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EFFECTIVE CLEANING METHODS TO REDUCE CHARGE ACCUMULATION ON FIBER OPTIC CONNECTORS

Daniel Hogberg, RCDD

INTRODUCTION

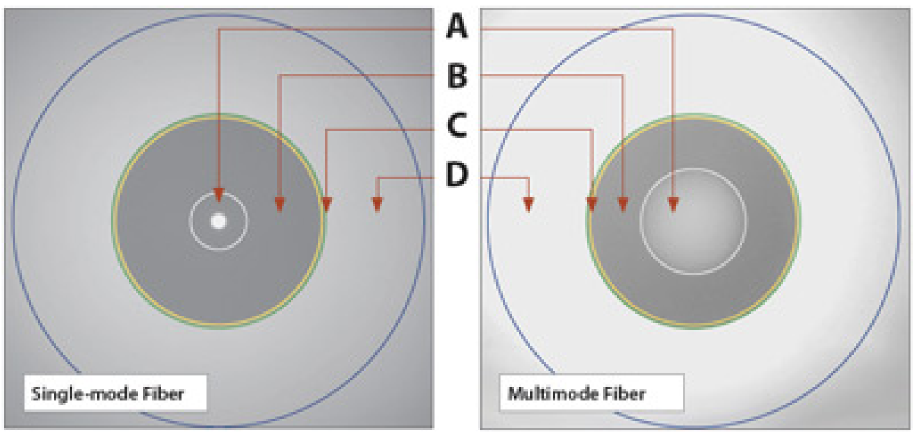
The performance of a fiber optic cable is dependent on more than just the quality of the materials used and workmanship of the manufacturer. How the cable is installed has a significant bearing on its performance in a given application. How was the cable routed? Were bend radius specifications considered? Was it handled properly? Was it inspected and cleaned prior to installation? Field technicians have a great deal of information to process when deploying fiber, and it is important to equip them with the proper information and tools to perform the highest level of work.

Whenever a connector comes in contact with the cleaning surface and is pulled across it, a charge is generated on that endface called a tribocharge. A tribocharge is created any time two materials are brought into contact and then separated (friction). Accumulation of tribocharges, and the increase of the electric field from said charges as a result of repeated cleanings, creates a scenario that can attract airborne particles and also make surface contamination difficult to remove.

Megladon and its partners have designed tests that measure the strength of the electric field generated through practical fiber handling, and using this data and static principles, can recommend a basic cleaning method that increases the success of a fiber connector installation.

WHY CLEANING FIBER ENDFACES IS CRITICAL

Cleaning of the fiber endface is a key component of the fiber installation. Without proper inspection and cleaning methods, the best possible performance cannot be achieved. The fiber industry has gone to great lengths to standardize the quality of a fiber endface, especially through the lEC 61300-3-35 endface inspection standard. This standard defines the cleanliness and condition acceptance criteria for SM and MM connector endfaces prior to installation. The standard defines the acceptable contamination/defect levels and locations, and creates a standardized, objective tool for grading a fiber endface.



Defining the Fiber Zones of IEC 61300-3-5

Defects and contamination create a long list of issues with fiber optic cables, and their prevention and removal is key to a successful installation. Here are some of the ways that contaminants effect transmission:

- Contamination near or on the core of the fiber prevents transmission of signal, creating Insertion Loss and Optical Return Loss issues
- Large particles near the core can prevent physical contact between two connectors and may result in an air gap, which will negatively effect signal transmission
- Particles in Zone B-D do not always have an initial effect on the performance of the cable, but data from the International Electronics Manufacturing Initiative (INEMI) collected in 2007 with

the help of Megladon, suggest that the particles tend to migrate towards the core with repeated matings. The mechanism for this movement is electrostatic charge.

- Contamination often damages the fiber endface upon repeated matings, causing scratches and pits to form that are permanent and can only be removed by polishing or replacing the connector

It is critical to the performance and lifespan of the connector to clean it properly and inspect it prior to installation. Installing a contaminated connector can compromise performance, damage the opposing connector or contaminate the opposing connector/port.

If contamination must be avoided, cleaning becomes the critical step in a fiber install. The challenge is to clean using an appropriate method that prevents electrostatic accumulation, assures the highest performance of the link, and doesn't compromise the service life of the installation.

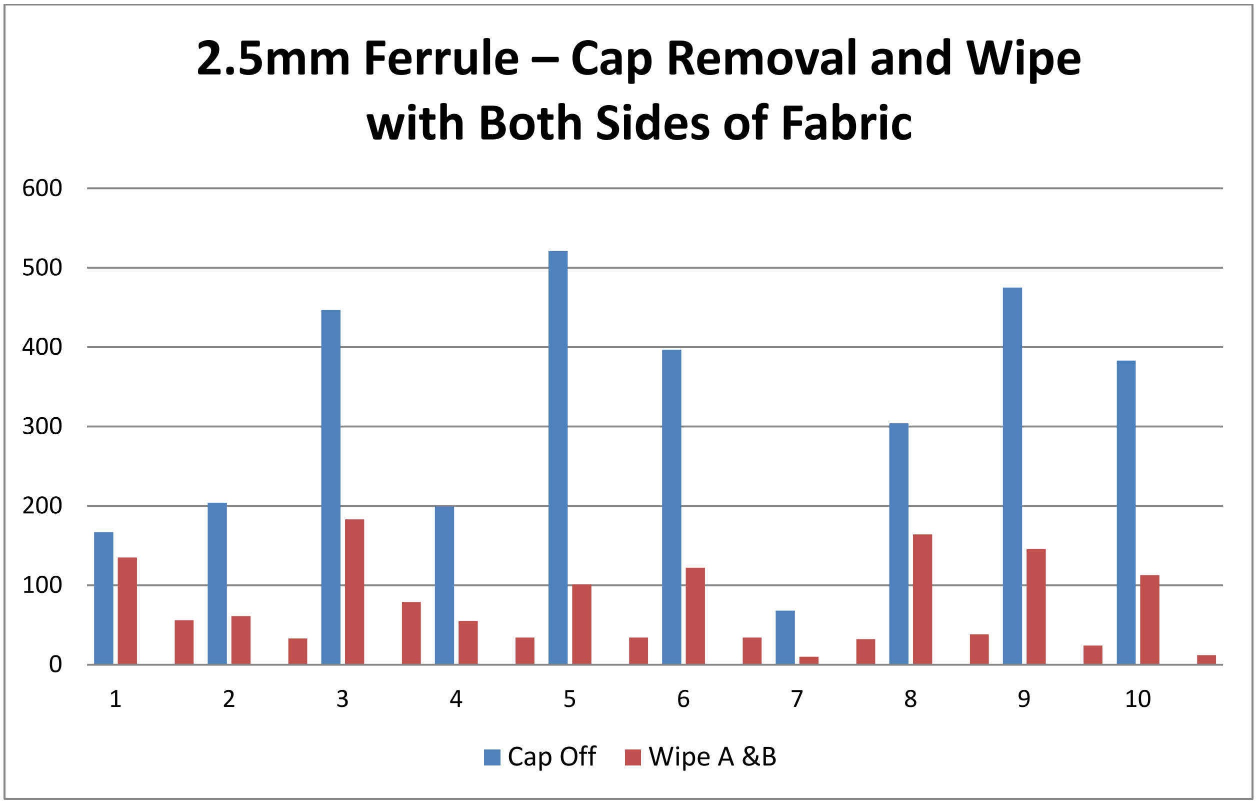
MEASURING CHARGE ACCUMULATION

The charge and electric field generated on the tip of the connector during handling and cleaning is very small, but not insignificant considering the micron-size particles that it has the ability to attract. Megladon worked in conjunction with static expert Dave Swenson at Affinity Static Control Consulting to develop a testing protocol that could accurately quantify the electric field on the tip of a fiber optic connector. Our challenge was to measure just the tip of the connector ferrule and be able to isolate the measurement to the ferrule without collecting any of the surrounding. By confining the measurement to the ferrule, we can isolate the effects of cleaning techniques and determine the greatest contributors to building an electric field.

A test fixture was built isolating the connector enface using a Monroe Electronics model 244 electrostatic voltmeter and a small field measurement probe. This setup allowed us to measure the charge on a space of about 2mm sq, roughly the equivalent of the tip of the connector ferrule.

We took measurements in a variety of scenarios, but focused on the removal of the connector dust cap and moving the connector over a standard non-woven fiber cleaning wipe. We distinguished between the sides of the wipe considering that they have different surface textures.

The chart below contains a brief overview of one of our data sets. The x-axis represents the different connector samples used and the Y axis is the measured charge in Volts.



As you can see, removing the cap of the connector creates charge, and so does the basic cleaning technique. For out tests we only moved the connector lightly over the cleaning wipe - increased traverse and pressure are assumed to cause the charge accumulation to rise even further.

This data presents a challenge to fiber field work. How do you clean a connector without making it more difficult to clean? The more "scrubbing" of the fiber endface that takes place, the more difficult it is to clean due to charge build up, and the more susceptible the connector is to attracting additional airborne contaminants.

CONTROLLING AND PREVENTING CHARGE ACCUMULATION

As discussed before, one of the most important parts of the installation is the cleaning and inspection of the optical interconnect, but if excessive cleaning can create a charge on the surface, how do you find a balance that gives the technician the greatest chance at success?

The first thought that may come to mind is employing traditional static control devices such as wrist wraps or heel straps. These devices are designed to work with conductive materials, but the ceramic ferrule is not conductive, but an insulator, and would be unaffected by the use of this equipment.

Humidity is a great contributor to the dissipation of electric fields. Relative humidity directly effects a surfaces' ability to store electrostatic charge. If the relative humidity is low (<30%), the surface will take longer to dissipate the charge. If relative humidity is high (>70%), charges will dissipate quickly because the moisture provides a conductive path for the charge.

The effects of humidity are important for a few reasons. First, installation environment has a strong impact on the connectors' cleanliness and cleanabilitv. In colder months when RH levels are low, connectors will be more susceptible to accumulating charge, and will be more difficult to clean. In warmer months when RH levels are high, the connector will be less susceptible to charge accumulation. But environmental conditions alone are not a strong enough tool to support the installer.

The use of a cleaning solvent is an effective tool for the installer. Applying the solvent to the endface temporarily takes the RH at the fiber surface to 100%, dissipating the surface charge. Removing the charge removes the bond between the contaminants and the surface, and assures a high first pass yield in field cleanings. It also leaves the endface with little or no surface charge, reducing the probability of future accumulation.

Solvents should be used with some caution. Do not over saturate wipes, and be sure to remove all moisture from the endface before installation.

CONCLUSION

Cleaning is a critical part of fiber installations and the way that you clean the connectors matters. Incorporating a solvent into the cleaning method ensures better first pass yield in field cleaning, better link performance, compliance with industry standards, and a prolonged service life of the installation.

Megladon will continue to generate more data to further define the best cleaning methods and materials, and will continue to study the materials that create charge and control it on the connector endface.

REFERENCES

INEMI - "Accumulation of Particles Near the Core During Repetitive Fiber Connector Matings and De-Matings
http://thor.inemi.org/webdownload/newsroom/Presentations/OFC NFOEC 2007/Accumulation of Particies.pdf

IEC 61300-3-35: Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-35: Examinations and measurements - Fibre optic connector endface visual and automated inspection

Dave Swenson, Affinity Static Control Consulting
www.affinity-esd.com