A More Effective Means of Cleaning Fiber Optic Connections in Outside Plant, FTTH and OEM Applications

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Overview

As telecommunications companies upgrade and expand their fiber optic networks and plan for Fiber-To-The-Home (FTTH) to accommodate high speed Internet access, the need for an effective, repeatable and cost effective means of cleaning optical fiber connections becomes essential. The limitations of traditional cleaning methods, lack of formal cleaning procedures, and the misuse and overuse of cleaning products can not only result in signal degradation but can also damage the optical fiber end face polish. New methods for cleaning end faces have been under study for some time, in both Outside Plant and OEM environments. A new method of cleaning has been developed, which has been proven in the field to be more efficient in removing contaminants and is expected to be more cost effective in servicing the millions of connections projected for FTTH.

Background

In the coming decade, growing consumer demand for high speed Internet access is anticipated to expand well beyond existing business requirements. Effectively cleaning fiber optic connections, that support high-speed data transmission rates, is essential to assuring trouble-free transmission of the full spectrum of data, Internet and video services.

To meet the need for contemporary high speed connections engineers have created a broad assortment of mechanical ferrule connectors and alignment sleeves, which are commonly in use today. However, in many cases these connectors themselves present a new set of cleaning problems. It has been reported that as many as 70% of all transmission problems are actually caused by soiled connectors. The fact that end faces must be cleaned each time a connection is made is new information to some technicians and engineers. Soils from many ambient sources, unless they are completely removed, can accumulate on the end faces and around the sides of ferrules and in the alignment sleeve. These soils can cross contaminate other connectors, causing measurable signal deterioration.

Processes

For many technicians, cleaning end faces before making a connection is standard procedure. Yet, there is still a sense of controversy regarding the best method of cleaning. Some advocate a Dry Cleaning technique using lint-free fabrics, while others prefer a Wet Cleaning Process, which employs a solvent cleaner. However, both of these techniques have drawbacks. Manufacturers of cleaning devices sometimes misstate claims and rarely detail exactly how their products should be used or how they can be misused. Improper Dry Cleaning can require corrective end face polishing and even jumper replacement. For example, when using a Dry Cleaning technique, the recommended “twist and turn” scrubbing motion applied to the dusty end face can result in scratches that can induce signal loss or signal deterioration. The “figure-8 motion”, used for end face polishing, should never be used for end face cleaning. This motion can create excessive lint and damage the end face. The figure-8 motion is a polishing procedure, which is not intended for use in routine cleaning.

Although use of a Wet Cleaning process largely avoids issues of scratching, using a solvent cleaner can also present problems. Even the highest grade of 99.9% IPA is unable to remove both ionic and complex non-ionic contaminants such as buffer gels, lubricants and these oily residues in combination with dusty soils. IPA can leave a thin layer of such contaminants on the end face, again resulting in signal degradation. Using excessive amounts of IPA can also contribute to signal loss through a phenomenon know as ‘haloing”, which is thought to be caused by residual alcohol combining with ambient soils and moisture, resulting in a residue that can adhere to the end face.

The use of pump spray bottles to store and apply IPA cleaning solvent exacerbates the problem. Since 99.9% IPA is very hygroscopic, it begins to absorb moisture the instant it comes in contact with any humidity present in the ambient air. IPA will continually absorb moisture until it reaches an equilibrium of 65% IPA to 35% moisture, making it even less capable of removing oily contaminants. Packaging any solvent in a pump spray container or plastic squeeze bottle can introduce ambient moisture contamination into the solvent because the volume of solvent expelled is replaced by outside air with each action of the dispensing pump. In addition, many spray bottles use mineral oil or another type of oil to lubricate the piston of the sprayer. This introduces another soil that can be applied to the surface being cleaned. The cleanest delivery system is an aerosol container, containing a micro-filtered solvent that is propelled with an inert gas.

Researchers at ITW Chemtronics® have developed an entirely new means of cleaning both Outside Plant and OEM fiber optic connections. For the first time proper techniques have been combined with precision cleaning solvents to define an effective fiber optic cleaning method. This new process overcomes the problems encountered in both, the Wet Cleaning process and Dry Cleaning technique. This Combination Cleaning Procedure or CCp™ utilizes a proprietary solvent that effectively removes all commonly encountered Outside Plant soils. This procedure cleans the broad range of contaminants typically found in Outside Plant and OEM applications.

Unique Solvent System

Since IPA is the traditional chemical commonly used for both end face cleaning and for fiber preparation before fusion splicing, it has achieved “universal solvent” status over the years. However use of IPA presents a number of issues. For example, in relation to more contemporary products, IPA evaporates slowly. The hygroscopic nature of IPA combined with its relatively low volatility and intrinsically higher surface tension, can result in adhesion of microscopic particles to the end face surface. Even after drying is apparently complete, these contaminants remain bonded to the end face surface and in “blind” areas such as the sides of ferrules, and within the bounds of generally accepted imperfections in the polished surface. The ITW Chemtronics Combination Cleaning Procedure incorporates the use of cost effective materials to clean end faces ferrules and alignment sleeves, for the full range of 2.5 mm, 1.25 mm and similar small form connectors. Each product has its own specific written procedures that were developed for its use.

To overcome the problems inherent in using IPA for cleaning fiber optic connectors, application specialists at ITW Chemtronics recommend using a proprietary cleaning solvent called Electro-Wash® PX Fiber Optic Cleaner. This product has been used in electronic precision cleaning applications since 1992. Filtered and packaged in a 5-ounce aerosol can that prevents contact with outside air prior to application, this cleaning solution effectively removes the types of soils most commonly encountered in Outside Plant and OEM operations. A variant of this cleaning solvent is also packaged in a pre-saturated wiper, which can be shipped by air in tool kits. To document its effectiveness, this solvent has been extensively tested in our laboratory, in side-by-side comparisons with IPA using a variety of commonly encountered soils.

Test Procedure

In order to compare the effectiveness of Electro-Wash® PX Fiber Optic Cleaner with 99.9% pure isopropyl alcohol (IPA), both solvents were tested side-by-side, using four commonly encountered soil types.

A sample of each soil type was applied on two areas of a 12” x 12”x ¼” white polyethylene panel and heated for 10 minutes in a 160 ºF oven. The sample was then allowed to return to room temperature before initiating the cleaning test. A small amount (<10%) of LubriMatic Black Lithium Multipurpose Grease was added to the clear or uncolored soils for better visual observation of the soil and to emulate the “real world” problem of complex soils, which are commonly encountered in Outside Plant situations. This further challenges the efficacy of the cleaning process.

Initially, one side of each board was sprayed with IPA for 5 seconds, while the other side was sprayed with Electro-Wash® PX Fiber Optic Cleaner for 5 seconds. Since each soil type was completely removed by the Electro-Wash® PX Fiber Optic Cleaner after a 5-second application, the spray time was reduced to 2-3 seconds in order to better differentiate the action of the two cleaners. The test results for each cleaner on each soil type were then documented.

1. Multipurpose Grease – LubriMatic #11316, a high-density black lithium grease, similar to the lubricating greases associated with Outside Plant mechanical equipment lubrication. This is a “worst-case” cleaning application scenario.

Soil prior to cleaning

Soil after cleaning

2. Animal Fat – Armour® Lard, which is used to represent the type of grease contamination caused by fingerprints, or transferred to the fingers from handling greasy foods (like French Fries).

Soil prior to cleaning ***Soil after cleaning***

3. Motor Oil – Quaker State 10W 40 motor oil, which is used to represent the type of light machinery lubricating oils that may be encountered in conjunction with dusty residues, in Outside Plant cleaning applications.

Soil prior to cleaning ***Soil after cleaning***

4. Silicone Oil – Dow Corning SF96100, which is similar to the type of contamination from Buffer Gel or Pulling Lubricant, used in Outside Plant cable installation operations.

Soil prior to cleaning ***Soil after cleaning***

Samples prepared from each of the four soil types tested showed only partial removal of the soil (<50%) after a 5-second spray when using the 99.9% IPA. More than 90% of each soil type was removed by the Electro-Wash® PX Fiber Optic Cleaner after only a 2-3 second spray. These results demonstrate the exceptional cleaning performance of Electro-Wash® Fiber Optic Cleaner PX for a wide range of soils.

CCp™, The Combination Cleaning Procedure

Development of an effective cleaning solvent was critical to overcoming the drawbacks of a Wet Cleaning Process, but this solved only half the problem. In order to prevent damage to the optical fiber end face during the cleaning process, ITW Chemtronics researchers have developed an entirely new cleaning tool – the QbE® Cleaning System.

Traditionally, Dry Cleaning has been accomplished using a spooling device, containing a cleaning tape, which slides over a non-replaceable neoprene platen. Opening a sliding door positions a small area of cleaning tape within a narrow slot. The fiber end face is then drawn across the tape surface exposed within the slot. Although a fresh section of tape is presented for use with each opening of the sliding door, the only practical way to make efficient use of the small tape area presented, is to use a "twist and turn" motion as one draws the fiber end face across the cleaning surface. This twisting motion can cause scratching of the end face and does not always remove complex soils. Furthermore, attempting to use a cleaning solvent with these devices usually results in the fiber connector becoming over-saturated with solvent.

An additional concern with cleaning spool devices is hardening of the non-replaceable neoprene platen. Over time, the platen in these devices tends to harden, due to plasticizer loss caused by natural atmospheric degradation and the repeated action of end face cleaning which is restricted to the same area of the platen. The optical fiber can be damaged if it is pressed too hard against this unyielding surface.

End face contaminants, which include dust, can be more effectively removed using CCp™, The Combination Cleaning Procedure, wherein the end face is moved from "wet-to-dry", using a smooth, unidirectional cleaning stroke over the larger cleaning surface provided by the QbE® Cleaning System. This process incorporates a small amount (<1ml) of cleaning solvent, with an "automatic" drying process.

The QbE® Cleaning System consists of 200 individual sheets of non-linting material. Each sheet is 3 inches square. This ample surface area encourages technicians to use a long cleaning stroke in only one direction, with no twisting or "back and forth" motion, which could result is scratching of the end face. The QbE® is packaged in a reinforced, double-walled container which was designed with input from Outside Plant service technicians. In use each fabric sheet slides over the platen so there is always a new cleaning surface for use. The platen will not harden over the expected life of the 200 individual cleaning sheets. When empty the box and platen is discarded, and a new QbE® cleaning unit is opened. There are no costly cleaning tape spools to replace.

To clean an end face using the CCp™, the technician sprays a small spot (about the size of a quarter) of Electro-Wash® PX Fiber Optic Cleaner onto one corner of a QbE® cleaning sheet. The optical fiber end face is moved from the wet area of the sheet, across the dry portion of the material. Because the lint-free QbE® sheet has such a large surface area compared to conventional cleaning tape devices, it better lends itself to using a long, single direction stroke rather than an abrasive twist and turn motion. The long, smooth cleaning motion acts, in effect, like a light-handed burnishing action. As in any cleaning procedure, the end face is then checked with a fiberscope or other inspection device, and the cleaning procedure repeated if necessary. The CCp™ technique is so efficient that many technicians report that the number of post cleaning fiberscope inspections is reduced.

After cleaning the top sheet of the QbE® should be discarded. While leaving the soiled sheet in place until the next cleaning is good practice, sheets should never be reused or cleaning performed over a previously used area. Some technicians leave this used sheet in place to remind themselves not to use it again. As the soiled sheet is discarded, a new sheet is drawn over the platen, giving a clean surface for further use. Technicians report that the low cost of the QbE® allows them to use a clean sheet for each end face to be cleaned. Complete training in the use of the CCp™ technique is readily available from ITW Chemtronics, through an established network of manufacturer's technical representatives.

ITW Chemtronics researchers developed the QbE® Cleaning System to be highly effective with either wet or dry cleaning techniques. Dry cleaning is acceptable when it can be verified that the contaminant to be removed does not contain potentially abrasive dust. The QbE® Cleaning System and the CCp™ technique should be used whenever the contaminant is more complex than simple hand oil residue or when visual inspection of the end face is not practical. The Combination Cleaning Procedure incorporating a small amount of solvent is field-proven to be highly effective.

Conclusion

The QbE® Cleaning System offers more complete removal of microscopic contaminants, with far less likelihood of damage to the optical fiber end face, than conventional cleaning methods in use today. Because the solvent is so effective, complex soils are completely removed. Finally, since the end face is being drawn from wet to dry along the surface of the lint-free cleaning material, all contaminant residues are captured within the weave of the QbE® sheet. Electro-Wash® PX Fiber Optic Cleaner offers the advantage of evaporating more completely and rapidly than IPA and of cleaning far more soil types. The CCp™ method combines the best features of both the wet and dry cleaning techniques to create a new process, which is superior to either.

The Combination Cleaning Procedure, or CCp™, is safe and effective. It is also faster and easier to use than traditional cleaning devices. The CCp™ is also claimed by field personnel to be highly intuitive, requiring minimal technician training. The most complicated issue in adopting the Combination Cleaning Procedure and the QbE® Cleaning System is the willingness to abandon old habits and work routines. The combination of effective products and application techniques make the CCp™ ideal for both Outside Plant and OEM cleaning applications.