POLYMER PROCESSING TERMINOLOGY

HYDROCARBONS

Hydrocarbons contain only two elements: carbon and hydrogen. Hydrocarbons can be divided into four groups: alkanes, alkenes, alkynes and aromatic hydrocarbons. The alkanes consist of carbon atoms bonded either to hydrogen or to other carbon atoms by four single bonds. The alkenes are hydrocarbons with one or more carbon-carbon double bonds. The alkynes have at least one carbon-carbon triple bond. The aromatic hydrocarbon atoms are connected in a planar ring structure.

WHAT IS ETHYLENE?

Ethylene is the simplest alkene. It is also known as ethene and has the chemical formula C_2H_4. The ethylene molecule is a colorless, odorless, flammable gas. Synthetic organic materials are made by chemically connecting long chains of carbon molecules together. The fundamental link or single molecule in the chain that is repeated is called a "mer". The process of attaching these monomers together is called polymerization and the completed chain is referred to as a polymer.

The polymer polyethylene is formed by persuading one of the electrons in the carbon double bond to transfer over and attach to an adjacent monomer of ethylene.

POLYETHYLENE

There are three types of polyethylene, low-density polyethylene (LDPE), medium-density polyethylene (MDPE) and high-density polyethylene (HDPE). Low-density polyethylene use to be produced under conditions of high temperature and pressure (500° C and 20,000 psi) which required special equipment and the reaction usually run behind a concrete barrier. Thanks to catalysts the conditions of manufacturing have been reduced to more reasonable and safer levels. Low-density polyethylene has good toughness and pliability. It has outstanding electrical properties and it is resistant to acids and bases. Polyethylene is used for films, drapes, table cloths, squeeze bottles, and coatings for foil. High-density polyethylene has high crystallinity and high melting temperature. It is used in bottles, housewares, toys, pipes, and wire and cable insulation. Polyethylene has a high molecular weight that accounts for its useful properties. Polyethylene is a thermoplast so it can be recycled and molded into other shapes.

LOW DENSITY POLYETHYLENE (LDPE)

The first of the polyolefins originally prepared some fifty years ago by the high pressure polymerization of ethylene. Its comparatively low density arises from the presence of a small amount of branching in the chain (on about 2% of the carbon atoms). This gives a more open structure. LDPE is a most useful and widely used plastic. It is translucent to opaque, robust enough to be virtually unbreakable and at the same time quite flexible. Chemically LDPE is unreactive at room temperature although it is slowly attacked by strong oxidizing agents and some solvents will cause softening or swelling. Polyethylene will not separate in water which is why it is used in a wide variety of food packaging, water bottles, etc. It may be used at temperatures up to 95° C. for short periods and at 80° C continuously. LDPE is ideally suited for a wide range of laboratory apparatus including washbottles, pipette washing equipment and tanks.

HIGH DENSITY POLYETHYLENE (HDPE)

A linear polymer prepared from ethylene by a catalytic process. The absence of branching results in a more closely packed structure with a higher density and somewhat higher chemical resistance than LDPE. It is also somewhat harder and more opaque and it can withstand rather higher temperatures (120 Deg. C for short periods, 110 Deg. C continuously). It lends itself particularly well to blow moulding; e.g. for bottles and containers.

RECYCLING

Nowadays, new methods of recycling are constantly being sought in industry so that used plastic products can be re-integrated into the energy cycle with maximum environmental compatibility. Basically, two different types of recycling are known in the PE sector at present:

Material recycling, in which the used PE is collected and then processed into new regranulate, which is used to manufacture PE products. Polyethylene is collected and sorted into categories and pressed into spherical shapes. In a regeneration plant, these are processed into a valuable raw material.

Thermal recycling, which is based on recycling the energy contained in the plastic waste. At the end of a product cycle, the energy from the crude oil which is contained in the polyethylene is used to save valuable raw materials such as coal, gas or mineral oil in cement kilns and refuse incineration plants. Thermal recycling does not require the products to be sorted strictly into categories, nor do they need to be as clean as for material recycling. Plastic waste which is "contaminated" with adhesive labels and residues of oil or food can be thermally recycled without any problems. The ton of oil that was once used to manufacture the PE products is virtually used a second time over to manufacture cement or to generate long-distance heat.

To make it easier to identify various plastics, the international symbol for recyclable plastics has been created. For this purpose, PE is divided into two different categories: "HD=High Density" and "LD=Low Density". However, these terms only define the length of the connected molecule chains: although this does have a direct influence on the characteristics of the material, it has no effects whatsoever on their ability to be recycled. So when you see the symbols "PE-LD" and "PE-HD" on our packaging items, you can be sure that you have an environmentally friendly PE product in your hands.

In addition, industry has developed an easily recognizable logo that is intended to simplify the identification of PE products for non-experts.

COMPARISON OF OPTICAL FIBER CABLE JACKETING MATERIALS

Since its development, polyethylene has been the industry choice for both the optical fiber and copper cable outer jacket material. Polyethylene has many demonstrated benefits, including toughness to protect the cable during handling and installation resistance to aging and the environment chemical resistance

There are typically three polyethylene grades used in cabling. These are medium density (MDPE) and high density (HDPE), used in optical cables, and linear low density (LLDPE), used predominately in copper cables. As their names indicate, the major difference between these grades are the density (measured in grams per cubic centimeter) of the materials.

Both the medium density and high-density polyethylene are high quality materials which have proved to be excellent choices for optical cable jacketing. Both provide the stability and ruggedness required for cables with long lifetime expectancy.

The selection of which jacketing material should be used in a cable design is not based solely on the performance parameters of the material. The material selected must best support all the needs of the cable design, such that all the cable performance requirements are met.

With this in mind, Alcatel has standardized on the MDPE material as a superior material for jacketing optical fiber cable. MDPE provides all the necessary protection and stability required in optical cable designs, and avoids some of the drawbacks that can occur with HDPE. A rationale of the differences between the materials is shown below.

Less tendency to shrink-back in cold temperature

LDPE and MDPE have lower density and lower crystallinity than HDPE. Because of this, cable jackets made of MDPE show less tendency to "shrink-back" or pull back from the cable core in low temperatures. Shrink-back occurs due to the orientation of the plastic molecules frozen into the cable jacket during manufacturing. Subsequent exposure to high and low temperatures can change this orientation and thus allow the jacket material to move.

Although cable design and good processing can reduce this short-coming, LDPE and MDPE show less tendency than HDPE to experience this change in orientation with temperature.

Jacket shrink-back can result in the jacket pulling out of a splice closure and exposing the splice point to moisture. As well, shrink-back can, in extreme cases, reduce the cable's thermal contraction window and create strain between the cable components, causing fiber attenuation increases.

Less tendency for jacket stress cracking

The lower crystallinity of LDPE and MDPE also means that the jacket can be less susceptible to stress cracking when exposed to extreme environmental conditions. Stress cracking over time reduces the life span of an installed cable.

More accessible at room and cold temperatures

LDPE and MDPE have a lower modulus across all temperatures, making the cable jacket easier to access than a HDPE jacket of the same size. This is especially true in low temperatures, where the difference in hardness of the two materials is more extreme. Removing a harder jacket may require more force, which may potentially damage the cable.

More flexibility

The lower modulus of the LDPE and MDPE ensures that the cable jacket is less stiff and more flexible. This benefit is even more significant at cold temperatures. Flexible cables are less susceptible to damage during the installation process, where bending and winding forces are exerted on the cable.

Excellent chemical resistance

Polyethylenes are highly resistive to chemical intrusion. LDPE and MDPE shows excellent resistance to the chemicals commonly found in the placement of cables. Because of its higher density, HDPE is slightly more resistant than both MDPE and LLDPE. However, the higher resistance of HDPE over LDPE and MDPE is of benefit only in exaggerated levels of chemical exposure. In fact, LLDPE is the least chemically resistant of the three materials, but has been used extensively in the copper cable industry as the outer jacket material, with no reported problems.

Friction during installation

LDPE, MDPE and HDPE have low coefficients of friction (COF), which measures the frictional resistance to pulling force. MDPE has a slightly higher coefficient than HDPE, which means that in perfectly equal conditions, it does create slightly more frictional resistance than HDPE.

However, ease of cable pulling is significantly more dependent on factors other than the jacket COF. In particular, the size and weight of the cable, the stiffness of the cable and the type and amount of lubricant used all impact the ease of the cable installation more than the jacket material. In fact, the LLDPE used in copper cables has the highest COF of the three materials, but is not significantly harder to install based on the jacketing material alone.

In summary, Alcatel believes that MDPE is an excellent jacketing material for fiber optic cables. MDPE allows Alcatel to manufacture cables meeting and exceeding all industry requirements, while avoiding some of the potential problems that can occur with other materials. It is the material used by most of the major fiber optic cable manufacturers, both in the U.S. and abroad.

DEFINITIONS

BDM - Biodegradable materials.

Chemical recycling - Recycling of raw materials: used plastics are reconverted into "synthetic crude oil" or other basic petrochemical materials. In turn, new plastics can be manufactured from these new raw materials.

Duroplastics - Hardened plastics which only undergo minimal changes when the temperature varies (polyurethane, epoxy resin).

Elastomers - Dimensionally stable plastics which nevertheless have high elastic deformability.

Extrude - (Latin: extrudere=to draw out) In a heated cylinder, there is a rotating screw which conveys the moulding material forwards, compresses, plastifies (melts) and homogenises it (homogeneous=uniform). A die is positioned in front of the screw cylinder. This changes the emerging plastic material into the desired form: for example, films (blown film extrusion), profiles, regranulates or tubes.

ISO 14001 - The internationally recognised standard for environmental management systems. The system describes and regulates the path towards the continuous improvement of environmental protection in industry. The standard for Petroplast.

ISO 9001 - The internationally recognised standard for quality management. The standard for Petroplast.

Material recycling - Recycling of substances or materials, downcycling: melting down used plastics to obtain granulate that can be re-utilised. In this way, products with useful technical characteristics can be made from recycled lastics.

Monomers - Small molecules which are usually highly reactive; they can combine to form polymers.

Plastics - Materials consisting of very large and very long molecules. They are created as a result of the chemical conversion of natural products such as crude oil, and they can also be created by fully synthetic means. Their characteristics are primarily based on their structure, and only secondarily on their chemical composition.

Polyethylene - A polymer produced from ethylene. There is a difference between high density polyethylene and low density polyethylene. An important and versatile plastic with many applications.

Polymers - Substances which are obtained from monomers by means of polymerisation.

Polymerisation - A chemical reaction which leads to very large molecules being built up.

Polyvinyl chloride - PVC, produced by polymerizing vinyl chloride. PVC is an important thermoplastic material.

Pyrolysis - Thermal decomposition (cracking) of chemical substances, such as crude oil.

Recycling - Reutilization of products by means of material recycling, chemical recycling or thermal recycling.

Styrene - An unsaturated aromatic hydrocarbon which occurs in coal tar and many foodstuffs. Styrene is also obtained during the pyrolysis of crude oil.

Thermal recycling - Energy recycling. Plastics which cannot be reutilized as materials can be used thermally. One kilogram of plastic contains the same amount of energy as one kilogram of heating oil. Thermal recycling can be used in industrial operations to replace coal or heating oil, and it can also take place in refuse incineration plants.

Thermoplastics - Thermoplastic materials flow when they are heated, and solidify when they cool down (polyethylene, PVC, etc.) For additional information about plastics properties and typical plastics products check out the link to http://www.endura.com/tpguide.htm