PROPERTIES AND USES.

Properties:

A] Processing properties:

Flow properties may be the most important properties of polystyrene processes. There are two widely accepted industry methods for the measurement of processing properties. These include the melt flow index and the solution viscosity.

The melt flow index is measured by ASTM method as a measure of the melt viscosity at 200^0 C and a 5kg load. The melt flow index of polystyrene is generally controlled by adjustment of the molecular weight of the material and by the addition of such lubricants as mineral oil. Polystyrenes are commercially produced with melt flow ranges of less than 1 to greater than 50, although the most widely available grades generally have melt flows between 2.0 and 20g per 10min.

Solution viscosity is another method for measuring the molecular structure of the polystyrene. Solution viscosity can be measured as an 8% solution in toluene and increases with increasing molecular weight.

B] Rheological properties:

Polystyrene is a non-Newtonian fluid with viscoelastic properties. The viscosity of polystyrene melts or solutions is defined as he ratio of shear stress to shear rate. Generally, as the molecular weight of the polymer is increased or mineral oil is decreased, melt viscosity increases.

C] Mechanical properties:

Crystal polystyrenes have very low impact strengths of less than 0.5ft-lb. Commercially available impact polystyrene grades can be obtained with values of 1.0 - 4.0 ft-lb. Generally, polystyrenes are not produced with greater than 15% total rubber because of polymerization processing constraints. Nevertheless, impact properties can be increased substantially without additional rubber by the proper control of rubber particle size, percentage of grafting, cross-linking, and percentage of gel.

Tensile and flexural properties are also important representation of the strength of polystyrenes. Increasing the rubber modification of polystyrene generally leads to lower

tensile strength, crystal grades being stiff and brittle. Tensile strength is also decreased by the addition of lubricants, such as mineral oil. Flexural strengths for polystyrenes can be obtained from 5000 to 18000psi and are also decreased by the addition of rubber and other additives to the polystyrene. Elongations can be obtained from 1% for crystal polystyrene to 100% for some impact polystyrene grades.

D] Thermal properties:

Annealed heat distortion is one popular method for measuring he resistance to deformation under heat for polystyrenes. The heat distortion temperature is decreased by the addition of rubber, mineral oil, or other additives to polystyrene.

The glass transition temperature for unmodified polystyrene is 373 K, and the glass transition temperatures for polybutadienes are 161-205 K, subject to the cis, trans, and vinyl content.

E] Chemical properties:

Solvent crazing of polystyrene is a commercially important phenomenon. High impact polystyrenes are susceptible to solvent crazing at the interface between the rubber particles and the polystyrene phase. The resistance of polystyrene to this crazing is referred to as environmental stress crack resistance (ESCR). For food-packaging applications, such as butter tubs and deli containers, polystyrenes with high ESCR properties are desirable. Increasing the percentage of gel, percentage grafting, and rubber particle size can increase stress crack resistance.

Residual levels of low molecular weight materials are also important to polystyrene performance. Some of the chemical impurities in the polystyrene are styrene monomer and ethyl benzene solvent. Residual levels of styrene below 200 ppm and ethyl benzene levels below 30 ppm are obtainable for very specialized applications.

F] Optical properties:

Crystal polystyrene is a transparent and colorless polymer; high impact polystyrene is generally opaque as a result of the rubber particles. Developmental grades of translucent impact polystyrenes have been produced but have not gained wide acceptance. The major optical; property for high impact polystyrene is gloss. Gloss is a

measure of the percentage of light reflected is generally controlled by the size of the rubber particle. In general, the smaller rubber particle gives higher gloss. Values from 20 to 95% reflectance are commercially available.

High impact polystyrene is naturally white and crystal polystyrene is naturally clear, but both can be readily colored.

G] Gas and water permeability of polystyrene:

When styrene polymers are used in packaging applications, the gas and water permeability characteristics take on an important aspect. Polystyrene itself has its limitations and in consequence is often used with other polymers so as to achieve different permeability properties. These properties can change dramatically as other monomers are introduced into the molecule.

H] Weatherability and ageing:

Polystyrene and the copolymers are susceptible to degradation by the action of sunlight; the main effect being due to UV radiation in the wavelength band of 300-400nm. the action of the UV radiation is accompanied by the oxidation so that the overall degradation reaction is one of photo oxidation. The extent of degradation varies from location to location owing to the differences in the intensity of the radiation. This is of considerable importance in many applications because the degradation is reflected, in the case of transparent compositions, in a yellowing effect and generally in a loss of mechanical properties such as a lower elongation at break and a reduced impact strength.

I] Toxicity:

Polystyrene is a low toxic product. The FDA for the food contact applications approves almost all commercially available polystyrenes. The polymer itself is not digestible and is not normally biodegradable.

Typical properties of the general-purpose polystyrene:

Mechanical property	Units	General purpose polystyrene
Tensile strength	MN/m^2	34.5-48.3
Elongation at break	%	20-30

Modulus in tension	MN/m^2	2700-3450
Impact strength	J/m	37-59
Flexural strength	MN/m^2	48.3-75.8
Deflection	in	0.15-0.35
Hardness	Rockwell scale	M45-M60

Electrical and allied property	**Units**	**GPPS**
Dielectric strength	V/mil	500-700
Volume resistivity	Ω-cm	10^{17}-10^{19}
Dielectric constant	cps	2.45-2.65
Power factor of dissipation	cps	10-30*10^{-8}
Arc resistance	S	60-135
Heat distortion	^0F	170-180
Water absorption	(in 24 hrs),%	0.03-0.04

Uses:

1. 1.Extruded foam sheet of polystyrene can be thermoformed into such parts as egg cartons or carryout food containers. Foam grade polystyrene is generally a high-heat crystal polystyrene with a high molecular weight.

2. Another type of polystyrene foam is that produced from expandable polystyrene beads. These beads can be molded to produce hot drink cups, ice chests, or foam packaging. Also, the expandable beads can be molded in very large blocks that can then be cut into sheets for thermal insulation. Densities of as low as $1lb/ft^3$ on foamed products are commercially obtainable.

3. Extruded crystal polystyrene sheet can be biaxially oriented by mechanically pulling the extruded melt in multiple directions. The stretched sheets is then cooled and allowed to set with the biaxially orientation frozen into the sheet. This process produces crystal polystyrene sheet of thin gauge wit very high strength.

Typical applications include envelope windows, cap layers for glossy sheet, or thermoforming into food packaging applications.

4. Optical property of polystyrene is used in manufacture of unbreakable glasses for gauges, windows and lenses, as well as in countless specialties and novelties and also for edge lighting for the edge lighting of indicators and dials

5. Solid or liquid pigments and dies color high impact and crystal polystyrenes. This can be accomplished in both extrusion and injection molding processes. These colorants are added and mixed during the melting stage of both the processes. Also, polystyrene parts are amenable to high quality printing. Labels can be printed directly on the polystyrene part to produce attractive containers.

6. Polystyrenes are also used in furniture, packaging, appliances, automobiles, construction, radios, televisions, toys, house ware items, and luggage.