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A REVIEW: POLYTHENE BIODEGRADATION

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ABSTRACT

Each year about 100 million tons of plastics are produced worldwide. Since last few decades synthetic polymers such as polythene and plastics have become an important part of modern life and used in various purposes such as packaging, food, clothing, shelter, pharmaceuticals, transportation, industries and agriculture in rural as well as urban areas, increasingly. Due to extensive use of polythene and plastics has elevated serious issue of it causes waste disposal and pollution. Biodegradation is a best way to degrade waste disposal and remove environmental pollution. Biodegradation is the process in which microorganisms like fungi and bacteria degrade the natural polymers (lignin, cellulose) and synthetic polymers (polyethylene, polystyrene. A number of microorganisms (Bacteria, fungus and algae) with the ability to grow on polyethylene have been isolated. The effects of these microorganisms on the physiochemical properties of these polymers have been reported; these include changes in crystalline, molecular weight, topography of samples and the functional groups found on the surface of polythene. Although the bio-degradation and bio-deterioration of polyethylene has been demonstrated by several researchers, the enzymes involved and mechanisms associated with these phenomena are still unclear. The present review is to summarize and to highlight the recent studies on polyethylene degradation and enrichment methods for effective degradation.

Keywords: Biodegradation, Environmental pollution, Synthetic polymers, Polythene, Microorganisms

I INTRODUCTION

Polyethylene is an organic polymer composed of several monomers called ethylene molecules and is nonpolar, saturated, high molecular weight hydrocarbons, which is principally produced by the cracking of ethane and propane, naphtha and gas oil. The two most common types of polyethylene compounds are high density polyethylene (HDPE) and low density polyethylene (LDPE). Polyethylene is entirely linear and accessible with flexible variety of thicknesses from 0.91-0.97 g/cm3. Short density polyethylene has intense at accidental spaces which indications to little packing of the polymer chains, however the high density polyethylene is additional linear

IJARSE
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with negligible splitting that leads to high packing density [1]. Low density polyethylene is one of the major sources of environmental pollution.

Plastics have been increasingly used in food packaging, transportation, for packaging textiles, for manufacturing laboratory instruments and automotive components. At present, about one hundred million tons per year of plastics are produced in the world. With the increase in production, the amount of plastics wastes has raised enormously [2].

The contamination of water due to dispersal of industrial and urban wastes generated by the human activities is of great environmental concern[3]. Biodegradation is the natural phenomenon in which microorganisms are capable of degrade most of the organic and inorganic materials into nutrients. "Degradation" means the decay is carried out by various organisms such bacteria, fungi, insects, worms, and other organisms that eat dead material and recycle it into new forms. In the natural environment, Plastic like cellulose, chitin and PHAs are all naturally produced and can be completely decomposed by microbes.

The concept of cleaning contaminated environment using different methods or organisms is about many years old. One of the major environmental threat is the slow rate of degradation or non biodegradability of the organic materials under natural condition, e.g. Polythenes. The most commonly used non-degradable solid waste is polythene and their increasing accumulation in the environment has been a threat to the planet.

Genomic engineering methodologies to rise the presentation of the bacteria or computational methods to motivate the degradation paths could be the coming to growth the degradation level of these polymers [4].

II POLLUTION DUE TO POLYTHENE

Pollution is the introduction of contaminants into the natural environment that is harmful or poisonous to living things. A pollutant is a waste material that pollutes air, water or soil. **Environmental Pollution is one** of the greatest problems that is increasing with every passing year and causing grave and irreparable damage to the earth. Polythene is the one major cause of environment pollution.

The natural environment has been exposed to hazardous waste. In many places, major disasters such as oil spills have ruined the local environment. The excessive use of non-biodegradable products like plastics and many more have degrad the land and water.

Million tones of polythenes are produced worldwide each year. It is used in the manufacture of plastic films for carry bags, cups, packaging films, garbage bags, etc. **Polythene pollution** involves the accumulation of plastic products in the environment that caused blockage in intestine of fish, birds, cow, deer and other animals.[5] If polythenes are burnt in the house, various gases are released into the environment. Living organisms, particularly marine animals, can also be affected by ingestion of polythene waste, and also cause interruptions in biological functions of human beings. Organic chemical substance degradation of nylon continues complete drastic erosion. [6]

IJARSE
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III BIODEGRADATION

Biodegradation takes place by the action of enzymes, chemical degradation with living organisms. Firstly, the fragmentation of the polymers into lower molecular mass species by means of abiotic reactions, like oxidation, photodegradation or hydrolysis, or biotic reactions, like degradations by microorganisms. Many of the microbes are active at aerobic or some anaerobic conditions. Any physical or chemical changes in polymer are due to environmental factors such as light, heat, moisture, chemical conditions and biological activity is termed as degradation of plastic. In experimental work weight loss of polymer, physical, chemical properties were measured.[7]

Biodegradation depends upon polymer, type of organism and nature of pretreatment. The biodegradation of polymers by using microorganisms and these polymers are natural and synthetic types. Disposal methods were used for the biodegradation of polymers. Various test were used for the determination of polythene biodegradation by microorganism.

3.1 Mechanism of Biodegradation

Polymeric materials are potential source of carbon and energy for heterotrophic microorganisms including bacteria and fungi in several ways. Decomposition or destruction of contaminant molecules by the action of the enzyme secreted by microorganisms is known as biodegradation.

The degradation of polythene can occur by different mechanisms, such as chemical, thermal, photo and biodegradation. The biodegradation of plastics proceeds actively under different conditions according to their properties, because the microorganism responsible for the degradation differs from each other and they have their own optimal growth conditions in the soil and water. Environmental parameters such as humidity, temperature, pH, salinity, the presence or absence of oxygen, sunlight, water, stress and culture conditions not only affect the polymer degradation, but also have a crucial influence on the microbial population and enzyme activity.

Polymer biodegradation involves the adherence of the microorganism to the surface of the polymer, Growth of microorganism by utilizing the polymer as the carbon source and Degradation of polythene. At least two types of enzymes are vigorously convoluted in biological decomposition of polymer, extracellular and intracellular depolymerases [8].

It is visibly observed present study that a synergistic effect of U.V. nitric acid and microbial action encouraged oxidation reaction that improve and increase the biodegradation rate of LDPE pieces [9].

3.2 Microorganisms Involved in Biodegradation of Plastic

The degradation of polythene begins with the attachment of microbes to its surface. It was observed that microbial growth occurred on the surface of polythene.

IJARSE
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The microbial species identified from the polythene surface were Staphylococcus sp., Streptococcus sp., Diplococcus sp., Micrococcus sp., Pseudomonas sp. and Moraxella sp. E.Coli, Klebsiella and , Xanthomonas spp., Flavobacterium spp., Phanerochaete chyrosporium, Penicillium frequentans, Bacillus mycoides, Pseudomonas putidaVM15A, Streptomyces spp., Fungi that include A. niger, Penicillium funiculosum, A. vesicolor, Fusarium redolens, A. ornatus, A. nidulans, A. cremeus, A. flavus, A. candidus and A. glaucus and soil microbes (mixed culture as well as Rhodococcus rhodochorus, ladosporium cladosporoides) have been described to decompose neat PE. [10],[11]

Aspergillius fumigates and Penicillium sp. was natural to the places of plastic removal and cause highest degradation of polythene and plastics[12].

In this study it is demonstrated that some biodegradable plastic materials might not be able to be degraded by deep sea microorganisms, thus to identify new biodegradable materials for ocean environment[13]. A high degradation potential by bacteria in the bulk ground water in gasoline- and fuel oil contaminated areas has been observed. B*acteria may play* an important role for degradation further downstream the spill area[14]. The degradation was observed by changes in physical and optical characterstics. The percentage of Pseudomonas sp degraded the plastic upto 8.16% and 20.5% of degradation was observed anaerobically. The maximum degradation was observed in staphyloccus sp. The maximum amounts of polyethylene degradation by weight loss method were observed [15].

The bacteria that degrade the compound of hydrogen and carbon present in the polymers and use by them as carbon source. The outcomes found are then confirmed by the elements like weight, tensile strength and reduction in thickness in some cases, molecular weight distribution, and breakability. This has displayed that HDPE polymers are resistance to soil conditions than LDPE.

Bacillus and Sporosarcina species were ability to degrade the toluene and this are isolated from the samples of sea water [16]. The biodegradability of plastics was determined by graphic changes in the polymer, plate assay and Carbon dioxide production. The chemical changes like appearance and shortening of peaks using FTIR also confirmed the degradability of the plastic (Ali, et al., 2009).[17] A good degradation was observed when there was a combination of Bacillus subtilis, Pseudomonas putida, Streptomyces and Bacillus firmus[18].

This study measured the optical density, percentage of loss of weight and tensile strength for the process biodegradation study.

IV CONCLUSION

Various strains of bacteria may be responsible for degradation of polythene but microbes of genus Bacillus, Pseudomonas, Staphylococcus Aspergillus are most common the process of biodegradation of plastics or polythene can be enhanced by altering the factors involved in the process. Though large number of microorganisms and fungihave been demonstrated to cause degradation of polythene still a lot of research needs to be done to

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developsuitable technologyand find most effective organism for degradation of polythene without causing any adverse effect the environment.

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