



Electrical insulation for wind turbines



Nomex.

With its unique combination of thermal properties, mechanical toughness and inherent dielectric strength, DuPont™ Nomex® has earned a reputation for delivering reliability—even when subjected to severe operating conditions such as wide temperature ranges, severe vibration and exposure to moisture.

Superior mechanical toughness

DuPont™ Nomex® insulation is strong and resilient with good resistance to tearing and abrasion. This superior mechanical toughness (refer to Table I) makes DuPont™ Nomex® robust enough to help withstand severe mechanical forces used in manufacturing wind turbine transformers and generators.

It also helps ensure that coil structures in fluid-filled transformers, which can be installed either at the base of the tower or in the nacelle (typically more than 100 meters above the ground), will remain tight and able to withstand short-circuit forces—even after years of service—giving owners peace of mind that the transformers will continue to operate reliably.

With generators being located inside the nacelle, the mechanical toughness of DuPont™ Nomex® insulation helps them stand up to extreme operating conditions, enabling them to reliably convert mechanical energy into electrical energy. Not only can this prevent disruptions to energy delivery, it helps reduce the frequency of repairs, which are quite costly due to logistics.



Based on its history of proven performance in generators and in both dry-type and liquid-filled transformers, it was a logical extension for DuPont™ Nomex® to become a preferred electrical insulation for the critical components of wind turbine systems. Today, DuPont™ Nomex® insulation helps wind turbines reliably deliver power upon demand.

Table I. Typical mechanical properties of DuPont™ Nomex®

Nominal thickness mil (mm)	2 (0.05)	3 (0.08)	5 (0.13)	7 (0.18)	10 (0.25)	12 (0.30)	15 (0.38)	20 (0.51)	24 (0.61)	25.5 (0.65)	29 (0.73)	30 (0.76)	Test method
Tensile strength, N/cm													
MD	39	65	137	219	285	378	459	606	741	758	860	841	ASTM D-828
XD	18	32	66	111	152	196	252	354	497	524	630	595	
Elongation, %													
MD	9	11	15	18	19	22	19	20	18	19	16	17	ASTM D-828
XD	6	8	12	14	15	17	14	16	14	16	12	13	
Elmendorf Tear, N													
MD	0.8	1.2	3.4	3.9	6.0	7.4	9.5	14.2	N/A	N/A	N/A	N/A	TAPPI-414
XD	1.6	2.3	5.2	7.4	10.8	14.2	17.2	23.7	N/A	N/A	N/A	N/A	
Initial Tear Strength,* N													
MD	11	16	33	50	71	93	116	163	201	209	252	251	ASTM D-1004
XD	6	8	17	27	42	55	74	113	157	159	199	200	

MD = machine direction of paper XD = cross direction of paper

*Data presented for Initial Tear Strength is listed in the direction of the sample per ASTM D-1004. The tear is 90 degrees to sample direction; hence, for papers with a higher reported MD ITR, the paper will be tougher to tear in the cross direction.

Exceptional thermal stability

The exceptional thermal stability of DuPont™ Nomex® insulation helps to ensure high reliability—even in more compactly designed transformers and in hot spot areas of generators.

That's because DuPont™ Nomex® does not shrink, embrittle, soften or melt during short-term exposure to temperatures as high as 300°C and maintains good insulating properties at continuous temperatures of 220°C. While this is well above the typical operating temperatures of transformers and generators used in wind turbines, high spikes in temperature can occur due to the use of effective inverters; operating conditions such as frequent stops and starts; mechanical problems such as locked rotors; or unusually high ambient temperatures.

The effects of long-term exposure to high temperature on the dielectric strength and initial strength of DuPont™ Nomex® are shown in Figures 1 and 2, respectively.

Figure 1. Effect of prolonged exposure to high temperature on the dielectric strength of DuPont™ Nomex®. (ASTM D-1830, curved electrodes)

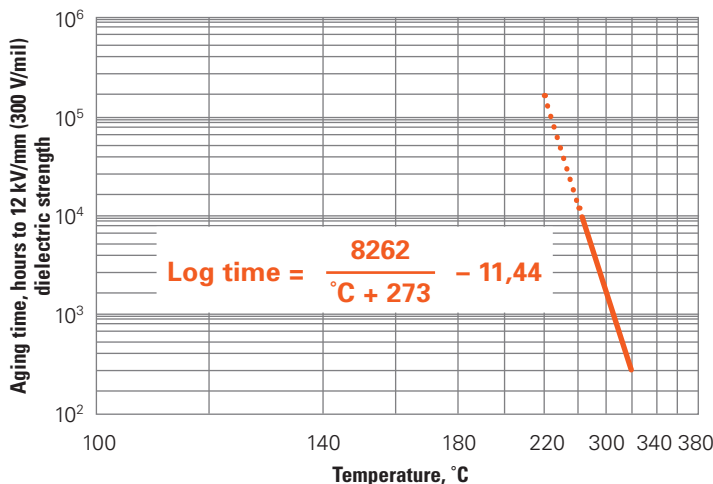
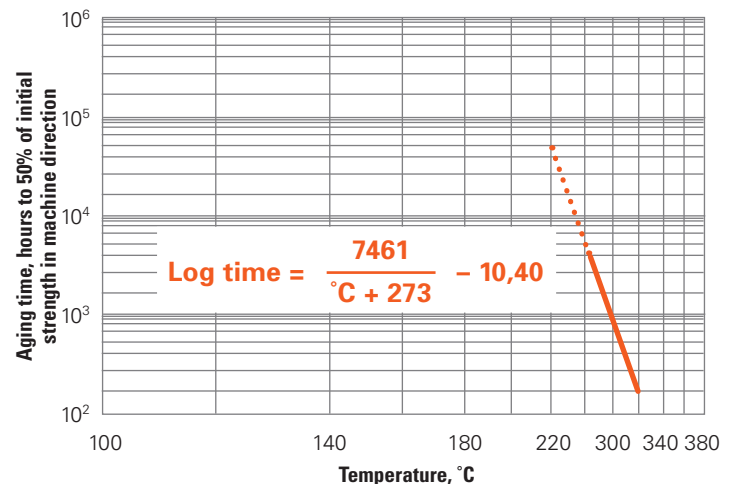


Figure 2. Effect of prolonged exposure to high temperature on the initial strength of DuPont™ Nomex®. (Tested per UL-746)



Inherent dielectric strength

DuPont™ Nomex® insulation helps enable long-term electrical performance of critical components like generators and transformers. Its inherent high dielectric strength is further enhanced by varnish or resin treatment.

Suitable for use in various environments

A distinct advantage of using DuPont™ Nomex® insulation for wind turbine systems is that it provides proven performance even under demanding operating conditions—including offshore installations. It is insensitive to moisture, resistant to chemical degradation and compatible with a wide variety of resins, adhesives, lubricants and dielectric fluids.

High performance, high reliability

With its exceptional thermal properties, mechanical toughness and inherent dielectric strength, DuPont™ Nomex® insulation helps ensure that wind turbine generators and transformers operate reliably at peak performance.

DuPont™ Nomex® insulation is also making important advances possible which helps enable manufacturers to improve their design of existing generators and transformers to better meet the unique requirements of this industry.

For example, high-fire-point fluid transformers insulated with DuPont™ Nomex® can be designed approximately 30% smaller than conventional fluid-filled transformers or designed to handle a 30% greater load.

To learn more about how DuPont™ Nomex® electrical insulation can help you produce higher-performing, higher-reliability components for wind turbines, call 1.800.931.3456 or visit www.nomex.dupont.com

Product safety information is available upon request

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Please note: The properties in this sell sheet are typical or average values and should not be used as specification limits. Unless otherwise noted, all properties were measured in air under "standard" conditions (in equilibrium at 23°C, 50% relative humidity). Note that, like other products of papermaking technology, DuPont™ Nomex® papers have somewhat different properties in the papermaking machine direction (MD) compared to the cross direction (XD). In some applications (for example, motor slot liners), it is necessary to orient the paper in the optimum direction to obtain its maximum potential performance.

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