American Polywater's

TeleTopics

A NEWSLETTER COVERING TECHNICAL SUBJECTS
OF INTEREST IN TELECOMMUNICATIONS CONSTRUCTION

ROUTE TO:

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Fiber Optic Cable Pulling

What special properties of pulling lubricants allow fiber optic pulls of 5,000-plus feet at tensions less than 600 lbs? How are *unassisted* pulls as long as 10,000 feet possible? How can 20,000-foot, *continuous* installations be made by using mid-assist units to combine long, single-pull lengths? What is the secret to safely pulling fiber such long lengths? How can the length of pull be maximized to save time and money? One key is a lubricant that optimizes three critical properties: viscosity, wetting character, and coefficient of friction. This "TeleTopics" will present some of the research on these important fiber lube properties.

Background

Examination of long, successful fiber pulls shows they have several things in common:

(1) The conduit runs are essentially straight. There are very few bends to add tension.

(2) The conduit is properly placed. That is, there are no "hidden" bends from snaking or winding of the duct. Bends introduced by such snaking can add significantly to the tension in "straight" runs.

(3) Lubrication is optimized. The coefficient of friction between jacket and duct is less than 0.20 and, occasionally, back-calculations from field-measured tensions show coefficients as low as . . . 0.10!

Fiber Cables are Unique

Not all pulling lubricants can produce such low coefficients of friction in fiber installation. A number of unique lubricant requirements have been discovered which are especially important for fiber pulling. To understand why these lubricant properties are important, we must first look at the unique character of fiber cable itself. Fiber cable is lightweight, much lighter than copper conductor cable. Underground multi-fiber cable typically weighs from one-half to two ounces per foot. From a "weight per length" perspective, gravity is not pulling fiber cable against the conduit wall nearly as much force as it pulls heavier copper cable. Thus, the fiber cable isn't squeezing or pressing on the lubricant as hard as copper cable would.

Fiber cable is also unique in the typical length of pull. It "rubs" over a much *longer* distance than copper cable does. There may be as much as ten times more *linear* contact in a fiber pull.

The unique properties needed in a fiber optic pulling lubricant result from these cable characteristics.

When Grease Doesn't "Grease" -- Or Viscosity Can Add Tension

Viscosity is a measure of the "thickness" or "flow ability" of a liquid. For instance, 30-weight oil is more viscous than water, and grease is more viscous than 30-weight oil.

One way to think of viscosity is a measure of the "internal strength" of a liquid or gel. The greater the viscosity, the more force is required to break or shear the liquid internally. It's harder to stir a pail of grease than it is to stir a pail of water; and, it's harder to row a boat on a lake of molasses than on a lake of water. These are viscosity effects.

Imagine the kind of force which might be needed to overcome the internal strength of a lubricant over thousands of feet of fiber cable during a pull. Fieldwork indicates that so much force is required to shear *high viscosity* (thick) lubricants, that they *add* to pulling tension, rather than reduce it!

At one time, this lubricant viscosity effect in fiber pulling was observed indirectly as a "temperature" effect. The viscosity of many oils and greases increases at lower temperature. During evaluation of highly refined petroleum grease for fiber optic pulling, it was found the grease worked fine at 90◦F, but produced unacceptably high tensions at 40◦F. At the time, no one knew why the grease didn't "lubricate" as well at 40◦F--we know now--it was more viscous!! It's important that lubricants have a consistent viscosity over a working temperature range. For instance, POLYWATER® F's viscosity varies by less than 15% from 40◦F to 90◦F.

Thinner is Better Only if it Clings

Does this mean that "water-thin" lubricants are best for fiber pulling? Not necessarily. Extremely "thin" lubricants don't cling to cable well. A few hundred feet into a run and they're completely rubbed off. Very thin, low viscosity lubricants aren't necessarily effective for long pulls. A good fiber optic lubricant is a liquid specially engineered to cling to the cable and stay with it for the long run. In POLYWATER® F, this is seen as a "stringy" property. This liquid lubricant holds to both the cable surface and itself.

Coating and Wetting

Another important property of fiber optic lubricants is called "surface wetting."

To understand "surface wetting", consider what happens when you put water on a newly waxed car. It "beads up" and forms droplets. In much the same way, lubricants can "bead up" on plastic fiber cable jacket. The droplets flow to the bottom of the cable, leaving the top and sides dry. When the lightweight fiber cable rubs on the top and sides of the conduit, which happens in long runs, it is not lubricated!!

POLYWATER® F was the first lubricant specially formulated to wet out on fiber cable jacket. It lubricates on all sides of the cable for the whole run. Some "me-too" competitors have added surfactants to their lubes to try to imitate POLYWATER® F's wetting properties. Unfortunately, such surfactants can cause stress cracking of polyethylene jacket, and some of the "me-too's" show stress-cracking tendencies. POLYWATER® F, on the other hand, does not cause stress cracking of jacket-grade polyethylene.

Drying Effects

In long cable pulls, pulling lubricants are subject to water-loss drying. The lubricant must maintain a low coefficient of friction through this drying. If not, the friction coefficient, and tension, will go up during the pull.

POLYWATER® F maintains a constant friction coefficient during drying. Tests show it pulls with the same tension after sitting for a week in the conduit. Most other lubricants do not, and some show significantly higher tensions as they dry.

All three properties: viscosity, wetting, and friction coefficient during drying, are critical on long fiber optic pulls. These properties are *not* as critical for shorter pulls with heavy cable.

The Long Haul

Good lubricant application procedures are also important to gain the full benefits of the lubricant in fiber pulling.

There are a number of neat ways to lubricate in long pulls. Pumping or pouring lube into the duct and spreading it in front of the cable with the LongShot™ Spreader is one good method. "Lubrication T's" can be placed at regular intervals when the conduit system is installed. These "T's" provide a place to pour in a lubricant *during* the pull. They're both inexpensive and effective.

How are you doing?

The "effectiveness" of a specific pulling operation can be measured by determining the friction coefficients obtained on actual fiber pulls. With field-measured tension and conduit system information, the Pull-Planner™ 2000 Software can calculate the "effective coefficient of friction" for a pull. If the coefficient of friction calculates to 0.2 or less, the operation is doing OK. On the other hand, if the coefficient of friction calculates to 0.3 or more, improvements may be possible to pull *farther* with *lower tension*.

Additional information on fiber optic pulling lubricants, lubricant use methods, and the Pull-Planner™ 2000 Software is available by calling American Polywater's® Customer Service Department toll free at **1-800-328-9384**

Comments, questions, or editorial requests, please contact:

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