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Applications Engineering Note

Corning Cable Systems Outdoor Cable Jacket Material – Medium Density Polyethylene

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In the selection of a material for an outdoor cable jacket, a manufacturer must choose a material that optimizes critical performance characteristics. The characteristics considered crucial for an optical fiber cable jacket are: ruggedness, tensile strength, heat and chemical resistance, flexibility, stress crack resistance, shrinkage, toughness, and long term environmental stability. For ruggedness, flexibility, stress crack resistance, shrinkage, and toughness, a low-density polyethylene (LDPE) would be the material of choice. High-density polyethylene (HDPE) would provide better performance for tensile strength, heat and chemical resistance. The use of additives compounded into the polyethylene resin, such as antioxidants and carbon black, best provide the material stability and long-term jacket material integrity demanded in outdoor environmental conditions. Corning Cable Systems chose a medium density polyethylene (MDPE) with additives as the standard jacket material for the loose tube cable products because this material offers the best combination of all these crucial characteristics, thereby yielding the best overall performance properties. Please see **Table 1** for a comparison of these jacket material properties.

TABLE 1

Properties	LDPE	MDPE	HDPE
Minimum Tensile Strength (MPa)	12.4	18.6	19.3
Jacket Toughness (GPa)	26	22	16
Minimum Elongation (%)	500	500	400
Brittleness (@ -76° C) (failures/sample)	2/10	0/10	2/10
Environmental Stress Crack Resistance (failures/sample)	0/10	0/10	0/10
Density (with additives) (g/cc)	0.920-0.940	0.940-0.955	0.953-0.973

The minimum tensile strength of a jacket material is the tensile load required to cause breakage of a test specimen with a known cross section area. Jacket toughness is a function of the ultimate tensile strength and elongation of a jacket material. Elongation specifies the increase in length of a jacket material before this material breaks under load. Brittleness testing determines the specific temperatures at which cable materials exhibit brittle failure under specified impact conditions. Environmental stress crack resistance of polyethylene jacket materials involves the use of strong detergents to determine the susceptibility of a material to cracking under continuous bending stresses. Density is the material's weight per unit volume, and is a measure of the polyethylene crystallinity and fill additives used in the polyethylene resin.

The placement of cables in ducts makes the coefficient of friction of the jacket material another important performance characteristic. MDPE and HDPE exhibit very similar coefficients of friction to the point where major manufacturers of cable lubricants often list a coefficient of friction value for only one of these materials and apply it to both in pulling tension calculations.

In the harsh, outdoor environment, light, heat, and moisture combine to cause mechanical and chemical changes in materials. The first line of protection of any optical fiber cable is the cable outer jacket. Corning Cable Systems has chosen MDPE as a cable jacket material because it blends all the advantageous properties of low and high-density polyethylene. Corning Cable Systems' MDPE conforms to the requirements of ASTM D1248, Type II, Class C, Category 4, Grade J4. Given the material properties above, Corning Cable Systems' MDPE outer jackets provide the following performance characteristics:

1) Increased resistance to environmental stress cracking and weathering.

2) Decreased jacket shrinkback due to low post extrusion crystallinity.

3) Increased jacket flexibility and durability due to low brittleness effects and higher toughness and elongation values.

4) Low coefficient of friction.

5) Increased ultraviolet (UV) and environmental stabilization of material due to compounding of carbon black and antioxidants into the base resin.

REFERENCES

1) United States Department of Agriculture, Rural Utilities Service, 7 CFR 1755.900, (formerly REA PE-90).

2) *Modern Plastics Encyclopedia*, Mid-October 1991, Volume 68, Number 11.

3) ICEA Standard for Optical Fiber Outside Plant Communications Cable, ANSI/ICEA S-87-640-XXXX.

Summary

Polyethylenes are a semicrystalline, lightweight class of thermoplastic polyolefins. They are produced by polymerizing ethylene gas (C_2H_4) in the presence of a catalyst under controlled temperature and pressure conditions. By varying the temperature, pressure, and catalysts, different types of polyethylene can be manufactured. The different polyethylene resins are normally classified according to melt index (MI) and density. Each of these parameters has an impact on the characteristics of the base resin. The MI is the measure of molten polymer at a fixed temperature and pressure, and relates to the molecular weight of the resin. Density is a measure of the crystallinity and fill additives used in the polyethylene resin.

Polyethylenes developed for optical fiber and conventional metallic conductor cable jacketing applications contain additives that are compounded into the base resin to impart high temperature stability, ultraviolet light stability and surface friction regulation. These additives include antioxidants and ultraviolet (UV) stabilizers such as carbon black. The antioxidant acts as a stabilizer to protect the resin from deteriorating from the first time it is compounded through the various melting processes and during long-term outdoor exposure. Outdoor integrity is also maintained through the use of carbon black as an additive. Carbon black limits the UV radiation exposure of the polyethylene resin and cable components, thereby protecting these materials from deterioration due to sunlight.