Biodegradable Plastics

Introduction

Synthetic polymers have become very versatile and useful material for the modern world. Since the discovery of manmade polymers, continuous and systematic efforts have been made to make polymers more stable, mechanically stronger and chemically resistant and environmentally safe and durable. The constituents of synthetic polymers are – Plastics, Manmade Fibers, Elastomers or more commonly known as Rubbers and Bio-polymers. In this paper we will mostly deal with Plastics and Bio-polymers, though the basic chemistry applies to all polymers.

The attributes like light weight yet strong, least energy consumption and minimum emission of pollutants in the air and water during production, inert characteristics, excellent water resistance and barrier properties, excellent insulation and dielectric characteristics, ease of fabrication into variety of shapes and structure – to name a few, have all made plastics not only a material of choice for an array of applications, use of plastics has become essential in every sphere of our modern life. The long life of plastics products has added to the convenience. Plastics have almost replaced materials such as metal, glass, wood, paper, fiber, ceramics etc. in packaging, automobiles, building construction, biomedical fields, electronics, electrical equipments, appliances, furniture, pipes and heavy industrial equipments. In a nutshell, from agriculture to transport and from aerospace to food packaging, the use of plastics has become an integral part of our modern daily living.

However, for certain applications, the properties of plastics are desired minus its long life. In fact, the products are required to degrade after a specific period of time. The 'Golf Tee' used to hold the golf ball, was one of the earliest applications of biodegradable plastics. The necessity of the natural degradation of the material was felt when many Tees remained uncollected due to traceability problem and were left in the field to create safety problem for the future golfers. Fasteners used to trap animals in the forests were also in the early development category. However the major emphasis for the development of biodegradable plastics was for natural degradation of some kind plastic products after its intended use, which otherwise created problem for recycling or disposal. Polymers which were initially developed to withstand the mechanical and environmental abuse during their useful life are required to be degraded shortly after their intended life span. One example of such application is 'mulch film' for agricultural use. After the production of the crop, it is not easy to wrap up the film from the entire field in a clean condition. The soil contamination with the film makes recycling a difficult proposition. Earlier the farmer used to burn the film after use. This was a cause of concern to the authorities (Japan). Although the Japanese Government had banned burning of agricultural film, still there was a tendency among the farmers for

disposing the film this way for many years. Hence, the farmer was comfortable when biodegradable agricultural film was developed, which used to get converted into manure and gets mixed with the soil – biodegraded / composted, after the yield of the crop. This gives triple benefit to the farmer - saving on water during the cultivation (the basic purpose of mulching), avoiding the effort to remove the film after use and increasing the fertility of the soil by composting the film with the soil.

This was a great challenge to the polymer scientists. One of the most important desired applications of biodegradable polymer is in the medical field like suture, which becomes a part of the human body after healing the wound.

Issues

Main issues are:

1. Definition
2. Are biodegradable plastics really environment friendly?
3. Do biodegradable plastics disappear or degrade in the environment or in the landfill of its own?
4. Recycling or Degradation / Composting - which should be given more priority?
5. Which application areas should be developed / encouraged for using biodegradable plastics?
6. How to judge in the market place – whether a plastic product is really biodegradable or not?
7. Technology status and availability at reasonable cost.
8. Role of Government – should it encourage Recycling or Biodegradation?

ICPE POSITION

On - Definition

Bureau of Indian Standard (BIS) has accepted the concept and definition of Compostable Plastics as provided in IS/ISO: 17088:2008, as Biodegradable Plastics. ICPE accepts this definition.

On - environment friendliness of biodegradable plastics (compostable plastics) and

On - whether compostable plastics disappear or degrade in the environment or in the landfill of its own?

It is evident that the degradation / composting process releases carbon dioxide in aerobic condition and methane and carbon dioxide in anaerobic condition. Both the situations are not desirable as both carbon dioxide and methane are greenhouse gases. Plastics recycling do not create such situation. Unless methane trapping arrangement is available, use of compostable plastics is not desirable. Biodegradable Plastics should not release harmful agents during its degradation process.

However, after considering overall assessment of specific application / s, when it is absolutely necessary that a product has to be designed with biodegradable plastic material, it is reasonable to agree that the compostable plastics, as defined in IS/ISO 17088: 2008 could be used in principle for such applications.

It is important here that appropriate facility for composting should be available in working condition and the disposal sites / landfill sites should be composting the waste as per laid down norm. In the Indian context municipality landfill sites are generally not equipped with this infrastructure of mechanical composting. For Agricultural Mulch film or Plant seeding bags (nursery bags), Golf Tees – which are supposed to get mixed with the soil at the site of use, this criterion is not necessary.

This is important because even if a product is certified as 'Compostable' as per designated ISO specifications, the same would not get composted in the disposal site if it is not appropriately treated.

Compostable Plastics do not degrade or disappear in to the soil of its own. It will remain in the open environment if not treated appropriately.

On - Recycling or composting - which should be given more priority?

Recycling should be given priority as a part of resource management. Material Recycling means replenishment of the resource. Plastics products, which can be **mechanically recycled** for producing products for non-food contact applications, save use of virgin raw materials thus saving resources. Composting generates greenhouse gases – carbon dioxide and methane, mechanical recycling does not. Although compostable plastics are generally made from renewable natural resources, still it is a debatable issue whether the farming activity should be principally restricted for human (and animal) food requirement. This debate is on for manufacturing biodiesel also.

Moreover, while making products from biodegradable or non-biodegradable plastics, lot of energy is required. In case of non-biodegradable products, the waste is recycled to augment the material (virgin) requirement and hence energy and resource is saved. In case of biodegradable plastics, the products are degraded / composted necessitating fresh input for product manufacture. The energy and resource is lost.

Biodegradable plastics also creates problem of mixing up with non-biodegradable plastics waste and normal recycling process chain is disturbed.

Multilayer plastics waste, which are generally difficult for mechanical recycling except manufacturing compressed boards etc, can also be treated for recovery of energy like co-processing in the cement kiln, replacing fossil fuel. Industrial fuel also can be generated from all plastics waste including multi-layer plastics waste.

In case of biodegradable plastics, such retrieval of recycled product or energy is not possible. Hence, biodegradable plastics may be developed and used only for applications, which cannot be recycled or recovered.

A Life Cycle Analysis, which computes the overall impact of a product on the environment, helps in taking any final decision on this issue.

On - Which application areas should be developed / encouraged for using biodegradable plastics?

Plastics products, which are difficult for **mechanical recycling or from which energy cannot be recovered**, may be manufactured with compostable plastics. Following are the recommended products, which may be made out of compostable / biodegradable plastics:

Agricultural Mulch Film, Nursery Bags, Special Food Wraps,
Coating on Paper/Jute/Textile, specialised fishery items, plastic water bottles to be carried during expedition in mountains, cutlery to be carried in boats / ships / trains, foam packaging products etc.

Use of appropriate Biodegradable / Bioplastics plastics in medical sector should be encouraged.

On - How to judge in the market place – whether a plastic product is really biodegradable or not?

This is a serious issue on the use of Biodegradable Plastics for any mass application. Unless there is any system of traceability and / or accountability, any biodegradable / compostable plastics application should not be recommended for any mass application like plastic carry bags.

On - Technology status and availability at reasonable cost

Technologies have been developed by many reputed and large companies of the world to manufacture compostable plastics / polymers for various applications. Adequate availability is however a constraint. World production of biodegradable (compostable) plastics is estimated at around 1.0 million tons compared to about 300 million tons for non-biodegradable plastics. Cost of biodegradable / compostable plastics is still very high.

On - Role of Government – should it encourage Recycling or biodegradation?

Governments of various developed countries have opted for encouraging recycling over degradation. French Government, which had a proposal to introduce biodegradable plastic carry bags in the entire country by banning normal plastic carry bags, had to drop such plan on the suggestion of the European Union Parliament, which stated that a nation cannot ban a particular product so long it fulfils specific requirements. In other words, plastics' recycling is desired.

Government of India need to encourage and facilitate plastics recycling by providing suitable fringe benefits and tax concessions as per the recommendation of the Supreme Court appointed Barman Committee Report on Solid Waste Management in Class I Cities of India - submitted in March 1999.

Government should also implement the Solid Waste (Management) Rule – 2016, which gives emphasis on segregation of dry and wet waste at source. This would indirectly facilitate recycling of not only plastics waste but also of other dry waste.

Government of India's position should be a facilitator for developing and implementing the use of truly biodegradable plastics (compostable or otherwise) for recommended applications, ensuring that it does not create additional burden on the environment – air, soil or water - visible or not and also it does not increase the requirement of energy for the same application/s. It should also ensure that appropriate testing facilities are installed in different parts of the country.

Before making a recommendation for a possible application in biodegradable / compostable plastics, an LCA study should be conducted to scientifically establish the necessity of such an action.

January 2017