Biodegradability: Myths and Realities

Polymers are very akin to materials made by nature. A simple belief that just one attribute of biodegradability will solve all the problems of our civilization in terms of waste management is an over simplified myth, says Dr. S. Sivaram, Director, National Chemical Laboratory, Pune

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Q. What is biodegradability of polymers and what are its merits & demerits?

Biodegradability of polymers is the ability of micro-organisms to metabolize organic polymeric materials to innocuous products. Biodegradability implies that no toxic residues are left in the landfill or compost pit at the end of the biodegradation process. Ideally, an organic polymer when subjected to biodegradation in presence of air (aerobic bacterial process) must convert all the carbon of the polymer to carbon dioxide; whereas, in the absence of air (anaerobic bacterial process) must covert all the carbon of the polymer to methane. The former process occurs in landfills, whereas, the latter process is prevalent in composting pits.

True biodegradability of a material in a composting environment renders waste disposal easy and converts organic wastes into useful products like biogas and organic manure. It is safer and cost effective as compared to incineration or land filling.

Q. What are the challenges that face biodegradable polymers?

Most organic polymers are not biodegradable either aerobically or anerobically. This is because organic polymers were originally designed to replace scarce natural materials like wood, silk and cotton or materials that consume substantial amount of energy and other scarce natural resources for its manufacture, such as, metal, paper and glass. For several applications of polymers such as structural materials, polymers need to have a long service life. Hence, biodegradability is not desired in all applications of polymers. On the other hand, biodegradability is a desirable attribute for a polymer whose service life is short (e.g. packaging).

However, as of today, truly biodegradable polymers that have all the property attributes of hydrocarbon-based polymers (polyolefins, PET etc.) are very rare. The challenge is to create biodegradable polymers with a diversity of properties available from non-biodegradable polymers.

Q. Do you see availability of biodegradable polymers and its costs an issue in its growth and acceptance?

The discovery and development of biodegradable polymers is at its technological infancy. So, in the immediate future, cost and availability will be an issue. As of today, the least expensive biodegradable polymer is at least four times the cost of polyethylene; the most widely used packaging material. Thus, large-scale commodity application of biodegradable polymers in low cost packaging applications is still a few years away. Biodegradable polymers are being positioned today for 'niche' specialty applications. Examples are trash bags for disposing off compostable domestic waste, disposable cutleries used in restaurants that need to be composted, packaging materials, agricultural mulch films etc.

Q. Are traditional materials biodegradable and what are the myths associated with biodegradability?

Biodegradability is not a universal attribute of materials. Nor should biodegradability be confused with materials produced by nature. Many materials found in nature are not biodegradable, e.g. glass, teak wood, minerals, metals etc. So, all of us have learnt to use materials derived from nature, irrespective of whether they are biodegradable or not.

Similarly, polymers are a class of material made by man, many of which are not biodegradable and some are. This is very akin to materials made by nature. We all will have to exercise a certain degree of selectivity in the use of such materials. Indiscriminate use of materials, either natural or man-made cause damage to our eco systems. Consequently, a simple belief that just one attribute of biodegradability will solve all the problems of our civilization in terms of waste management is an over simplified myth.

Wisdom lies in approaching the problem in a holistic manner. We need to reduce consumption in the long run, learn to conserve, reuse, recycle and implement disciplined processes of waste disposal. Just as plastic waste, there are no simple ways of handling metal wastes (from automobiles or ships) or glass wastes.

Q. Are the basis of biodegradability or eco-friendliness of materials used, properly understood by people? Please comment.

Biodegradability and eco-friendliness of materials are most misunderstood by many, including the common man. To bring some meaning into the discussion, we must shift the debate from material attributes to material waste disposal issues. Also, to talk about biodegradability without defining the final resting place of the material is pointless. This implies that we must have clear uniform guidelines and understanding as to where each of the material that we consume finally end-up after its use. Biodegradability must also be application specific and is not needed for all polymer applications. Biodegradability must have one clear scientific definition. We must have test methods and standards that can qualify such materials. Biodegradability also has a dimension of time. One must define the time period within which the polymer needs to be completely metabolized. Many people do not realize that even polyethylene, if left in the environment for sufficiently long time, will degrade into innocuous products under the combined action of light, heat and micro-organisms.

Q. Is durability an important parameter for material selection in application development and are plastics a viable option?

Durability of plastics, like that of metal, wood and glass is an important attribute of polymers that has led to its widespread acceptance by the consumer. Long life, lightweight, superior aesthetics and enormous flexibility in design are some of the major desirable properties of polymers. Plastics, thus, serve a very useful role in many applications where such attributes are desirable (textiles, furniture, automobiles and aircrafts, packaging and preservation of food etc.)

Q. Is the industry taking any initiatives to address the issues relating to biodegradable polymers and their applications?

The plastic industry has taken several initiatives to educate the public and law-makers on the benefits of plastics. It has also advocated responsible urban waste handling systems to be implemented by the Municipal Corporations. The industry at the same time must also advocate the principles of 3 R's namely - Reduce, Reuse and Recycle, especially for plastics, which have a short service life.

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