Technical Note

GSE Polyethylene Geomembranes

Polyethylene has proved to be the most popular geomembrane lining material. This popularity is due to polyethylene's high UV and chemical resistance in addition to its flexibility. Through developments in resin technology, today's polyethylene geomembranes exhibit outstanding resistance to stress cracking and thermal aging.

Crude oil is the primary source for a wide range of intermediate organic products including gases and liquid mixtures. One of the products obtained from the refinement of crude oil is ethylene. The ethylene molecule is two carbon atoms bonded with a double bond and two hydrogen atoms attached to each carbon.

Ethylene molecules are able to participate in a chemical reaction called "polymerization". Polymerization is the process by which small molecules are combined to form large molecules called polymers. The polymerization of ethylene molecules occurs in a stepwise fashion. First, two ethylene molecules are bonded together, then another is added and so on until the reaction terminates. In this way, long molecules that fold, bend and intermingle are formed.

The reaction occurs in large reactors that can be pressurized and heated. A catalyst is typically required and a comonomer is often employed. Selection of pressure, temperature, catalyst and comonomer determine the particular grade of polyethylene that is produced. Pressure and elevated temperatures force the gaseous ethylene molecules together in close proximity. A comonomer can be used to further control the molecular structure of the finished product. A comonomer is commonly added in small amounts during polymerization to control or alter the molecular structure, in particular the branching, and performance of the polymer. With the great number of variations and combinations, there can be a great number of unique types of polyethylene materials.

The finished product is characterized primarily by: molecular weight, molecular weight distribution and degree of branching. Molecular weight is a quantitative measure of a single molecule's mass. Polymerization reactions do not result in molecules that all demonstrate the same molecular weight. As a result, the finished product contains a range of molecular weights; that is quantified by the molecular weight distribution. Since the molecules exist as discrete chains, the way those chains are ordered is important. The degree of crystallinity is closely related to density and has an effect on the material's stress crack resistance. Variations of these polymer characteristics may have a significant effect on both the processing characteristics and the life expectancy of the finished product.

There are two primary types of extrusion processes used to manufacture polyethylene into sheet goods, those with a round die and those with a flat die. Each method requires the polyethylene resin used to exhibit some range of properties. The world's polyethylene geomembrane manufacturers are charged with the responsibility of bridging the gap between resin processing characteristics and long term survivability as a containment liner.

Considerations for environmental projects include resistance to chemical, UV and thermal degradation. Polyethylene's stress crack resistance is not always a concern to resin suppliers since they supply so many different markets. This is in strong contrast to the environmental market where long term performance is of the utmost importance. As a result, polyethylene geomembrane manufacturers must work closely with their resin supplier(s) to achieve the longest lifespan of the material. Since the finished product is only as good as the raw material, special relationships between the resin supplier and the geomembrane manufacturer must be established and maintained.

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