SENGENUITY
Sensor Engines by Vectron International

Partial Discharge on Switchgear Assets

Theory of Partial Discharge

Partial Discharge (PD) is a term coming from high voltage technology, as it usually occurs in electrical insulation systems running under high voltage stress. Although PD is often mentioned in the context of switchgear systems, it also occurs and should be monitored in rotating machinery (e.g. generators, motors) and transformers.

PD is a dielectric breakdown emerging locally within voids, cracks, bubbles or inclusions of dielectric insulations or interfaces. Partial Discharge appears when such irregularities lead to inhomogeneous electrical fields. For example; a gap or void in the insulation will oppose a lower resistance (dielectric strength) to voltage arcing than a cable does, resulting in some parts of the electrical field crossing the gap.

The appearance of PD can develop inside material (gaseous, liquid or solid insulating mediums) or on the surface of insulators. In addition to weak spots inside insulation mostly caused by manufacturing processes the reasons for surface damages are usually due to manufacturing damage during installation and handling, aging or contamination.

Furthermore, the incurrence of PD is heavily affected by other influences such as the voltage and load going across the line, the temperature, humidity, vibration and pressure. In particular, at the surface, an increased humidity of the environment is a catalyst for Partial Discharge events since this increases the conductivity. Therefore, it is advisable to monitor not only Partial Discharge in isolation but also other parameters.

Depending on its characteristics PD is mostly invisible and therefore, can be very dangerous when left unmonitored. However, some manifestations will occur as corona discharges which are usually visible via a steady glow, or as arcing between lines.

Once started, partial discharge won't stop again without actions. The consequences of continuous PD can result in energy loss (heat, sound and light), leading to the destruction of the insulation beginning at the small void and eventually to a complete electrical failure, or worse, to catastrophic impacts.

SenGenuity's Switchgear Monitoring Portfolio

Given the above mentioned interdependency with various environmental influences SenGenuity's wide portfolio for switchgear monitoring is the ideal choice. It can combine temperature measurement directly at hotspots and humidity sensing within a switchgear cabinet in addition to partial discharge detection.

The Wireless Sensor Reader WSR-T2 detects Partial Discharge via its connected antenna. Ideally suited for this purpose is a Planar Inverted F-Shape Antenna (PIFA), for example SenGenuity's ANT-PIF-0001. Additionally, this antenna can be used for sensing SenGenuity's wireless, passive temperature sensors. The WSR-T2 will use the

antenna to scan multiple frequencies within a limited frequency range in order to avoid disturbances of other transmitters on a single frequency. Thereby, every scan consists of thousands of observation cycles. A highly efficient real-time algorithm analyzes the received signal pattern and reports the number of Partial Discharges within this cycle. Although this number might not be the exact number of events, it will give a sufficient statement of the actual health of system in terms of PD.

In particular, the PD function is intended for long-term monitoring and detecting long-term degradation of insulations, this is a valuable add on and when combined with the WSR-T2, temperature sensors and the Humidity Sensor Reader (HSR-01) it provides a perfectly thorough monitoring system. Since the wireless and passive temperature sensors are only powered via the WSR-T2 Unit, they do not require batteries or cables which allows them to be installed easily at nearly every potential hotspot inside the switchgear.

Joined with the recently released Human Machine Interface HMI-T-0001 all of the described sensors can be combined to an overall stand-alone switchgear monitoring system as illustrated in figure 1. This HMI-T-0001 gives operators various possibilities to easily configure a widespread monitoring network with customized set up including alarm and warning functionalities.

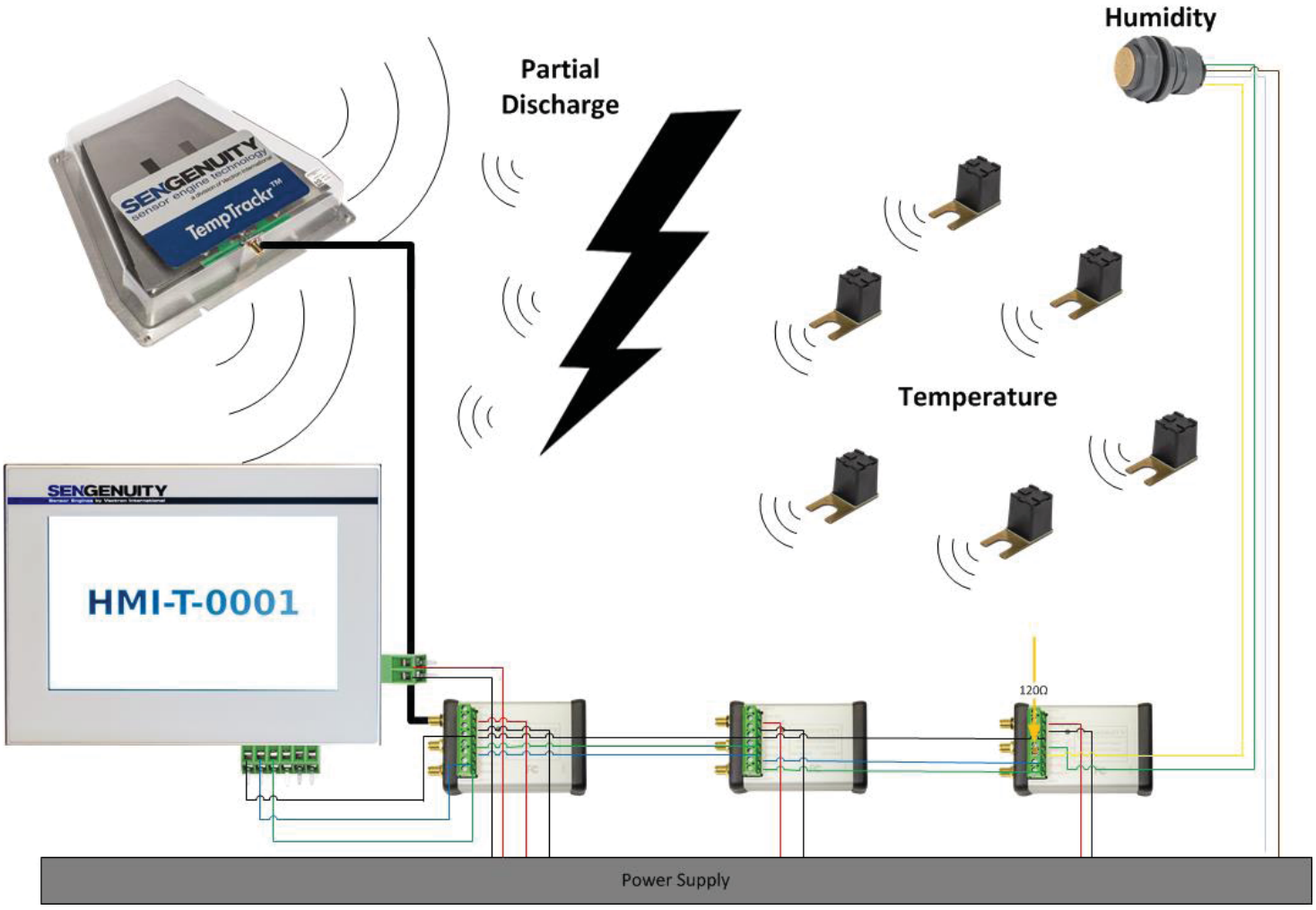

Figure 1: Overview of SenGenuity's complete Switchgear Monitoring System

With the ability to leverage the WSR-T2 Reader and Antenna's capability to measure temperature as well as partial discharge; SenGenuity's Systems offer a perfect cost-effective solution for switchgear monitoring.

Traditional ways to measure Partial Discharge

Many possibilities to measure Partial Discharge are available on the market and are more or less widely used. A huge disadvantage of most systems is the fact that they are only done periodically and offline, requiring personnel. This will not only use valuable resources but also only provides a snapshot of the system's health. Furthermore, as discussed above, many parameters are influencing PD and depending on these, the snapshot can give a completely inaccurate picture at that point of time.

One possibility is the High Frequency Current Transducer (HFCT) technology whereby the HFCT is installed around the equipment which should be tested and measures the intervals between current bursts occurring across the insulation weak spot – as the insulation deteriorates, the shorter the intervals between the bursts.

Another possibility is the creation of a circuit around the expected PD spot using proper resistances and illustrating the current via an oscilloscope. Furthermore, with sufficient equipment, it is possible to hear partial discharge as it emits ultrasonic sound waves. Measuring the Transient Earth Voltages (TEVs) that emerge directly proportional to PD is also common, however, not sufficiently sensitive enough for all kind of applications.

Many measurement principles base their results on comparison with the factory results of the unimpaired insulation during acceptance testing before delivery.

These are only a few possibilities to measure PD and depending on the used technology and algorithms established behind not only the presence but also the severity and the place of the actual PD can be located.

Summary

Partial Discharge is a well-known risk in switchgear or any other high voltage assets. Its monitoring can prevent and avoid damage as well as failure. However, by only monitoring Partial Discharge in isolation, or worse, only at some points in time, critical data can be missed or misinterpreted. Therefore, an online monitoring system in combination with various other measurements can not only secure your assets, it can also save your resources!

For more information, please ask sensors@sengenuity.com