DOWNLOAD PDF DEGRADABILITY OF PLASTICS

Chapter 1 : Polystyrene Biodegradability: Waste Management

The first strategy involved production of plastics with high degree of degradability. The word 'bio-plastic' is used confusingly. In our understanding, however, bio-plastics consist of either biodegradable plastics (i.e., plastics produced from fossil materials) or bio-based plastics (i.e., plastics synthesized from biomass or renewable.

Controversy[edit] Many people confuse "biodegradable" with "compostable". The waste management infrastructure currently recycles regular plastic waste, incinerates it, or places it in a landfill. Mixing biodegradable plastics into the regular waste infrastructure poses some dangers to the environment. With the inclusion of "inorganic compounds", the above definition allows that the end product might not be humus , an organic substance. The only criterion the ASTM standard definition did outline is that a compostable plastic has to become "not visually distinguishable" at the same rate as something that has already been established as being compostable under the traditional definition. The withdrawn description was as follows: Advantages and disadvantages[edit] Under proper conditions, some biodegradable plastics can degrade to the point where microorganisms can completely metabolise them to carbon dioxide and water. For example, starch -based bioplastics produced from sustainable farming methods could be almost carbon neutral. There are allegations that biodegradable plastic bags may release metals, and may require a great deal of time to degrade in certain circumstances [8] and that OBD oxo-biodegradable plastics may produce tiny fragments of plastic that do not continue to degrade at any appreciable rate regardless of the environment. They contain salts of metals, which are not prohibited by legislation and are in fact necessary as trace-elements in the human diet. Oxo-biodegradation of polymer material has been studied in depth at the Technical Research Institute of Sweden and the Swedish University of Agricultural Sciences. Much of the rest is exported. Only a tiny fraction of the national corn crop is directly used for food for Americans, much of that for high fructose corn syrup. The carbon is permanently trapped inside the plastic lattice, and is rarely recycled, if one neglects to include the diesel, pesticides, and fertilizers used to grow the food turned into plastic. There is concern that another greenhouse gas, methane , might be released when any biodegradable material, including truly biodegradable plastics, degrades in an anaerobic landfill environment. Methane production from managed landfill environments is captured and used for energy;[citation needed]some landfills burn this off through a process called flaring to reduce the release of methane into the environment. In the US, most landfilled materials today go into landfills where they capture the methane biogas for use in clean, inexpensive energy. Disposing of non-biodegradable plastics made from natural materials in anaerobic landfill environments will result in the plastic lasting for hundreds of years. While not a solution to the disposal problem, it is likely that bacteria have developed the ability to consume hydrocarbons. In , a year-old boy reportedly isolated two plastic-consuming bacteria. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. That is significantly lower than the average recovery percentage of As of , food scraps and wet, non-recyclable paper respectively comprise Biodegradable plastics can replace the non-degradable plastics in these waste streams, making municipal composting a significant tool to divert large amounts of otherwise nonrecoverable waste from landfills. Rather than worrying about recycling a relatively small quantity of commingled plastics, proponents argue that certified biodegradable plastics can be readily commingled with other organic wastes, thereby enabling composting of a much larger portion of nonrecoverable solid waste. Commercial composting for all mixed organics then becomes commercially viable and economically sustainable. More municipalities can divert significant quantities of waste from overburdened landfills since the entire waste stream is now biodegradable and therefore easier to process. This move away from the use of landfills may help alleviate the issue of plastic pollution. The use of biodegradable plastics, therefore, is seen as enabling the complete recovery of large quantities of municipal sold waste via aerobic composting that have heretofore been unrecoverable by other means except land filling or incineration. Research done by Gerngross , et al. This information does not take into account the feedstock energy, which can be obtained from non-fossil fuel based methods. Polylactide PLA was estimated to have a fossil fuel energy cost of They report making a kilogram of PLA with only In contrast, polypropylene and high-density polyethylene require Gerngross reports a 2. Furthermore, it is important to realize the youth of alternative technologies. Technology to produce PHA, for instance, is still in development today, and energy consumption can be further reduced by eliminating the fermentation step, or by utilizing food waste as feedstock. For instance, manufacturing of PHAs by fermentation in Brazil enjoys a favorable energy consumption scheme where bagasse is used as source of renewable energy[citation needed]. Many biodegradable polymers that come from renewable resources i. For the US to meet its current output of plastics production with BPs, it would require 1. Federal Trade Commission and the U. EPA set standards for biodegradability. ASTM International defines methods to test for biodegradable plastic, both anaerobically and aerobically , as well as in marine environments. The specific subcommittee responsibility for overseeing these standards falls on the Committee D Standard specifications create a pass or fail scenario whereas standard test methods identify the specific testing parameters for facilitating specific time frames and toxicity of biodegradable tests on plastics. Two testing methods are defined for anaerobic environments: This section needs expansion. You can help by adding to it.

Chapter 2 : Degradable plastics

The Degradability of Plastics With few exceptions, it can be shown that the onset of oxidative degradation limits the useful lifetime of commodity thermoplastics.

Zinc Degradable plastics As with so many technological advances, plastics bring not just enormous benefits to society but also grave threats if misused. On the one hand they allow us to make goods that would otherwise be impossible to fabricate economically, goods that we rely on in everyday life. On the other hand, plastics have two great environmental handicaps. First, the vast majority are made from non-renewable fossil fuels, oil and natural gas. Secondly, their desirable virtues of strength, inertness to chemicals, microorganisms and light also make them difficult to dispose of in an eco-friendly way. With natural polymers, specific enzymes have developed over billions of years to aid rapid degradation; for most of the plastics developed over the last 80 years, no such enzymes exist. There are already several solutions to the problems of both manufacturing and disposing of plastics, but these are not always mutually compatible. Making a plastic from a renewable resource does not necessarily mean that its disposal will be eco-friendly. For example, poly ethene could and a small proportion soon will be made from biomass via ethanol and ethene but it is still very difficult to degrade. Conversely, polycaprolactone is a biodegradable plastic but is produced via cyclohexanone, itself derived from benzene whose manufacture is based on oil. In the following sections these types of degradable plastics are discussed: They are made from renewable materials and are readily degradable. PHAs are polyesters which are produced by bacteria grown on certain substrates from which nutrients such as nitrogen are withheld. The bacteria are encouraged to produce an energy store for later use, similar to the way that plants produce starches. Considerable work is being devoted to producing genetically-engineered e. Amongst these polyesters, poly hydroxybutanoate , PHB, is the best known. It is produced by fermentation of glucose solutions produced from starch by hydrolysis to which propanoic acid has been added. The bacterium is Ralstonia metallidurans. The polymer has physical properties similar to those of poly propene. Unlike many other bioplastics, it is water-insoluble and resistant to UV radiation. However, it is readily hydrolyzed by acids and thus can be easily degraded. A well known co-polymer is Biopol. It is a random co-polymer with blocks of PHB and blocks of poly hydroxypentanoate , often known as polyhydroxyvalerate, PHV. Like other PHAs, the film is used to wrap foods, coatings for paper and cardboard, kitchen ware cups, saucers, plates , and many medical uses, including sutures, gauzes and coatings for medicines. The lactic acid, traditionally made from ethanal acetaldehyde and hydrogen cyanide, is now being increasingly produced by an alternative method, the fermentation of sugars from maize corn syrup and cane sugar molasses using the lactobacillus bacterium. However, the acid cannot be polymerized directly as the water produced prevents the polymerization process proceeding to high enough molecular masses. The acid is therefore first dimerized by heating the acids strongly. The dimer undergoes ring opening polymerization using tin octanoate as a catalyst. This method avoids the formation of water during polymerization: The co-polymer can also be produced as a shrink film for packaging and as a foam for packaging fast foods. By kind permission of BASF. This may appear to be the more ecologically sound of the two processes but it does have the drawback of being energy intensive because of the purification procedures that have to be used. Further, ethanal, the traditional precursor of the acid could be produced in the future from ethanol, produced from biomass. The properties of PLA such as its strength can be improved using additives without reducing its very good optical properties transparency and it is used for food packaging, bottles, cups and dishes and grocery bags. It is also readily composted. Threads of the co-polymer, which is a block co-polymer are used for stitching internal wounds and are degraded back to their parent monomers within 90 days after surgery. The acids are biocompatible with the body. The starch used is from corn maize. This contains a high proportion of amylose, which consists of linear chains of glucose units. The starch is treated with epoxypropane propylene oxide which reacts with some of the hydroxy! The resulting polymer can be used in place of polymers such as poly propene and poly chloroethene , PVC. It is being increasingly used for packaging, for example as bags and as shown here in packaging for biscuits and chocolates. By kind permission of DuPont. The polymer is also composted readily by microorganisms in the soil. Degradable plastics from fossil fuels. These polymers are synthetic biodegradable polymers, that is polymers which are not made by biological processes, but which will still degrade. These granules are degraded by bacteria and the tiny fragments of poly ethene produced degrade at a faster rate than poly ethene without the starch, although more slowly than biopolymers. Also, their production wastes valuable oil unless the poly ethene has been derived from a biorefinery which is still restricted to a few factories in Brazil. Other synthetic polymers which have been treated with starch granules include poly propene and poly phenylethene. There is another group of polymers derived from fossil fuels which degrade readily in composts, an example being poly caprolactone , produced via benzene and cyclohexanone. Like PLA, it hydrolyzes slowly in acid conditions and is used for stitching internal wounds and for drug delivery, where the drug is coated with the polymer. The coating dissolves slowly allowing the medicine to be delivered over a measured period of time. Another use is in making models. The polymer is sometimes blended melted and extruded together with PHB. Another important example of a fast degrading polymer derived from a petrochemical source is poly ethenyl alcohol , known better by its older, unsystematic name, polyvinyl alcohol, PVA. Over 1 million tonnes are made annually worldwide. PVA cannot be made from its parent monomer, ethenyl alcohol vinyl alcohol , as this would immediately form its more stable tautomer, ethanal: Instead PVA is made from the polymer poly ethenyl ethanoate , usually known as polyvinyl acetate. The polymer is treated with methanol and an aqueous solution of sodium hydroxide. For some uses, all the ethanoate groups are hydrolyzed to form hydroxyl groups fully hydrolyzed PVA: However, for other uses, only partially hydrolyzed PVA is used. PVA is a readily degradable water-soluble polymer and among its uses are as an adhesive paper, fabrics, leather and for coating paper and paperboard. It is also used as a thickener in a wide range of liquids including paints, glues and hairsprays. However its main use is in making polyvinyl butyral, PVB. However it will be susceptible to hydrolysis. PVB is used extensively as the middle layer in laminated safety glass used, for example, in cars. Photodegradable polymers These are polymers whose disintegration is initiated by sunlight. Some have functional groups such as carbonyl groups with bonds which absorb UV radiation. They trap enough energy for nearby bonds to be ruptured, thereby breaking the polymer chain into smaller fragments. These smaller fragments degrade more quickly than longer chains. Nonetheless they suffer from the same disadvantages as synthetic biodegradable polymers in that they are derived from materials which have been obtained from fossil fuels. Another strategy is to add a compound to the plastic, known as a prodegradant additive. They are added to conventional polymers such as poly ethene and poly propene and used, for example, in shopping bags. Added at the extrusion stage, they promote free radical attack on the polymer and thus initiate the degradation and as above, cause chain scission to form smaller fragments at which stage bacterial degradation occurs. The polymers are degraded within a few months in a conventional compost facility, and have better mechanical properties than the starch-filled polymers. The main use for these polymers is in shopping bags and food wrapping. Please send these comments to:

Chapter 3 : Degradable | Define Degradable at calendrierdelascience.com

Biosynthesis & Degradability. Degradability: Degradation to carbon dioxide and water will occur only when they expose the polymer to microorganisms found naturally in soil, sewage, river bottoms, and other similar environments.

Some packaging materials on the other hand are being developed that would degrade readily upon exposure to the environment. A prominent example is polyhydroxybutyrate , the renewably derived polylactic acid , and the synthetic polycaprolactone. Others are the cellulose-based cellulose acetate and celluloid cellulose nitrate. Polylactic acid is an example of a plastic that biodegrades quickly. Under low oxygen conditions plastics break down more slowly. The breakdown process can be accelerated in specially designed compost heap. Starch-based plastics will degrade within two to four months in a home compost bin, while polylactic acid is largely undecomposed, requiring higher temperatures. Nevertheless, it takes many months. Many plastic producers have gone so far even to say that their plastics are compostable, typically listing corn starch as an ingredient. However, these claims are questionable because the plastics industry operates under its own definition of compostable: ASTM D [21] The term "composting" is often used informally to describe the biodegradation of packaging materials. Legal definitions exist for compostability, the process that leads to compost. Four criteria are offered by the European Union: Biodegradable technology[edit] Now biodegradable technology has become a highly developed market with applications in product packaging , production, and medicine. The biodegradation of biomass offers some guidances. This reaction occurs even without prodegradant additives but at a very slow rate. That is why conventional plastics, when discarded, persist for a long time in the environment. Oxo-biodegradable formulations catalyze and accelerate the biodegradation process but it takes considerable skill and experience to balance the ingredients within the formulations so as to provide the product with a useful life for a set period, followed by degradation and biodegradation. Biodegradable polymers are classified into three groups: The polymer meaning a material composed of molecules with repeating structural units that form a long chain is used to encapsulate a drug prior to injection in the body and is based on lactic acid , a compound normally produced in the body, and is thus able to be excreted naturally. The coating is designed for controlled release over a period of time, reducing the number of injections required and maximizing the therapeutic benefit. Professor Steve Howdle states that biodegradable polymers are particularly attractive for use in drug delivery , as once introduced into the body they require no retrieval or further manipulation and are degraded into soluble, non-toxic by-products. Different polymers degrade at different rates within the body and therefore polymer selection can be tailored to achieve desired release rates. Biodegradable implant materials can now be used for minimally invasive surgical procedures through degradable thermoplastic polymers. These polymers are now able to change their shape with increase of temperature, causing shape memory capabilities as well as easily degradable sutures. As a result, implants can now fit through small incisions, doctors can easily perform complex deformations, and sutures and other material aides can naturally biodegrade after a completed surgery. They are often lumped together; however, they do not have the same meaning. Biodegradation is the naturally-occurring breakdown of materials by microorganisms such as bacteria and fungi or other biological activity. Biodegradable material is capable of decomposing without an oxygen source anaerobically into carbon dioxide, water, and biomass, but the timeline is not very specifically defined. Similarly, compostable material breaks down into carbon dioxide, water, and biomass; however, compostable material also breaks down into inorganic compounds. The process for composting is more specifically defined, as it controlled by humans. Essentially, composting is an accelerated biodegradation process due to optimized circumstances. This organic matter can be used in gardens and on farms to help grow healthier plants in the future. Biodegradation can occur in different time frames under different circumstances, but is meant to occur naturally without human intervention. This figure represents the different paths of disposal for organic waste. The two main types of composting are at-home versus commercial. Both produce healthy soil to be reused - the main difference lies in what materials are able to go into the process. Commercial composting is capable of breaking down more complex plant-based products, such as corn-based plastics and larger pieces of material, like tree branches. Commercial composting begins with a manual breakdown of the materials using a grinder or other machine to initiate the process. Because at-home composting usually occurs on a smaller scale and does not involve large machinery, these materials would not fully decompose in at-home composting. Furthermore, one study has compared and contrasted home and industrial composting, concluding that there are advantages and disadvantages to both. The first study, "Assessment of Biodegradability of Plastics Under Simulated Composting Conditions in a Laboratory Test Setting," clearly examines composting as a set of circumstances that falls under the category of degradation. The third and final study reviews European standardization of biodegradable and compostable material in the packaging industry, again using the terms separately. Biodegradation technology has led to massive improvements in how we dispose of waste; there now exist trash, recycling, and compost bins in order to optimize the disposal process. However, if these waste streams are commonly and frequently confused, then the disposal process is not at all optimized. Therefore, it is important for average citizens to understand the difference between these terms so that materials can be disposed of properly and efficiently. Environmental and social effects[edit] Plastic pollution from illegal dumping poses health risks to wildlife. Animals often mistake plastics for food, resulting in intestinal entanglement. Slow-degrading chemicals, like polychlorinated biphenyls PCBs , nonylphenol NP , and pesticides also found in plastics, can release into environments and subsequently also be ingested by wildlife. In her work Silent Spring, she wrote on DDT , a pesticide commonly used in human agricultural activities. Birds that ate the tainted bugs, Carson found, were more likely to produce eggs with thin and weak shells. A well-known example of biomagnification impacting health in recent times is the increased exposure to dangerously high levels of mercury in fish, which can affect sex hormones in humans. Marine litter in particular is notably difficult to quanitfy and review. In , a garbage patch the size of Mexico was found in the Pacific Ocean. It is estimated to be upwards of a million square miles in size. While the patch contains more obvious examples of litter plastic bottles, cans, and bags , tiny microplastics are nearly impossible to clean up. When the ecosystem changes in response to the invasive species, resident species and the natural balance of resources, genetic diversity, and species richness is altered. The World Trade Institute also notes that the communities who often feel most of the effects of poor biodegradation are poorer countries without the means to pay for their cleanup.

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Chapter 6 : Biosynthesis and Degradability | Bioplastics Information Research & Solutions

Biodegradable plastics are plastics that can be decomposed by the action of living organisms, usually bacteria. [1] Two basic classes of biodegradable plastics exist: [2] Bioplastics, whose components are derived from renewable raw materials, and plastics made from petrochemicals containing biodegradable additives which enhance biodegradation.

Chapter 7 : Biodegradation - Wikipedia

Degradability of Plastic Waste: Life Cycle Challenges and Solutions Extrusion Manufacturing (Polymers) Retailers Customer Use Waste Recycling Why is the topic relevant?

Chapter 8 : The degradability of biodegradable plastics in aerobic and anaerobic waste landfill model react

Degradable plastics As with so many technological advances, plastics bring not just enormous benefits to society but also grave threats if misused. On the one hand they allow us to make goods that would otherwise be impossible to fabricate economically, goods that we rely on in everyday life.

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These results indicated existence of the great variations in the degradability of BPs in aerobic and anaerobic waste landfills, and suggest that suitable technologies for managing the waste landfill must be combined with utilization of BPs in order to enhance the reduction of waste volume in landfill sites.