19CH201 ENGINEERING CHEMISTRY FOR CIRCUIT BRANCHES

UNIT-4 HIGH POLYMERS

PROPERTIES AND CLASSIFICATIONS

Plastics are usually classified by: the chemical structure of the polymer's backbone and side chains; some important groups in these classifications are: the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics.

Plastics can also be classified by: the chemical process used in their synthesis, such as: condensation, polyaddition, and cross-linking.

Plastics can also be classified by: their various physical properties, such as: hardness, density, tensile strength, resistance to heat and glass transition temperature, and by their chemical properties, such as the organic chemistry of the polymer and its resistance and reaction to various chemical products and processes, such as: organic solvents, oxidation, and ionizing radiation. In particular, most plastics will melt upon heating to a few hundred degrees celsius.

Other classifications are based on qualities that are relevant for manufacturing or product design. Examples of such qualities and classes are: thermoplastics and thermosets, conductive polymers, biodegradable plastics and engineering plastics and other plastics with particular structures, such as elastomers.

Thermoplastics and thermosetting polymers

The plastic handle of a spatula that has been deformed by heat.

One important classification of plastics is by the permanence or impermanence of their form, or whether they are: thermoplastics or thermosetting polymers. Thermoplastics are the plastics that, when heated, do not undergo chemical change in their composition and so can be molded again and again. Examples include: polyethylene (PE), polypropylene (PP), polystyrene (PS) and

polyvinyl chloride (PVC). Common thermoplastics range from 20,000 to 500,000 amu, while thermosets are assumed to have infinite molecular weight.

Thermosets, or thermosetting polymers, can melt and take shape only once: after they have solidified, they stay solid. In the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is an example of a thermosetting process: before heating with sulfur, the polyisoprene is a tacky, slightly runny material; after vulcanization, the product is rigid and non-tacky.

Amorphous plastics and crystalline plastics

Many plastics are completely amorphous, such as: all thermosets; polystyrene and its copolymers; and polymethyl methacrylate.

However, some plastics are partially crystalline and partially amorphous in molecular structure, giving them both a melting point, the temperature at which the attractive intermolecular forces are overcome, and also one or more glass transitions, the temperatures above which the extent of localized molecular flexibility is substantially increased. These so-called semi-crystalline plastics include: polyethylene, polypropylene, polyvinyl chloride, polyamides (nylons), polyesters and some polyurethanes.

Conductive polymers

Intrinsically Conducting Polymers (ICP) are organic polymers that conduct electricity. While plastics can be made electrically conductive, with a conductivity of up to 80 kS/cm in stretch-oriented polyacetylene they are still no match for most metals like copper which have a conductivity of several hundred kS/cm. Nevertheless, this is a developing field.

Biodegradable plastics and bioplastics

Biodegradable plastics are plastics that degrade, or break down, upon exposure to: sunlight or ultra-violet radiation, water or dampness, bacteria, enzymes or wind abrasion. In some instances, rodent, pest, or insect attack can also be considered as forms of biodegradation or environmental degradation.

Some modes of degradation require that the plastic be exposed at the surface (aerobic), whereas other modes will only be effective if certain conditions exist in landfill or composting systems (anaerobic).

Some companies produce biodegradable additives, to enhance biodegradation. Plastic can have starch powder added as a filler to allow it to degrade more easily, but this still does not lead to the complete breaking down of the plastic.

Some researchers have genetically engineered bacteria to synthesize completely biodegradable plastics, such as Biopol; however, these are expensive at present.

Bioplastics

While most plastics are produced from petrochemicals, bioplastics are made substantially from renewable plant materials such: as cellulose and starch. Due both to the finite limits of the petrochemical reserves and to the threat of global warming, the development of bioplastics is a growing field.

However, bioplastic development begins from a very low base and, as yet, does not compare significantly with petrochemical production. Estimates of the global production capacity for bio-derived materials is put at 327,000 tonnes/year. In contrast, global production of polyethylene (PE) and polypropylene (PP), the world's leading petrochemical derived polyolefins, was estimated at over 150 million tonnes in 2015.