



Degradation of Polymer

T.Shanmuga Prabha

Since the formation of the earth over 4 billion years ago, in its giant 'laboratory', elements like carbon, hydrogen, oxygen and nitrogen have been combining to form complex molecules. Such a combination someday must have triggered off the most intriguing and fascinating process called life, the material basis for whose origin was a polymer. This polymer called protein got synthesized in Nature from simple chemical compounds like methane, ammonia and carbon dioxide.

Meanwhile polymers had also appeared in their other natural forms like wood, cotton, cellulose, starch etc., which man had begun to use. He started using animal skin to cover his body a structure of leaves and trees as shelter, wood clubs as weapons and in doing so, he had furthered his association with natural polymers.

Over the many civilizations, however, human beings have been finding different ways to meet their basic requirements. For instance, the need to cover the body as met by animal skins at one time, but perhaps it is being met by polyester today. But then as now, it is only polymer whether natural in the form of animal skin or synthetic in the form of nylons and polyesters that came forward to meet not only the genuine need, but also the wanton wants of men and women.

Polymers have not been discovered overnight. They came out of long and persevering studies by a host of motivated scientists whose work has enriched human life. Polymers are complex and giant molecules. These macro molecules are made up of many small molecules which have combined to form a single long or large molecule. The individual small molecules from which the polymer is formed are known as monomers and the process by which the monomer molecules are linked to form a big polymer molecule is called polymerization. Addition,

condensation, chain, step, bulk, solution, suspension and emulsion polymerization techniques are involved in the preparation of polymer.

Polypropylene polymers are used for producing package films, pipes, storage tanks; seat covers etc., Polymethyl methacrylate is used in buildings for decorative purposes. Polymer materials are also used in industry and day to day life of human beings. With increasing global consumption of polymer, it gets accumulating in the environment also. In turn it pollutes the land and marine. Today the degradation caused by the polymer has becomes vast [Hayden K. Webb *et al.*, 2013].

Polymer degradation is characterized by an uncontrolled change in the molecular weight. There are thermal, mechanical, ultrasonic waves; photo, high energy radiation, oxidative, hydrolytic and biodegradation. Generally speaking, natural degradation of plastic begins with photo degradation, a molecular degradation process brought about by ultra-violet light. The polymer in molten state gives on irradiation with ultra-violet rays an almost quantitative yield of the monomer.

Many polymers have a carbon-carbon chain as the back-bone of their thermal stability is dependent on the stability of the C-C bond. As the number of substituents increases, the stability of the polymer backbone bond decreases.

When dilute solution of a high molecular weight polymer is subjected to ultrasonic waves, the polymer begins to degrade there by reducing its molecular weight. Oxidative degradation leads to hardening, discolouration as well as surface changes. The ease of oxidative degradation of the polymer depends primarily on its structure. Thus, unsaturated polymers such as polyisoprene, polybutadiene containing double bonds are easily attacked by oxygen. Polyethers are used in cosmetic, lubricant, pharmaceuticals and surfactants. Under aerobic condition [Premraj and Mukesh Doble, 2005], these species *Flavobacterium* sp. and *Pseudomonas* sp. has the capacity to degrade the polyether into carbon dioxide and water. *Pelobacter venetians* can degrade the polyethylene glycol under anaerobic condition.

Thermoplastic polymers can be reformed; their properties do degrade with each reuse. Thermosetting polymers are much more difficult to recycle. Most of the research has been developed for recovery and reuse of polymer waste. A Physico-chemical method of degradation is more effective than biodegradation.

Reference

Hayden K. Webb, Jaimys Arnott, Russell J. Crawford and Elena P. Ivanova, Plastic Degradation and Its Environmental Implications with Special Reference to Poly (ethylene terephthalate), *Polymers*, **5** (2013) 1-18

Premraj. R and Mukesh Doble, Biodegradation of polymers, *Indian Journal of Biotechnology*, **4** (2005) 186-193.