American Polywater's
Technical Talk
A Publication for Engineers Involved in Cable Installations

White Paper

Tension Reduction and Lubrication On High Performance Data Cable

Recent field installations show that cable pulling lubricant can affect high-performance, low-voltage copper data cable. Occasionally, data cable is failing attenuation testing where the cable is pulled into conduit with the assistance of lubricants. Since cable lubricant is critical to minimize tension in these installations, a study was fast-tracked to understand the effects of lubricant on the signal properties of cable. The study also includes friction reduction measurement and lubricant effect on the physical properties of the cable jacket.

A History of Cable Lubrication

Modern cable pulling lubricants are primarily used for outside plant (OSP) telephone and electrical cable installations. These lubricants meet rigorous performance criteria specific to these end uses. A good outside plant or electrical cable lubricant will wet out on the cable jacket, providing a lubricating coating that will cling to the cable as it travels long distances through the conduit. Almost all cable pulling lubricants are water-based. Electrical lubricants are UL listed and tested for compatibility according to IEEE standards. There are Bellcore specifications for OSP pulling lubricants.

TIA cable installation standards limit cable fill, run length, and degree of bend in the raceway. Even with these limitations, there are cases where cable lubricant is needed because, to maintain integrity, the cable must be pulled with less than 25 pounds force. Contractors turn to the most convenient and available lubricant, which is almost always intended for outside plant or electrical cable pulling. As we will see, the use of such lubricants for high baud rate data cable installations is not always appropriate.

A New Class of Lubricant

The unique installation requirements for data cable should be considered before a cable lubricant is specified or chosen. An appropriate lubricant will reduce friction and cable pulling tensions. It should be compatible with the cable jacket material and should have a limited effect on the signal and attenuation measurements on the cable. Most commercial cable lubricants are water-based. Even lubricants touted as "wax-based" or "silicone-based" contain water as a primary ingredient. A thinner, fast-drying lubricant that requires only a very thin coat has tested as the best choice for this type of installation.

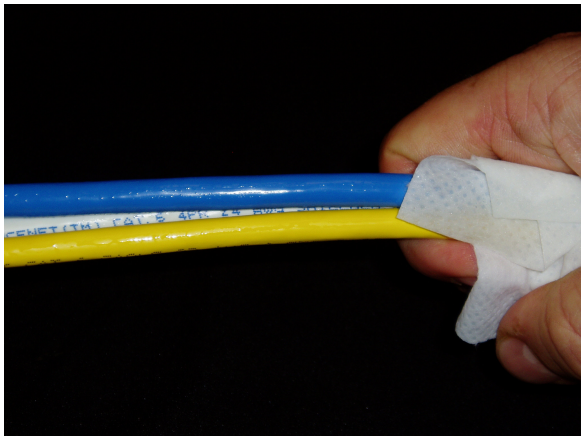


Photo 1: FTTx Wipe Lubricant reduces friction with only a light coating on the cable jacket.

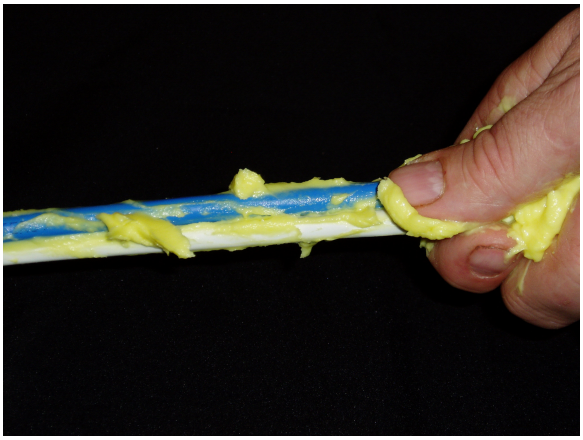


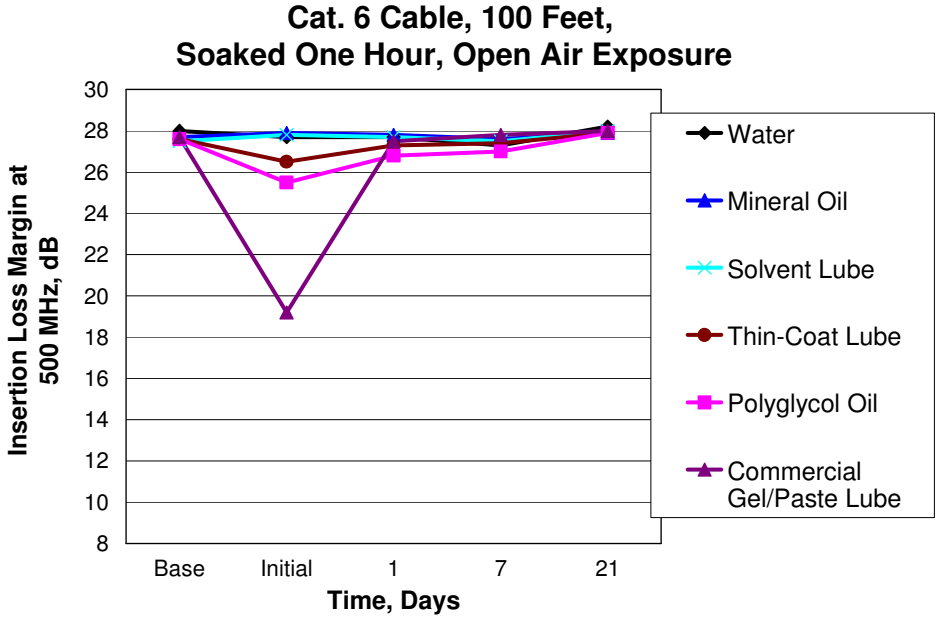
Photo 2: Conventional wax paste and gel lubricants require a thick coating of lubricant.

Polywater® FTTx Lubricant Wipe, manufactured by American Polywater Corporation works well for high-performance data cables. It is concentrated to reduce the amount of lubricant needed and can reduce friction at very thin coats. The following tests show the performance of FTTx Wipe Lubricants as compared to more traditional thick coat lubricants.

Diagnostic Testing and the "Wet Link Phenomena"

In the first phase of the compatibility testing, Category 6 Data Cable is soaked in the lubricant (at 23 degrees C) for one hour, and is then removed and strung linearly for testing. The amount of lubricant on the jacket is what was retained naturally, and as expected, is highest for the gel and paste lubricants.

A full set of diagnostic tests is performed at regular time intervals using a Fluke DTX1800. All conditions and connection hardware are kept constant unless noted. Graph 1 shows the insertion loss or attenuation measurements. The control or "base" reading is taken before lubricant is applied, and the "initial" reading is taken immediately after the cable is removed from the lubricant. Testing is continued until the diagnostic readings stabilize.



Graph 1: The effect on attenuation is immediate, but also reversible.

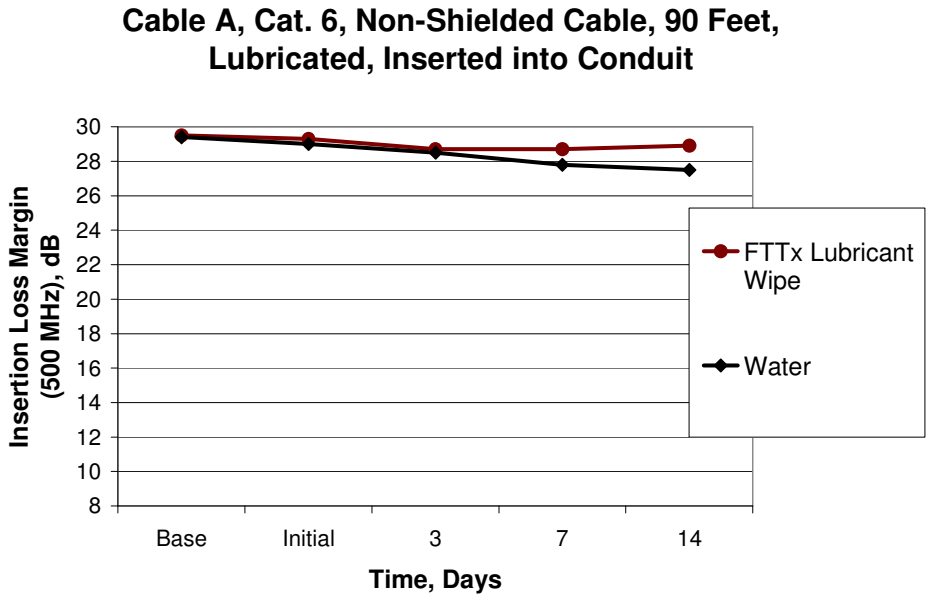
The effect of the lubricant is immediate, and develops before the lubricant has any chance to permeate the jacket. As the lubricants are allowed to dry, the attenuation returns to the control level in one day to three weeks. In other words, *testing shows that the insertion loss effect is reversible*.

The commercial water-based gel and wax lubricants cause the greatest insertion loss, and the non-polar oils cause the least. The thin-coat lubricant, while water-based, shows a minimal effect, presumably because there is very little lubricant to absorb energy.

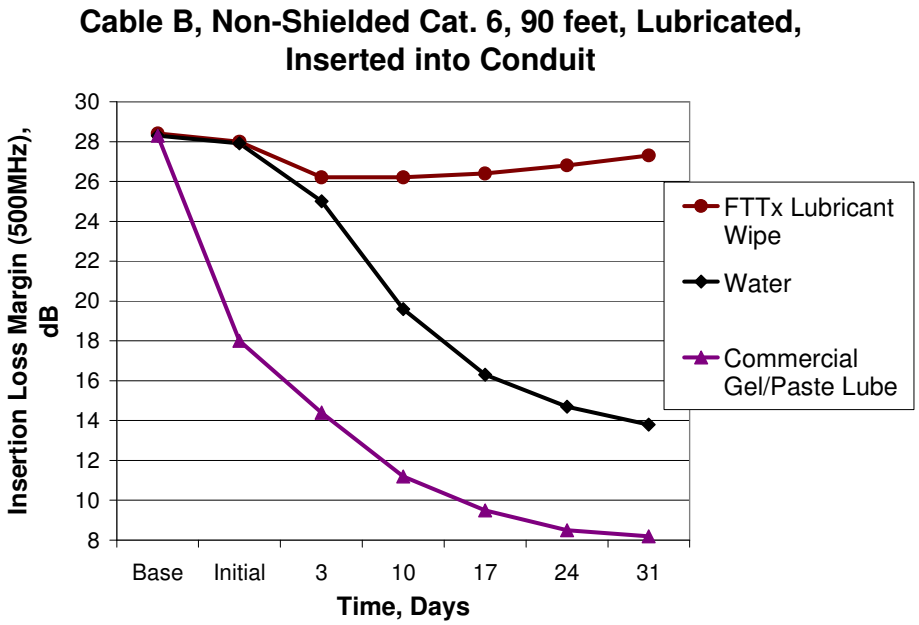
In a second phase of this testing, 300-foot sections of four, non-shielded Category 6 cables are wiped with the wipe lubricant and a full set of diagnostic tests are performed on the cable. Immediately after application of the lubricant, each cable shows minimal Insertion Loss and "passes" the full set of tests.

Conduit Test

In the next test, cable is coated with lubricant as it is pulled into a conduit. The conduit ends are then closed with duct plug putty, so the lubricant is not allowed to dry. Plain water is used as one of the comparisons. Several cables from different manufacturers are used in this testing, with the results from two types shown below.



Graph 2: Cable A shows very little effect, even when the water and wipe have no chance to dry.



Graph 3: Cable B shows more effect, which varies by lubricant

Graphs 2 and 3 show the impact of lubricant and water over time. With Cable A, attenuation loss was minimal and stable over time. (Graph 2) With Cable B, the attenuation shows a continued degradation. (Graph 3) Performance is dependent on the cable. For all the cables tested, the FTTx Wipe Lubricant generally shows least attenuation effect.

Why not use non-water based lubricants?

Almost all cable lubricants are water based, but the preceding data shows that water content, especially in a gel form, deteriorates the data signals unless allowed to dry. It might seem logical to use a mineral oil or solvent-based lubricant. However, oils and greases were not developed for lubricating cable. The cable jacket remains in contact with the lubricant residue for the entire cable life, and oil-based compounds are not compatible with the jacket materials.

To test compatibility, six different jacket materials are stripped from cables or obtained in plaque form and soaked for 7 days at 50°C in the same lubricants tested in the first phase. The weight change and tensile and elongation properties are then measured for comparison. When exposed to a solvent-based lubricant and to mineral oil, the jacket material shrinks and its elongation property is drastically reduced. The cable jacket becomes brittle so that it easily cracks and breaks. Testing shows that oils, greases, and solvents are not compatible with these jackets.

Why not use dry lubricants?

The primary purpose of a cable lubricant is friction reduction. While “dry” lubricants may not have an effect on the signal properties of the cable or the physical strength of the jacket, these materials show little or no friction reduction on data cables, as is seen below

Coefficient of friction was measured for the lubricants in this test on six different high-performance data cables. In this test, each data cable is pulled (as a single cable) into an EMT conduit with two 90° bends. For each pull, an initial back tension of eight pounds is put on the cable. The pulling tension is measured and a friction coefficient is calculated. The data below shows the average friction coefficient over the six different cables.

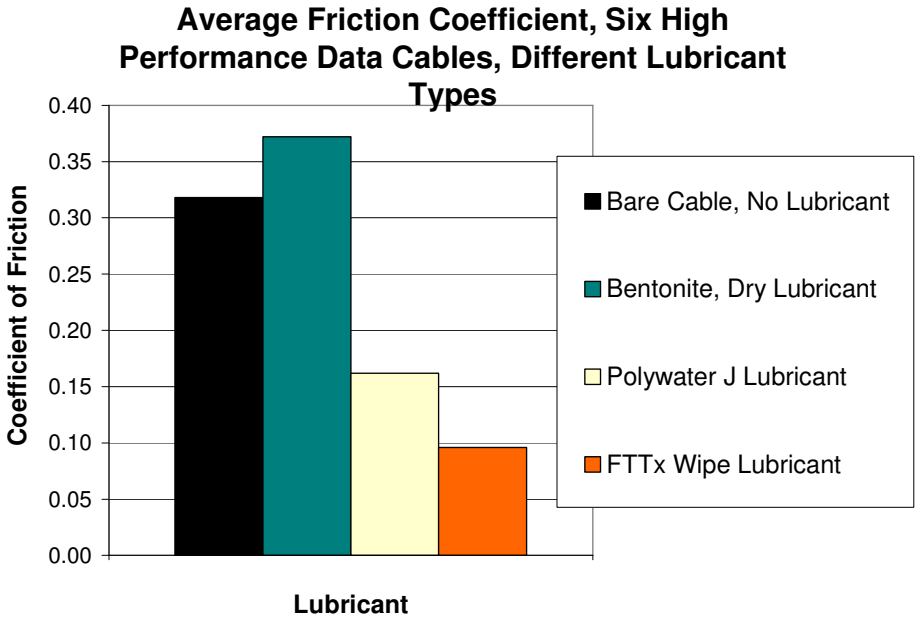


Chart 1: Friction Coefficient Measurements Indicate That Bentonite and Talc Are Not Effective Lubricants.

In the test, the pulling tension without lubricant and with the dry lubricants is above 25 pounds force. Even in a short conduit section with two bends, this tension is above the maximum recommended. *A thin layer from the FTTx Wipe Lubricant lowers the friction coefficient by more than 60%, resulting in dramatic tension reduction during the installation*.

Summary

Cable lubricants must meet both performance and compatibility standards for the cable. A new thin-film lubricant, FTTx Wipe works well on the high-performance data cables, reducing friction using very small quantities. Additionally, the FTTx Wipe Lubricant shows minimal impact on the data-carrying capability of high-performance cables and does not deteriorate the physical strength of the cable jacket material.

If you would like to receive samples or literature on Polywater FTTx Wipe Lubricant or any other American Polywater products, please contact customer service at 1-800-328-9384 or 651-430-2270.

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