Corona Suppression During Cable DC High Potential Testing

This column focuses on electrical inspection methods and technologies that are performed while the electrical system remains energized. Although no-outage inspections can be very valuable tools, always remember to comply with proper safety guidelines when conducting energized, on-line inspections.

by Don A. Genutis
Group CBS

Introduction

Direct current high potential testing is still the most widely specified acceptance test for newly installed, medium-voltage cable. Although this testing is not conducted on-line, important observations made during energized testing are examined in a unique manner that supports the importance of adequate corona suppression methods.

What is corona?

When the potential gradient is great enough at a point in gas, liquid, or solid insulation, that point ionizes and becomes conductive. If a conductor has a sharp point, the air around that point will be at a much higher gradient than elsewhere on the conductor. Air near that point can become ionized or partially conductive. When this occurs, it has the effect of increasing the apparent size of the conductor. Since the new conductive region is less sharp, the ionization may be isolated to this local region. However, if the geometry and gradient are such that the ionized region continues growing, a completely conductive path may be formed through the insulation which results in flashover or complete breakdown of the insulation.

The concept of corona's effect to increase the apparent size of the conductor can be seen in Figures 1 and 2. (These pictures were taken using a daylight corona camera while applying high potential dc in a laboratory environment. In Figure 1 the alligator clip of the high voltage test lead rests atop an insulating blanket, and in Figure 2 a small wire was placed vertically in the alligator clip jaws. The blue clouds shown in the picture are the actual ionized air created by corona. As can be seen, especially in Figure 2, the apparent conductor size is much larger than the original conductor.

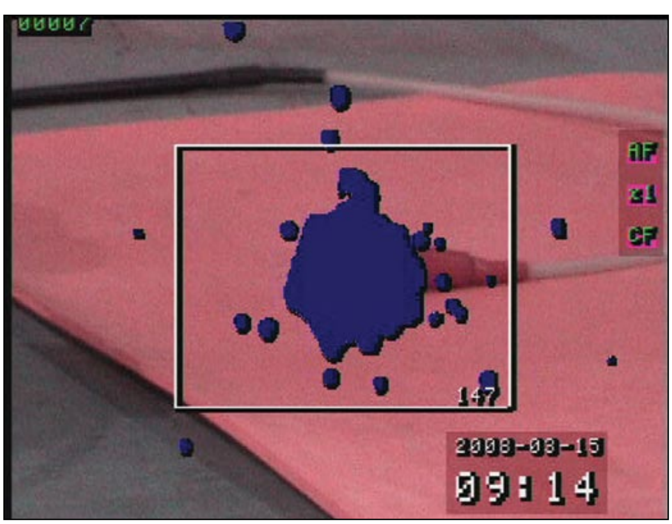

Figure 1

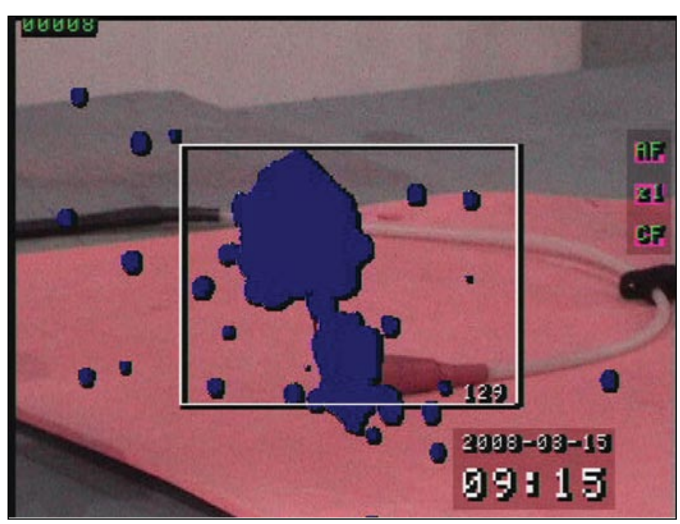

Figure 2

Many factors influence corona generation including temperature, humidity, air pressure, conductor shape, applied voltage and frequency. Since voltage is a major factor in corona generation, great care must be taken to design transmission systems to eliminate or reduce the effects of corona. Even at distribution voltage levels, corona and partial discharge can lead to premature insulation failure.

Why suppress corona during dc high potential testing?

We all know about the detrimental effects of corona on electrical insulation but why should we be concerned about corona during dc high-potential testing of cables?

There seems to be three main possibilities why corona suppression must be addressed during testing. These are test errors caused by direct corona losses, indirect test errors resulting from excessive leakage current due to misapplied corona suppressors, and flashover due to lack of corona suppression.

DC leakage currents are typically measured in units of microamperes, and corona (and partial discharge) can be measured in units of charge known as picocoulombs. One coulomb is defined as one ampere second. Although it is not quite correct to compare leakage current with charge, we can get a relative feel for the fact that it will take a lot of corona to influence the leakage current values. Experiments performed in our laboratory seem to support this statement. So, under most circumstances corona is unlikely to significantly affect test results. However, we have seen inconsistent puffs of wind appear to be related to some minor fluctuations in the dc analog microampere leakage meter. This could be explained by corona ionizing the air near the termination and then recharging after the wind has dissipated the ionized air.

Figure 3

There are many different and some very creative methods for suppressing corona. Let us look at the guard ring first. Figure 3 illustrates a corona ring installed on a high voltage insulator. The corona ring is extremely important for keeping unwanted corona from occurring on transmission insulators where this activity can cause severe damage. The ring electrically smoothes out sharp edges where the voltage gradients can be great enough to generate corona. Corona rings can be used in a similar manner for dc high potential testing to eliminate corona at the termination.

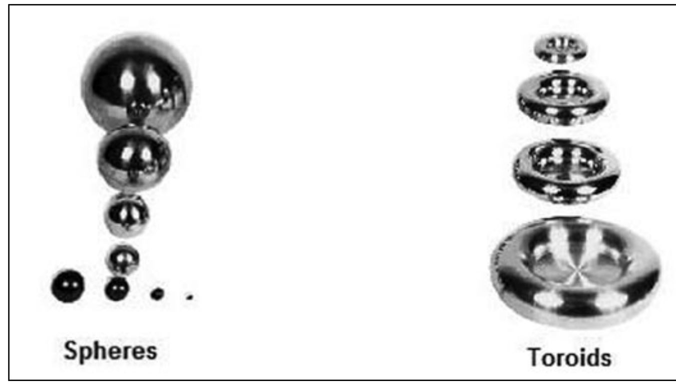

Figure 4

Corona spheres, also known as field reduction spheres, along with toroids shown in Figure 4, can also perform the same function as the rings. Although these types of corona suppression are very popular for laboratory use, the equipment is fairly bulky, rigid, and not a real good practical choice for field testing. Figure 5 shows the effectiveness of the corona sphere during dc high potential application to a conductor in the laboratory as no apparent ionization of the air is occurring when viewed through the daylight corona camera

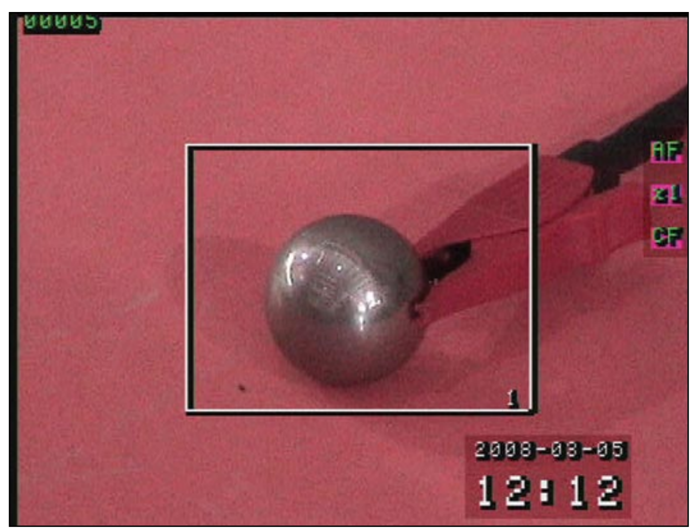

Figure 5

Plastic baggies, plastic wrap, rubber lineman's gloves, duct seal and the presently popular capped PVC pipe all may be considered forms of corona suppression. However, many of these solutions come in direct contact with the conductor or apparent conductor and introduce additional unwanted current leakage paths. Poor or contaminated insulating materials used as corona suppressors can actually introduce a much greater test error than the corona can itself; therefore, if corona suppression is not used properly it may be best to not use it at all.

Flashover

Avoiding flashover or the complete breakdown of the air between conductors is a much greater concern than introducing test errors during field high potential testing of cables as it can terminate the test prematurely and sometimes frighten the electrical inspector witnessing the test or the technician himself. Cable terminations are often installed in relatively tight switchgear enclosures and cannot be isolated from one another far enough to prevent flashover in air at higher test voltages as the air ionizes around the conductor. In order to prevent flashover, methods such as placing a capped PVC pipe over the conductor under test becomes an inexpensive but usually reliable flashover solution by trapping the ionized air within the tube and by the tube acting as an additional insulation barrier between conductors.

Conclusion

When conducting dc high-potential testing of cables, always closely examine both ends of the cables before proceeding. By using proper corona suppression, testing can commerce without introducing measurement error and without causing flashover. As always, do not forget barrier tape, warning signage, and other safety precautions.

Acknowledgements

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Mr. Genutis received his BSEE from Carnegie Mellon University, has been a NETA Certified Technician for 15 years, and is a Certified Corona Technician. Don's technical training and education are complemented by twenty-five years of practical field and laboratory electrical testing experience. He is presently serving as Vice President of the Group CBS Eastern U.S. Operations and acts as Technical Manager for their subsidiary, Circuit Breaker Sales & Service located in Central Florida.