typical Thickness		mm	0.28	0.30	0.33	0.38	0.51	0.61
		mil	11	12	13	15	20	24
Basis Weight		kg/m²	0.32	0.35	0.38	0.46	0.63	0.77
		lb/yd²	0.59	0.65	0.71	0.84	1.17	1.4
Tensile Strength	kN/m	MD	3	15	18	23	39	49
		CD	8	14	17	32	53	54
	lb/in	MD	75	85	105	134	220	49
		CD	45	80	100	134	220	49
Elongation to Break		%	35	19	40	46	50	64
Elmendof Tear	grams	MD	580	640	640	1100	1100	1200
		CD	2400	2400	2400	2400	N/A	N/A
Breakdown Voltage		kV	5	8	10	14	22	N/A
Dielectric Constant @ 23 °C		%	N/A	N/A	N/A	2.9	3	N/A
Dissipation Factor @ 23 °C		%	N/A	N/A	N/A	1	0.8	N/A
Thermal Conductivity @ 180 °C		W/m-°K	N/A	N/A	N/A	0.19	0.21	N/A
Moisture		%	<1	<1	<1	<1	<1	<1

TufQUIN®/Film Laminates			TFT		FTF
			7-3-7	7-14-7	1-5-1
Typical Thickness		mm	0.43	0.71	0.18
		mil	17	28	7
Basis Weight		kg/m²	0.5	0.92	0.22
		lb/yd²	0.92	1.7	0.4
Tensile Strength	kN/m	MD	22	53	10.5
		CD	N/A	N/A	9.5
	lb/in	MD	125	300	60
		CD	N/A	N/A	54
Elongation to Break		%	N/A	N/A	40
Elmendorf Tear	grams	MD	N/A	N/A	320
		CD	N/A	N/A	1040
Breakdown Voltage		kV	10	N/A	7
Moisture		%	<1	<1	<1

* All data is for nominal product properties and is not for specification purposes
N/A=Not Available

Innovative Paper Technologies, LLC
PO Box 739
Tilton, NH, USA 03276-0739
Tel: 866-357-2737
Fax:603-286-4859

Description of Test Methods

Tensile Strength and Percent Elongation ASTM D828

Summary: The Tensile Strength and Elongation to Break (stretch) is the average of tests performed on the four cross direction quarters of the material. A 1" wide by 10" long strip is clamped at both ends and stretched at a constant rate until the equipment senses a break..

Use: Test results are used in product development, process control, and material comparison.

The machine direction tensile strength of CeQUIN, TufQUIN, and millboard is tested regularly.

he machine direction tensile strength of film and glass laminates and the cross direction ensile strength of paper and millboard products are only occasionally tested following product development.

Internal (Elmendorf) Tear Strength ASTM D689

Summary: Tear Strength is the materials resistance to tearing once a tear has started.

A sufficient number of 2½" wide by 3" strips of paper or laminate from the four cross direction quarters of the web is clamped in the jaws. The strips are slit to a specified depth and the pendulum is released. The pendulum swing is converted to tear strength (grams).

Tear strength is the average value of the tests. M.D. and C.D. tear strength tests are tested as the directionality of the material permits.

Use: Test results are useful in product development and material comparison.

Testing is only occasionally performed following product development.

Flame Resistance UL 94

Summary: Flame resistance is the length of time, in seconds, a ½" wide by 5½" long bar continues to glow or burn following a flame application. Other criteria are the flame reaching the clamp, and flame droplets igniting cotton padding placed under the bar.

Burn-through resistance is the materials resistance to a flame burning a hole in the material.

In both tests, a Bunsen burner was used to apply a controlled flame for a specified length of time.

Use: Test results are used in product development and acceptance testing. The tests are performed on products having UL 94 certification.

Dielectric Constant & Dissipation Factor ASTM D150

Summary: The Dielectric Constant is the ratio of an insulating materials ability to store electrical energy to that of air. A low dielectric constant (<4) is desirable in insulation used in electrical equipment such as motors and transformers.

The dissipation factor rates an insulating materials rate of power consumption when subjected to an alternating voltage.

Voltage is applied using cylindrical electrodes. Sample conditioning and test conditions greatly influence test results. Different materials are affected differently.

Relative permitivity is another term for dielectric constant. Loss factor and power factor are more or less equivalent terms for dissipation factor.

Use: The test results are useful in product development and comparisons.

Basis Weight (Grammage) ASTM D646

Summary: The Basis Weight of flexible insulation is measured using 9 15/16" M.D. by 8" C.D. rectangular samples from the four cross direction quarters of the web. The basis weight of millboard is measured using four 12" by 12" samples from the four cross direction quarters of a millboard sheet.

Use: Test results are used in process control, material comparisons, and in acceptance sampling where specified.

Mullen Burst Strength ASTM D774

Summary: Mullen Burst strength is the hydraulic pressure required to cause a rubber diaphragm to burst a sample. A cross direction strip of paper is folded a specific number of times and placed between two clamps. Mullen is the average of four such tests.

Use: Test results are used in product development, process control, and material comparisons.

The test is performed on CeQUIN papers. It is not performed on products such as TufQUIN, film and glass laminates, or millboard, where directionality or other factors cause damage to the diaphragm.

Breakdown Voltage/Dielectric Strength ASTM D149

Summary: Alternating voltage, increased from zero to the value at which breakdown occurs, is applied to the specimen. Failure should occur within 10 to 20 seconds. The breakdown voltage is the average of four tests. Dielectric strength is the breakdown voltage divided by the thickness.

Use: Test results are used in product development, process control, and material comparisons.

In general, the results cannot be used to determine the dielectric behavior of a material in an application. Voltage endurance and partial discharge testing as well as breakdown voltage testing after thermal aging should also be performed. Ideally, alternative materials should be tested side by side.

Caliper (Thickness) of Paper TAPPI T411 – ASTM D645

Summary: The caliper is the average thickness of eight equally spaced points along a cross direction strip of material. A bench micrometer with a ⅝" presser foot applying 7.3 psi is used.

Use: The test results are used in process control and acceptance sampling.

Caliper (Thickness) of Millboard

Summary: The caliper is the average thickness of twenty equally spaced points along a cross direction strip of material. An Ames dial indicator with ¼" anvils is used in the test.

Use: The test results are used in process control and acceptance sampling.

Thermal Conductivity ASTM E1530

Summary: The Thermal Conductivity of a material is its ability to transfer heat energy across a temperature difference.

A sample is placed between metal cylinders maintained at different temperature. Using the sample thickness, test data is converted to a thermal conductivity value, expressed in watts per meter per degree Kelvin or W/m-°K.

Test conditions, such as applied pressure, greatly affect the measured thermal conductivity of some materials.

Use: Test results are useful in product development and material comparisons. Ideally, alternative materials should be tested side by side, and at different pressures when practical.

Testing is infrequent following product development

Moisture ASTM D644

Summary: Percent moisture is determined by weighing a 10-20 gram sample, placing it in an oven at a preset temperature (105°C or 140°C) for 15 to 30 minutes, then reweighing the sample immediately upon removal from the oven. The weight loss in percent of the original weight is the moisture content.

Use: Test results are mainly useful in process control.

These test results have some limited use in product development and material comparisons.

Gurley Stiffness

Summary: A rectangular sample is cut to a specified length and width and clamped in the jaws of the tester. The tester applies a force to a pendulum through the sample. The stiffness is determined when the sample flexes sufficiently to release the pendulum.

Use: Test results are useful in product development and material comparisons. Ideally, alternative materials should be tested side by side. Some products lose a significant amount of stiffness when flexed.