Abrasion Resistance and Ease of Installation of the MDPE Jacket material.

Application Note AN-100

OFS utilizes black medium density polyethylene as the primary material for optical fiber cable outer sheaths. Medium density polyethylene (MDPE) provides good processing characteristics combined with toughness, stress crack and deformation resistance.

The primary method of classifying polyethylene plastics is by their relative densities. The standard specification for polyethylene plastics used in molding and extrusion is ASTM D 1248. The ASTM standard identifies four Types. See Table 1. The classifications are according to the density of the base resin without carbon black additives.

Table 1

Type	Nominal Density,[A] g/cm^3	Term
I	0.910 to 0.925	Low
II	0.926 to 0.940	Medium
III	0.941 to 0.959	High
IV	0.960 and higher	High

[A] Uncolored, unfilled material (without carbon black)

OFS employs a medium density jacketing compound specifically developed to meet the need for an improved medium density black sheathing material for fiber optic cable applications. A special requirement for fiber optic cable applications is the need for good performance during temperature cycling. At operational temperature extremes (-40°C and +70°C) , shrinkage stresses imposed by the polyethylene jacket can cause optical signal loss due to a phenomenon known as fiber macrobending. The MDPE compound was developed to provide minimal shrinkage stress, especially at the most critical low temperature conditions.

Fiber optic cables sheathed with MDPE have been proven to be easy to install as well as resistant to abrasion. The two most significant properties that dictate how easily a cable is to install in a duct system are coefficient of friction and cable flexibility. Abrasion resistance is related to polyethylene density.

When coefficient of friction measurements are performed in a laboratory on an inclined plane test apparatus, higher density polyethylene exhibits a lower coefficient of friction than MDPE due to differences in density. When installing cable in the field, coefficient of friction differences are secondary in comparison to the geometry of the cable pull, the duct system construction and the installation procedures applied. The geometry of the pull is the single most important variable in how easily a cable is installed in a duct system. The number and severity of bends, the changes in elevation, and the length of the run greatly impact ease of installation. Also of significance are the duct system construction and the installation procedures followed by the craftsmen. For example, a plowed-in rigid duct will allow for an easier pull than a trenched-in flexible duct. If a pulling lubricant is applied to the cable during the pull, polyethylene sheathed cables install much more easily. The addition of pulling lubricants practically eliminates the coefficient of friction differences between different density polyethylenes. The geometry of the pull, the duct system construction, and the installation procedures utilized are much more significant than differences in sheath coefficients of friction when installing cables in actual field applications.

Cable flexibility also dictates the ease in which a cable is installed. The flexibility of polyethylene is related to it's modulus. A low modulus compound will be less stiff and more flexible, especially at low temperatures. MDPE possesses a lower modulus than higher density polyethylene. When comparing two cables of like design, an MDPE sheathed cable would be easier to install than a cable sheathed with a higher density polyethylene. In practice, cable designs are not identical. The design and construction of the cable plays a significant role in determining overall cable flexibility and related ease of installation and handling in field applications.

The characteristic of abrasion resistance is related to polyethylene density. In the absence of a recognized industry standard, the Union Carbide Corporation developed an internal procedure to measure the relative differences in abrasion resistance between polyethylenes. The Union Carbide test procedure utilizes a Taber Abraser apparatus which abrades the material sample after a preconditioning phase. The material loss is weighed after 100 abrading cycles. Typically, there is only a 3 mg difference in abrasion resistance between medium and high density polyethylenes (higher density is slightly more resistant). This difference is small compared to the 9 mg difference between low and high density polyethylenes. Cables are designed to compensate for potential abrasion as could be encountered in the field. The cable sheath wall thicknesses are such that field abrasion will not damage the cable core, effect cable performance, or reduce cable lifetime.

In summary, MDPE sheathed cables install as well as cables sheathed with higher density polyethylenes in actual field installations. Slight coefficient of friction differences are insignificant compared to pull geometry, duct system construction and installation procedures, especially when lubricants are used. MDPE is more flexible, especially at low temperatures, which enhances ease of cable installation (the design of the cable is also a primary determinant of cable flexibility). Regarding abrasion resistance, the difference between medium and higher density polyethylenes is small and cable designs compensate for abrasion by incorporating sheaths thick enough to protect the cable core from damage. OFS MDPE sheathed optical fiber cables are among the toughest, most abrasion resistant, and easy to install cables available.