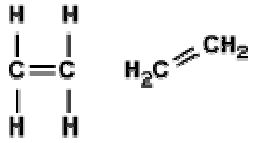
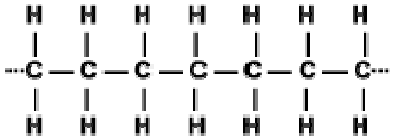
WHAT IS POLYETHYLENE?

Polyethylene is comprised of long chains of the building block ethylene monomer. Ethylene monomer looks like this:



By the way, there is no correlation between polyethylene plastic and crude oil. The feedstocks are either natural gas or the naptha section of crude oil. Gasoline and motor oils cannot be made from naptha, or "higher alpha olefins". Polyethylene looks like this:



Variations in how these chains are put together determine the wide variety of resin properties. The fancy name for this is molecular weight distribution. The two main properties which determine a resins's personality are density and melt index. Specific gravity, or density expressed in grams per cubic centimeter (gm/cc) influences the properties the most. *Melt index* (MI) measures viscosity by weighing the amount of plastic resin which extrudes from a cylinder with a hole in the bottom at 300 degrees for 10 minutes. The test method is ASTM D1238. The number of grams is the melt index. A *fractional melt* has less than a gram, hence the name fractional, or less than 1 gram. It's common sense that resins with high viscosity (resistance to flow) are inherently strong. In film applications, fractional melt is suitable for shipping sacks and shrink film. There is a trade off between melt index and clarity. The higher the melt index, the clearer the resin.

Physical properties

Polyethylene is a thermoplastic polymer consisting of long hydrocarbon chains. Depending on the crystallinity and molecular weight, amelting point and glass

transition may or may not be observable. The temperature at which these occur varies strongly with the type of polyethylene. For common commercial grades of medium- and high-density polyethylene the melting point is typically in the range 120 to 130 °C (248 to 266 °F). The melting point for average, commercial, low-density polyethylene is typically 105 to 115 °C (221 to 239 °F).

Chemical properties

Most LDPE, MDPE and HDPE grades have excellent chemical resistance, meaning that it is not attacked by strong acids or strong bases. It is also resistant to gentle oxidants and reducing agents. Polyethylene burns slowly with a blue flame having a yellow tip and gives off an odour of paraffin. The material continues burning on removal of the flame source and produces a drip. Crystalline samples do not dissolve at room temperature. Polyethylene (other than cross-linked polyethylene) usually can be dissolved at elevated temperatures in aromatic hydrocarbons such as toluene or xylene, or in chlorinated solvents such as trichloroethane ortrichlorobenzene.

Process

Ethylene (ethene).

The ingredientor monomer is ethylene (IUPAC name ethene), a gaseous hydrocarbon with the formula C_2H_4, which can be viewed as a pair ofmethylene groups ($=CH_2$) connected to each other. Because the catalysts are highly reactive, the ethylene must be of high purity. Typical specifications are <5 ppm for water, oxygen, as well as other alkenes. Acceptable contaminants include N_2, ethane (common precursor to ethylene), and methane. Ethylene is usually produced from petrochemical sources, but also is generated by dehydration of ethanol.

Polymerisation

Ethylene is a rather stable molecule that polymerizes only upon contact with catalysts. The conversion is highly exothermic, that is the process releases a lot of heat. Coordination polymerization is the most pervasive technology, which means that metal chlorides or metal oxides are used. The most common catalysts consist of titanium(III) chloride, the so-called Ziegler-Natta catalysts. Another common catalyst is the Phillips catalyst, prepared by depositing chromium(VI) oxide on

silica. Ethylene can be produced through radical polymerization, but this route is only limited utility and typically requires high pressure apparatus.

Classification

Polyethylene is classified into several different categories based mostly on its density and branching. Its mechanical properties depend significantly on variables such as the extent and type of branching, the crystal structure and the molecular weight. With regard to sold volumes, the most important polyethylene grades are HDPE, LLDPE and LDPE.

- Ultra-high-molecular-weight polyethylene (UHMWPE)
- Ultra-low-molecular-weight polyethylene (ULMWPE or PE-WAX)
- High-molecular-weight polyethylene (HMWPE)
- High-density polyethylene (HDPE**)**
- High-density cross-linked polyethylene (HDXLPE)
- Cross-linked polyethylene (PEX or XLPE)
- Medium-density polyethylene (MDPE)
- Linear low-density polyethylene (LLDPE)
- Low-density polyethylene (LDPE)
- Very-low-density polyethylene (VLDPE)
- Chlorinated polyethylene (CPE).

  High-density polyethylene (HDPE)HDPE is defined by a density of greater or equal to 0.941 g/cm^3. HDPE has a low degree of branching and thus low intermolecular forces and tensile strength. HDPE can be produced by chromium/silica catalysts, Ziegler-Natta catalysts or metallocene catalysts. The lack of branching is ensured by an appropriate choice of catalyst (for example, chromium catalysts or Ziegler-Natta catalysts) and reaction conditions. HDPE is used in products and packaging such as milk jugs, detergent bottles, butter tubs, garbage containers and water pipes. One third of all toys are manufactured from HDPE. In 2007 the global HDPE consumption reached a volume of more than 30 million tons.