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Applications
Engineering Note

Corrosion Resistance of Armored Optical Fiber Cable

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Armored optical fiber cable is often exposed to the most rugged of installation environments. It is expected to stand up to direct burial in rocky terrain, the tenacious jaws of aggressive rodents, and to be able to withstand lightning strikes as well. It is imperative that this armor protects its fiber optic core throughout the cable's life. For this reason, the corrosion resistance of that armor can be an issue of major concern.

Research conducted by the US Department of Agriculture, Rural Utilities Service (RUS), (formerly known as the Rural Electrification Administration) has demonstrated the outstanding resistance of copolymer coated steels to corrosion. Testing was conducted using several armor types and a variety of soil conditions. The armor in each cable had a "ring," consisting of a circumferential cut exposing 1.3 cm (0.5 in) of armor and a "window," consisting of a section of exposed armor 1.3 cm wide by 5.1 cm (2 in) long. Windows simulated installation damage to the cable jacket, while rings simulated rodent attack on the cable jacket. These samples were buried for approximately five years.

The RUS study then evaluated the samples for corrosion and rated them on a scale of zero to ten. A zero rating meant that corrosion had occurred to the extent that the armor was electrically discontinuous, i.e., corroded completely through. A ten rating meant that there was no indication of corrosion. Armor ratings of seven and above indicate that pitting corrosion may have occurred, but there were no perforations in the armor.

Table 1 summarizes a portion of this test data.[1] Of particular interest is the column titled "Under Jacket" because it most adequately represents a properly installed cable. This is because in a properly installed cable, some jacket damage may occur, either due to rodents, or installation conditions. The "Under Jacket" column assesses the ability of the cable to prevent the spread of corrosion from the exposed (damaged) area. In that column, there is little difference between coated steel and stainless steel.

Of course, the ultimate proof of performance is actual field history, and the corrosion performance of coated steel has been excellent. During Corning Optical Communication' twenty plus years of cable field installations, there have been no reported corrosion-related failures of its low-carbon steel tape armored cables. Corning Optical Comminication’ field data contains rare instances where rodents removed the outer sheath and chewed away the plastic coating from the armor. As the RUS testing predicted, minor corrosion in the form of localized pitting occurred only where the plastic coating was removed from the armor. At no time did the corrosion migrate under the plastic coating and away from the initial jacket penetration. No corrosion related cable failures occurred.

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Soil Type	Armor	Window	Ring	Under Jacket	1/2" from Window	1/2" from Ring
Hagerstown Loam	Aluminum	9	9	9	9	9
	Copper	8	8	9	9	9
	Stainless	10	10	10	10	10
	Coated Steel	10	10	10	10	10
Clay Soil	Aluminum	1	0	0	1	0
	Copper	0	8	9	9	9
	Stainless	10	10	10	10	10
	Coated Steel	8	8	10	10	10
Coastal Sand	Aluminum	9	9	9	9	9
	Copper	10	10	10	10	10
	Stainless	10	10	10	10	10
	Coated Steel	8	8	10	10	10

Table 1: REA/NBS Corrosion Test Results[1]

Choosing a cable's armor material is not merely a matter of selecting the most corrosion resistant material. The primary purpose of armor is to provide mechanical protection for the cable. Having added armor to a cable, susceptibility to lightning damage becomes an issue as well. It is unrealistic to discuss any of these important characteristics without acknowledging the trade-offs and interactions that exist between them. A cable must be able to withstand minor rodent and other mechanical damage, while maintaining its corrosion and lightning resistance.

When choosing an armor design, there can be a trade-off in performance between these areas of concern, especially when craft-friendliness is considered. Corning Optical Communication uses a copolymer coated steel tape armor that offers the best combination of rodent and corrosion resistance, while minimizing susceptibility to lightning damage. Additionally, this type of armor offers the best performance in terms of craft-friendliness. Corning Optical Communications' cables are easy to enter with common tools.

Rodents have jaws capable of exerting up to 124 Mpa (18,000 psi) of force[2], so it is safe to say that standard armored cables will not be "rodent-proof." However, Corning Optical Communications' single-armored cable offers excellent rodent resistance, and in areas with a high likelihood of rodent attacks, double-armored cable offers even better performance. Corning Optical Communications' low carbon steel tape offers excellent tensile strength and is more rodent resistant than copper clad stainless steel of the same thickness.[3]

As mentioned above, once armor is applied to a cable, lightning resistance can become a concern. Corning Optical Communications' outdoor cables have been rigorously tested at current levels up to 105 kA, meeting the requirements of "Standard for Fiber Optic Outside Plant Communications Cable," ANSI/ICEA S-87-640-1992. Approximately 95% of all lightning strikes are less than 100 kA.

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Other armor designs have excellent rodent and corrosion resistance; however these factors alone cannot wisely be used in choosing an armor material. For example, some manufacturers use stranded wires in conjunction with tape armors. However, testing has shown that these wires are not capable of handling the currents of a lightning strike, and can heat to the point that they literally slice through the cable jacket(s).[4]

As stated above, a copolymer coated low carbon steel tape is susceptible to corrosion only in areas where the coating is removed. Corrosion migration under the cable jacket is not a concern with this design. In contrast, if a cable containing copper clad stainless steel armor has its outer sheath removed, the copper cladding can corrode away. Since bare stainless steel has a high electrical resistance, about 4 times that of low carbon steel, some augmentation is required to conduct electrical discharges to ground. In an uncorroded cable, copper serves this purpose. However, should lightning strike a cable that has lost its copper layer to corrosion, the higher resistance coupled with the high lightning current can cause intense local heating. The resulting heat can cause heavy cable damage.

Thus, all three corners of the “armor triangle” must be considered when selecting an armor material: mechanical protection, lightning susceptibility, and corrosion resistance. In addition to its low susceptibility to lightning damage and excellent rodent resistance, Corning Optical Communications uses a copolymer coated steel tape armor for its corrosion resistance and excellent mechanical performance. The plastic coating, along with the polyethylene jacket, isolates the armor from external moisture in the event of cable damage, thereby improving corrosion resistance. Copolymer coated steel tape is the armor of choice to provide mechanical protection for your optical fiber cable over its lifetime.

For information on related topics see Corning Optical Communications Applications Notes:

“Lightning and Fiber Optic Cables”

“Rodent Protection for Fiber Optic Cables”

References:

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