THE GUND COMPANY
MANUFACTURERS & FABRICATORS OF ENGINEERED MATERIAL SOLUTIONS

G-Flex™ Aramid Paper YT510

A Comparison of Dielectric and Partial Discharge Performance

Aramid papers are commonly used as a primary dielectric insulator in high-temperature electrical systems. Since aramid paper combines multiple unique characteristics such as heat and flame resistance, tear resistance, and dielectric performance, it has become the preferred primary insulation material for harsh environments.

In the design of motors, generators, and transformers, there are numerous characteristics we need to consider. Two essential characteristics we must consider are dielectric strength and partial discharge.

Dielectric Strength

Dielectric strength measures a material's ability to withstand high electrical potential. Dielectric strength is determined by applying an increasing voltage across a certain thickness of material in a voltage ramp or steps between two electrode surfaces over a short period of time until electrical breakdown occurs. Electrical breakdown is determined during the test by an abrupt visible and audible rupture through the thickness of the specimen, resulting in a visible puncture and decomposition of the specimen in the breakdown area.

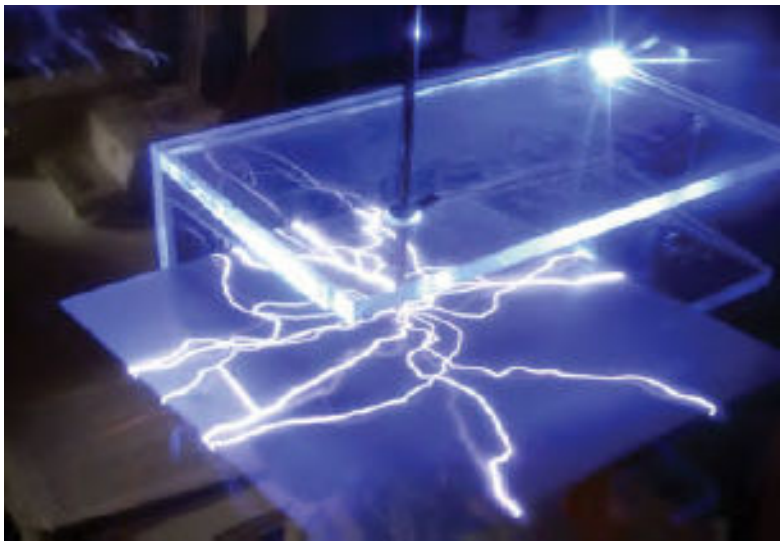

Figure 1- Dielectric strength testing of insulation materials.

Dielectric strength in volts/mil or kV/mm is obtained by dividing the breakdown voltage by the thickness of the material between the electrodes. Dielectric strength is one of the most important properties used by engineers in insulation design. Obviously, the higher the volts/mil or kV/mm, the stronger is the insulation.

Partial Discharge

Partial discharge is not as well-known as dielectric strength and not well understood by many outside of electrical equipment design. However, it is a critical consideration, especially for the insulation and equipment's long-term performance.

Insulation material is not perfectly homogeneous, and there are often microscopic areas where the material is relatively less dense and with the presence of air voids.

Such weak zones could result in localized electrical breakdown under high potential without the complete electrical breakdown of the bulk insulation.

The problem is that energy from repeated partial discharges could erode the material and cause the carbonization of organic insulation. The partial discharge could degrade the insulation to such an extent that complete electrical breakdown can occur over the longer periods of time.

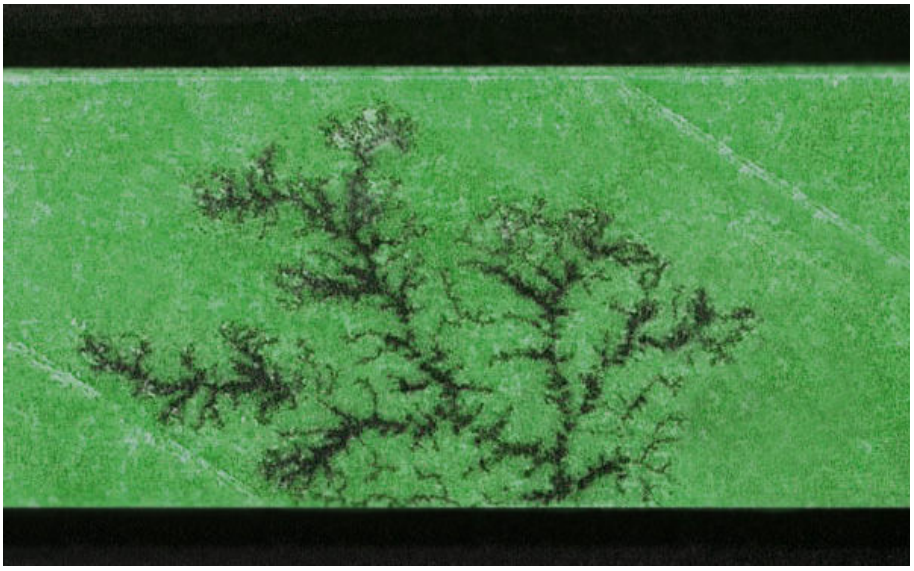

Figure 2- Image of partial discharge branching in insulation material.

Partial discharge is measured using a specialized tester and is expressed as inception voltage (ramp-up) and extinction voltage (ramp down); again, the higher these voltage thresholds, the more suitable the material is for higher voltage exposure over long periods.

While partial discharge is considered a short-term test, it is used to assess an insulation's long-term performance. Depending on the sophistication of the equipment, other electrical units like leakage current and pico-coulombs are also measured, which can assist insulation and equipment life estimation.

Insulation and Insulation System

For motor, generator, and transformer applications, more than one insulation is often used as part of the insulation system, such as varnished or oil-impregnated flexible solid insulation. It is more important to understand how the combination of insulation materials work together. As one can see in Table 1, the dielectric strength of varnish (impregnated) paper can be quite different than unvarnished paper. This phenomenon is due to the unique structure of the G-Flex™ aramid paper, which allows the varnish to saturate and bond with the paper during the impregnation process. This same characteristic also improves air displacement, resulting in a more homogeneous micro-structure throughout the entire insulation system (Resin+Paper).

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Since aramid paper is expected to perform at high temperatures, it is also appropriate to understand the dielectric strength thermal endurance of these materials. Chart 1 compares the dielectric strength thermal endurance at 280˚C of G-Flex™ YT510 and a common aramid paper. Both materials were impregnated with Elantas Ripley varnish prior to testing. It is easy to see that these materials both have equal high temperature dielectric endurance performance by this single point thermal endurance comparison.

While dielectric strength is important, partial discharge can many times be the deciding design limitation for an

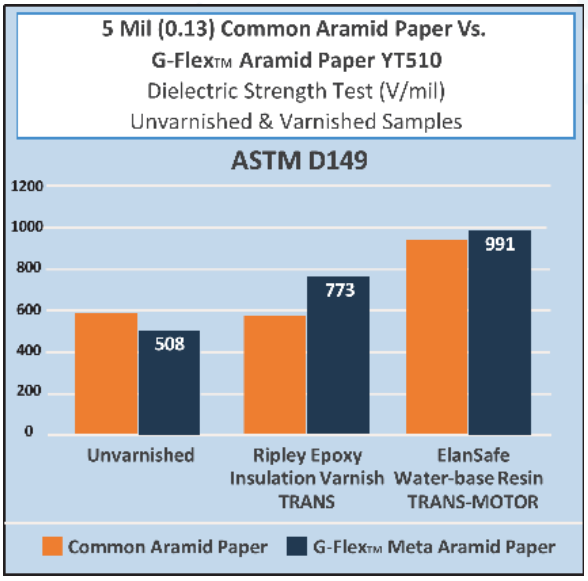

Table 1- Comparison of varnished and unvarnished aramid paper dielectric strength.

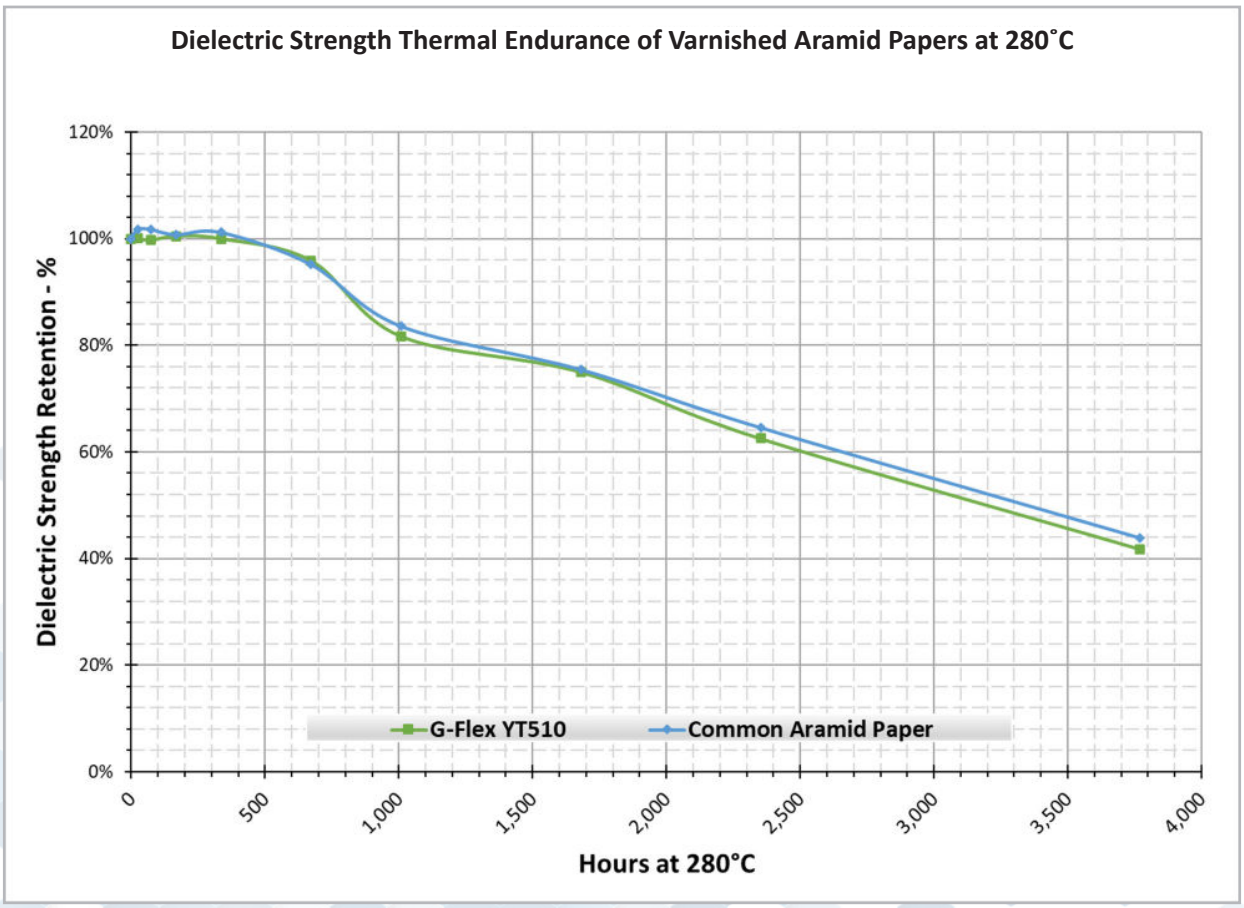

Chart 1- Dielectric strength thermal endurance at 280˚C of varnished aramid papers.

insulation material. Table 2 below shows the partial discharge properties of the G-Flex™ YT510 aramid paper vs common aramid paper tested in oil. Both the inception and extinction voltages of the G-Flex™ YT510 aramid paper are higher, i.e., partial discharge happens later, and extinction is faster.

The results indicate that G-Flex™ YT510 aramid paper will be able to endure slightly higher voltages over long periods of time. It can also indicate that G-Flex™ aramid paper will have longer insulation and equipment life as there will be lower incidents of discharge over time.

GB/T 7354/2003 Partial Discharge Determination	G-Flex™ Aramid Paper in Oil	Common Aramid Paper in Oil
Inception Voltage, kV	3.38	3.08
Extinction Voltage, kV	2.88	2.73

Table 2- Partial discharge comparison of aramid papers.

Summary

G-Flex™ YT510 aramid paper is equivalent to other common aramid papers when comparing dielectric strength and partial discharge. High temperature dielectric performance is also equal. In many cases, the enhanced saturation and bonding exhibited with YT510 during resin VPI (impregnation) gives it an advantage against other common aramid papers when comparing dielectric strength.

Learn more about the G-Flex™ aramid paper and the G-Flex™ family of flexible insulation solutions by going to: www.thegundcompany.com/g-flex