POLLUTION AND ENVIRONMENT

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Book Title: **Pollution and Environment**

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Authored by: **Almas Parveen, Dr. Mandira Gupta, Naira Nayab, Dr. Md Anzer Alam, Subhashini A., Dr. Utpal Goswami, Dr. Rajabhuvaneswari Ariyamuthu, Bhuyan Pinky Moni, Nath Pranab Kumar, Kardang David, Gogoi Dip Kumar, Lopamudra Ghosh, Komal Rajoriya, Ramhari Meena, Anita Kumari, Tanmay Ghosh, Dr. B. Mallesh Reddy, Dr. Arpan Manna, Dr. Shaveta Chauhan, डॉ. राजेश मौर्य, प्रो. जे. पी. मित्तल**

1st Edition

ISBN: **978-93-90847-02-0**

Published: **Dec 2021**

Publisher:

KRIPA DRISHTI PUBLICATIONS

Kripa-Drishti Publications

A/ 503, Poorva Height, SNO 148/1A/1/1A,
Sus Road, Pashan- 411021, Pune, Maharashtra, India.
Mob: +91-8007068686
Email: editor@kdpublications.in
Web: https://www.kdpublications.in

CONTENT

ISBN: 978-93-90847-02-0

10. Polythene: Problems and Solutions

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Polythene (Polyethylene or Polymethylene) is one of the important and great inventions. Because of its significant properties like water resistance, electric resistance, high ductility, lightweight, and less toxicity, polythene is widely used in various domestic and industrial products.

But due to its improper and overuse, it became a serious problem. Now the entire world is concerned with polythene pollution.

Polythene is a type of plastic that can be molded into various shapes. It consists of nonpolar, saturated, high-molecular-weight hydrocarbons.

Chemically polythene is a group of synthetic polymers with general formula $(C_2H_4)n$. It is produced by polymerization of ethylene, which is mainly obtained from petroleum or natural gas.

Polyethylene was first synthesized by Hans von Pechmann in 1898, and the first industrially practical polyethylene was developed by Eric Fawcett and Reginald Gibson in 1933.

But the commercial production of industrial polythene was started in 1939 by the synthetic process developed by Michael Perrin.

10.1 Properties:

- Polyethylene is a thermoplastic, that means, on heating it becomes soft and malleable (plastic) rather than burning and become hard and solid on cooling. This process can be repeated several times with polyethylene.
- It melts between 105 to130 °C, and some types can withstand up to 146 °C. Combustion typically occurs above 349 °C.
- Its optical density can vary between almost clear, milky-opaque, and opaque.
- Polyethylene is of low strength, hardness, rigidity, and friction, but has a high impact strength and ductility.
- Polythene is insoluble in water and can resist several other solvents, and it can be dissolved in toluene, xylene, trichloroethane or trichlorobenzene at high temperature.
- Polythene is a bad conductor of heat, but due to its malleable nature, it can't be used as heat resistance or heatproof material.
- It is nonpolar and a bad conductor of electricity, hence it is readily used as an electric insulating material and also offers good electrical treeing resistance.

10.2 Uses:

Polythene is one of the most widely used plastic in industrial as well as domestic materials. The primary use is to make carry bags for groceries, medicines, fruit and vegetables, and garbage.

It is also majorly used in the packing of various types of materials at industrial and retail levels. Now a day's almost all processed foods and drinks are packed with this polythene. Other than this, polythene is also used in the insulation of cables and wires. It is also present in Adhesive tapes and packing films.

Various household products like crates, trays, bottles for milk, water, and fruit juices, caps for containers, cans, and drums contain polyethylene. Polythene is used in water pipes and hoses for pipes and fittings manufacturing. It is also used in refrigerator trays or shelves, kitchen racks, etc.

Different types of toys play kits, baby shoes, and diapers also contain polyethylene contents. It is also used in outdoor playground furniture, golf-ball covers, and other sports materials.

In agriculture, polyethylene is used to make mulching films, greenhouse covers, silage films, cultivation trays, irrigation pipes, bird and fish nets, etc. Pesticide cans seed bags and fertilizer bags are also coated with polyethylene.

Polythene is molded into fibers and used in making of certain types of ropes, curtains, and modern protective cloths. It is also used in jacket backing and carpet backing.

Lightweight, chemical inertness, and impermeable nature make polyethylene ideal for various medical instruments specifically catheter tubings and coil hoops. It is also used for coating various medical and radiological equipments.

Due to better clarity, improved heat seal temperature range, and superior seal strength, Polyethylene, and other modified PE material are also commonly used in the medical field.

10.3 Limitations:

- The origin materials of polythene are petroleum and natural gas, which are non-renewable, hence it become rare and costlier in the future.
- Polythene is non-degradable or very slowly degradable.
- It is easily flammable, hence can't be used in high temperature and high friction areas.
- It has very poor weathering resistance, which can reduce the life of the material.
- Poor thermal resistance and subject to stress cracking

10.4 Problems:

However, polythene is a very useful material with excellent features, but its overuse and improper use make it one of the major pollutants at the universal level.

All most all countries are concerned with the management of polythene pollution. Presently polythene is the most concerned pollutant on the earth as it pollutes all types of habitats and interferes with the life processes of various organisms.

The use of polythene is increasing every year and most of these polythene materials like carry bags, trash bags, water bottles, pickings of food and grocery, etc are non-reusable (one-time use materials). So, they get accumulated in landfills. Presently polythene represents a major portion of the municipal solid waste of every small and big city. The polythene is non-biodegradable or very slowly degradable, hence accumulates in landfills.

In addition to stacking, they also release toxic substances into the soil and water when perish under sunlight. These harmful chemicals released by polythene leaching enter deep into the soil and pollute the groundwater.

Due to their thin size and lightweight, polythene bags and packing wrappers can easily be blown by the wind and spread to long distances. Hence, they are present everywhere in the villages, agriculture fields, roadsides, ponds, lakes, and forest sites.

From land, these polythenes enter into the water channels, then to rivers, and finally end up in the oceans. Our rivers are acting as carriers for the plastics into oceans, where it forms mountains of plastics. All most sea beaches and islands are polluted with these polythene materials.

Now the polythene is ubiquitous, present everywhere from the Arctic to Antarctica.

Polythene materials specifically polythene bags accumulate in gutters and clog the drainage channels. It creates waterlogging, foul odor and may lead to artificial floods in cities. They also form stockpiles on roadsides, in ditches and small pools, and act as a breeding ground for mosquitoes.

Polythene pollution poses a bigger threat to plants and animals also. Polythenes get accumulated on aquatic bodies may reduce or prevent the entry of sunlight into the water and leads to the destruction of aquatic flora. It also reduces the diffusion of oxygen into the water and kills fishes and other aquatic organisms due to hypoxia.

Millions of animals are killed by plastics every year either due to engulf or entangled in. Many marine organisms like fishes, whales, sea turtles, etc. get confused with polythene as their food and engulf it. All most all sea birds eat plastic one or another time. The consumed polythene may stick in their digestive system and leads to the death of the organisms. There were instances where large, endangered tortoises were found to have suffocated because of swallowing of plastic bags. Animals entangled in the marine debris of plastic bags face starvation, choking, laceration, infection, and can give up their last breath. Even the planktons, the producers of the aquatic ecosystem are also bearing the pressure of these polythenes in the aquatic bodies.

Cattles and other street animals also eat polythene along with the food and get into the problem. Polythene affects the digestive system and reproductive system of these animals.

Polythene bags and films accumulate in the soil and form a thick layer of plastic on the surface or just beneath the topsoil. These layers interfere with the water and gas budget of the soil. They may reduce water percolation and can alter water evaporation. These layers may also affect exchange of gasses.

Polythene also shows its terrible impact on agriculture and forests. Polythene films in the soil decrease soil porosity and air circulation. Polythene layers in the soil also interfere with seed germination, seedling establishment, water, and mineral absorption by roots. It also alters soil microbiota and reduces soil fertility.

On exposure to solar radiation, the plastic produces methane and ethylene, which are considered dangerous greenhouse gases. Burning of plastic releases toxic substances like furans, dioxins, and polychlorinated biphenyls into the air and cause ambient air pollution.

These chemicals and black soot coming from plastic burning may increase the risk of respiratory problems like asthma, skin problems, heart diseases and may promote several types of cancers.

Small pieces of plastic, less than 5 mm in length are called microplastics and less than a micron is called nanoplastics. These microplastics and nanoplastics are even more dangerous as they can easily mix with soil and can be easily engulfed by animals. These micros and nanoplastics enter into the food web through planktons and hampers all the forms of life. Microplastics have been detected in drinking water, food products including seafood and table salt. They are known to reduce fertility and vigor in fishes, birds, and other organisms. They can cause Sevier diseases and can alter the genetics of organisms including human beings.

10.5 Solutions:

Polythene is very harmful to plants, animals, human beings, and the environment. It has very terrible and long-term effects on nature. Hence it is very necessary to reduce the use or to find some better alternatives to the polythene.

10.6 Reduce and Reuse:

Avoiding the use of polythene is the best way to avoid the pollution caused by it. But now we are extremely addicted to polythene, hence it is better to use thick reusable polythene in place of single-use polythene stuff. The reusable objects can be used several times and can reduce a large amount of polythene litter. Instead of using a single-use water bottle, one can maintain a stainless steel or thick plastic bottle which can be refilled from any water unit.

The use of paper or cloth bags for carrying groceries, fruits, vegetables, etc. can also reduce polythene waste. Avoiding single-use coffee cups, straws, disposable cutleries also minimize everyday polythene litter.

Purchasing large packs of food items and other consumer goods instead of small packs is also useful to reduce polythene.

10.7 Promotion of Research:

Promotion of research and availing of funds to develop and test safe and alternative materials and discovering biodegradable pathways are useful to tackle the problem of polythene pollution.

10.7.1 Alternative Materials:

The development of alternative materials which can be used in place of plastic will be useful and can reduce polythene litter.

Presently, research is going on to develop plant-based plastics and biodegradable plastics, but it needs further comprehensive research to develop an affordable and sustainable alternative to plastic.

10.7.2 Biodegradation:

Biodegradable plastics can be decomposed into water and carbon dioxide by the action of living organisms.

Among all other methods used for lowering down the polythene littering, biological degradation appears to be the most promising and permanent method.

Certain organisms have specific enzymes to digest the polythene and use it as a source of carbon.

Some of the bacteria like *Pseudomonas fluorescens*, *Sphingomonas*, *Brevibacillus borstelensis*, *Acinetobacter sp.* and some other organisms like Indian mealmoth larvae, the caterpillar of *Galleria mellonella* have the potential to digest several types of plastics.

Further investigation and detailed study of these organisms and the degrading enzymes will provide a safe and sustainable way to digest polythene materials.

10.8 Waste Management and Recycling:

Most of the polythene materials can be recycled and reused if managed properly. Recycling keeps plastic out of landfills and oceans and can also reduce the addition of new plastic into circulation.

Use of the used polythene to make roads or any other permanent constructions can sink these materials for a very long period.

Moreover, the used polythene can be used to prepare plastic cement and other base chemicals which can be used in chemical industries. But it needs the development of a proper sustainable model for plastic waste management at various levels like towns, cities, and metro cities.

10.9 Rigorous Rules:

The problem of polythene has burgeoned into a global crisis that requires immediate and sustained attention and action. Development and strict implementation of strict laws regarding the manufacturing, use, and management of polythene is very necessary.

Ban on single-use plastic at the local, state, and national levels helps to minimize polythene waste. Imposing heavy taxes, mandating a buy-back system for polythene manufacturing companies are also necessary.

10.10 Awareness:

Educating the people and spreading awareness about polythene pollution and its impact on health and the environment is also very necessary. Conducting programs on polythene pollution at school, college, and higher education levels can bring awareness among the students and can change their behavior towards the use of plastic. Making videos and short films showing the impact of plastic on wildlife and habitat will also be useful to provoke people to rethink the issue.

About the Book:

In the present world, human activities are deteriorating the environment to a great extent. Air, water and all other valuable resources are depleting day by day which is now become a threat for the entire world. Time has come to aware people about those issues related to our environment and also to let them know about the various pros and cons. To sustain the global health, we need to work together; we need to live in harmony with mother nature so that we can leave the earth as it is for our future generations.

Therefore, the objective of this book was to enumerate the various present day problems faced by our environment and also how to mitigated with those issues on the basis of the knowledge and research done by the learned academicians across the globe. We sincerely believe that this book will be of great value and a research guide for all of us especially to the environmentalists. I hereby offer my sincere thanks to all the learned academicians, researchers across the country who contributed to this book and enriched it with their valuable inputs.

About the Editor:

Dr. Sangeeta Das *is an Assistant Professor of Botany at Bahona College, Jorhat, Assam, India. She did her Ph.D from Dibrugarh University, Assam, India. She also worked as DST Women Scientist (WOS-A) at Assam Agricultural University, Jorhat, Assam, India. She has edited many books and published a number of research papers and popular science articles in reputed journals and magazines. She has presented number of research papers in different National and International Seminars/ Webinars in and around the country. She has also delivered talks on various issues as resource person both inside and outside the country. She is a member of editorial board (Honourary) in International Journal of Integrated Research and Development (IJIRD), Journal of Intellectuals (JOI) and a reviewer in many National and International Journals.*

KRIPA DRISHTI PUBLICATIONS

Kripa-Drishti Publications
A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk,
Pune – 411021, Maharashtra, India.
Mob: +91 8007068686
Email: editor@kdpublications.in
Web: https://www.kdpublications.in

ISBN: 978-93-9

9 789390 847020