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PLASTIC WASTE AND ITS MANAGEMENT

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EDITORIAL

This year the UNEP theme for World Environment Day - 2018 is "Beat Plastic Pollution". University Grants Commission (UGC) has directed all universities and higher educational institutions to ban the usage of single-use plastics on campus in India. We have minimize the plastic in different ways because from 1950-2017, it was estimated that 6 crore 80 lakhs tones of plastic deposited and in these years only 20% degradable in different forms. Plastics are disturbing local ecological balances and show up in water and land as micro-plastics. In their macro-form, they act as physical barriers, degrade soil quality, and get ingested by livestock and also other fauna, lead to blockages in drains and streams. The plastic molecules comes in the drinking water. In the near future the people of the world will be affected by the plastic pollution through the drinking water. To save these problems, the use of plastic must be stopped in the school, colleges, offices etc. Recycling can help alleviate some of these problems, but the best way to protect the earth from plastics is to replace them with more eco-friendly materials. We can motivate the people about the alternative use of plastic through awareness programme.

(Ashis Kumar Panigrahi)

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Plastic Waste and its Management

Introduction

Plastic is a word that originally meant "pliable and easily shaped." It only recently became a name for a category of materials called polymers. The polymer means "of many parts," and polymers are made of long chains of molecules. Over 150years human have using polymers from natural substance like cellulose but in recent more often using the plentiful carbon atoms provided by petroleum and other fossil fuels. In 1869 by John Wesley Hyatt was first invented synthetic polymer. He discovered a plastic that could be crafted into a variety of shapes and made to imitate natural substances like tortoise shell, horn, linen, and ivory. That time people thought the creation of the new materials can help the economic growth and solve the scarcity of natural resources.

The production of plastic materials is done in more than 30,0002 units across India. Approximately 90% of these units are small and medium-sized enterprises, often producing low-grade plastics in unorganized and informal ways. It is particularly difficult to monitor and regulate production of plastics in these enterprises. Plastic products range from things like containers and packaging (soft drink bottles, lids, shampoo bottles) to durable goods (think appliances, furniture and cars) and non-durable goods including things from a plastic party tray to medical devices. 35% of plastic consumption is in packaging, and 23% is in building and construction. Other relevant categories are transport (8%), electronics (8%) and agriculture (7%). Consumption of plastics in consumer goods is growing at an alarming rate, and much of this growth is likely to be rooted in rural areas.

Plastic waste directly and indirectly affects the ecosystem and living organisms with an increasingly high impact on marine life at a macro and micro level. According to United Nations, almost 80% of marine debris is plastic. The global manufacture of plastics continues to increase and the quantity of plastic debris in the oceans, as well as on land, is likely to increase day by day. Some types of plastic may be 'safer' for the environment, however, immediate action is needed to control and remove of plastic waste and new sources of plastic pollution. Efforts such as light weighting of packaging and shifts to biodegradable plastics are options. Policies should be taken to minimising the use of plastics such as bottle bills and bag bans are other ways to decrease the production and consumption of plastics. Over the last 50 years plastics have saturated our world and changed the way of living of human (Fig.1).

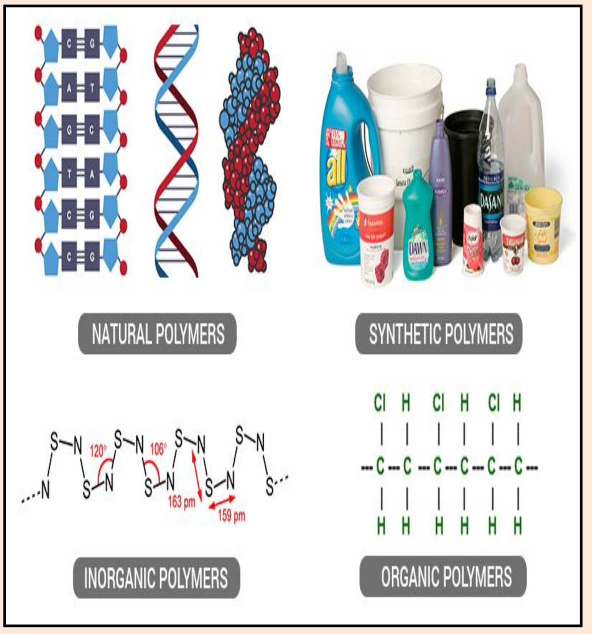

Figure: 1 Different types of polymer

Source: https://byjus.com/chemistry

Types of plastic and use

i) Acrylic or Polymethyl Methacrylate (PMMA)

Acrylic is used as alternative to glass and typically in sheet form create products such as acrylic mirrors and acrylic plexiglass.

ii) Polycarbonate (PC)

It is an excellent engineering plastic that is stable and transparant as clear as glass and 250 times stronger. Polycarbonate plastic have wide application including greenhouses, DVDs, sunglasses, police riot gear and many more.

iii) Polyethylene (PE)

It is the most common plastic on earth, Each different density of polyethylene gives the final plastic unique physical properties. There are the four common types of polyethylene densities:

- Low-Density Polyethylene (LDPE)
- Medium-Density Polyethylene (MDPE)
- High-Density Polyethylene (HDPE)
- Ultra High Molecular Weight Polyethylene (UHMWPE)

iv) Polypropylene (PP)

This plastic material is a thermoplastic polymer and the world's second-most widely produced synthetic plastic. It is stronger than PE, it still retains flexibility. It is used to make laboratory equipment, automotive parts, medical devices, and food containers. Just to name a few.

v) Polyethylene Terephthalate (PETE or PET)

The most common thermoplastic resin of the polyester family, PET is the fourth-most produced synthetic plastic. This plastic material is in fibers for clothing, containers for foods and liquid, glass fiber for engineering resins, carbon nanotubes, and many other products that we use on a daily basis.

vi) Polyvinyl Chloride (PVC)

The third-most produced synthetic plastic polymer, PVC can be manufactured to possess rigid or flexible properties. PVC is commonly in construction materials, doors, windows, bottles, non-food packaging, and more.

vii) Acrylonitrile-Butadiene-Styrene (ABS)

It can be manufactured in a range of thicknesses from 200 microns to 5mm with a maximum width of 1600mm.

Environmental Issues on plastic

Plastic, especially that used in plastic bags, is one of the major toxic pollutants of our times. Being composed of toxic chemicals (lead and cadmium pigments, commonly used in light-density polyethylene (LDPE), high-density polyethylene (HDPE) and polypropylene (PP) as additives) and most importantly, being a non-biodegradable substance, plastic pollutes the air, water and soil.

- **Non biodegradable**

Plastic is non-biodegradable and do not decay by biological actions of microbes. They remain in the same state as we throw them. So, dumps or garbages are created making our cities and soil polluted.

- **Harmful Chemical**

By burning the plastic, they emit harmful chemical gases like carbon dioxide (CO,), carbon monoxide (CO), nitrous oxide (NO), methane (CH_4), sulphur dioxides (SO_2), etc. These gases pollute the environment.

- **Ocean Pollution**

The plastic wastes like plastic bags, bottles, etc. are drawn to a sea or an ocean by rivers and they are deposited in them. They pollute and disturb the eco-system of the sea or the ocean (Fig.3)

Figure: 3 Ocean pollution

Source: https://www.pinterest.com

- **Ecosystem Imbalance**

The environment, water, soil and air pollutions are caused due to wide scale use of plastic which lead to imbalance of various ecosystem of the Earth. Only solution to this plastic hazard is to awar people and take preventive measures.

- **Plastic bags kill animals**

Plastic bags tend to disrupt the environment in a serious way. They get into soil and slowly release toxic chemicals. Thousands of whales, birds, seals and turtles are killed every year from plastic bag litter in the marine environment as they often mistake plastic bags for food such as jellyfish. Plastic bags, once ingested, cannot be digested or passed by an animal so it stays in the gut.

Figure: 4 Plastic bags kill animals
Source: https://listverse.com

Methods of Plastic Waste Disposal

In the broadview there are 4 main method of plastic disposal.

✓ Landfilling

All plastics can be disposed in landfills. However, landfilling is considered highly wasteful as it requires a vast amount of space and the chemical constituents and energy contained in plastic is lost (wasted) in this disposal route. When plastics decompose in landfills, they may leak pollutants (phthalates and bisphenol A) into the soil and surrounding environment.

✓ Incineration

Plastics are derived from petroleum or natural gas, giving them a stored energy value higher than any other material commonly found in the waste stream. Incineration return some of the energy from plastic production.

However, plastic incineration tends to cause negative environment and health effects as hazardous substances may be released into the atmosphere.

✓ Recycling

Many plastics can be recycled. and the materials recovered can be given a second-life. However, this method is not fully utilized, due to difficulties with the collection and sorting of plastic waste. Even though recycling is the most effective way to deal with plastic waste, its effectiveness is highly depended on public awareness, economic viability, and the implementation of public infrastructures to make recycling

Figure: 5 Methods of Plastic Waste Disposal
Source: http://blog.nus.edu.sg

✓ Biodegradation

Biodegradable plastics are plastics that decompose by the action of living organisms. Biodegradable plastics have the potential to solve a number of waste-management issues, especially for disposable packaging that cannot be easily separated from organic waste. Even though biodegradable plastics can be completely metabolize by organisms into carbon dioxide and water, there are allegations that Oxo-Biodegradable plastics may release metals into the environment.

Reuse of plastic

Plastics used in construction

In the world of building and construction, plastics provide an outstanding range of properties (such as durability, lightweight and good barrier properties) which are critical to green building design – design of structures that efficiently use energy, water and other resources; protect occupant health; and reduce waste, pollution and environmental degradation.

In addition, plastics play a critical role in newer technologies being used in green buildings such as wind power, solar cells and cool roofing (highly reflective and emissive materials that stay cooler in the summer sun, thereby reducing energy costs.). The technology for blending polymer with bitumen in road has been pioneered by Dr. R Vasudevan, head, department of chemical engineering, Madurai University. Later, the Delhi-based Indian Centre for Plastics in Environment has come forward to spread the technology across the country. Fig. 6.

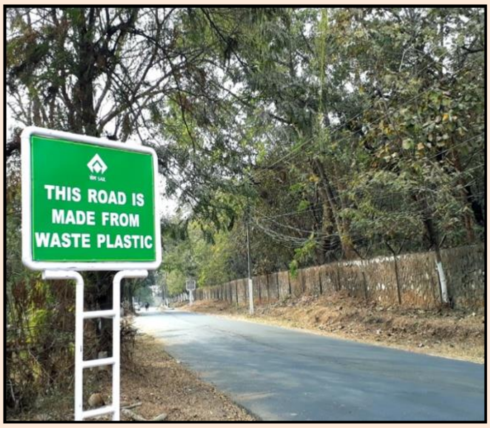

Figure: 6 Plastics Used in Construction

Source: http://english.samajalive.in

Converting plastic waste into fuel production

Plastics play an important role in everyday life. Plastics are relatively cheap, and are easy to use and disposable culture. Plastic waste management has become a non-degradable property of a world which create tremendous environmental problem. Most landfills, assigned to plastic waste disposal, are approaching their full capabilities. Therefore, recycling is becoming more and more necessary. To producr encegy the plastics are shredded and then heated in a vacuum oxygen-free chamber (known as pyrolysis) to about $400^{o}C$. As the plastics boil, gas is separated out through distillation and often reused to fuel the machine itself. In this process no resultant toxins are released into the air, as all the gases and or sludge are reused to fuel the machine.The Doing Group's waste plastic pyrolysis plant is a device that converts waste plastic into fuel. It is a chemical process that breaks macromolecular plastics into smaller molecules of petroleum, natural gas and carbon black (Fig.7).

Figure: 7 Converting plastic waste into fuel

Source: http://www.china-doing.com

Alternative of plastic

Bioplastic

Bioplastics are derived from renewable sources of biomass, like agricultural by-products, vegetable fats and oils, corn starch, microbiota etc. and can be used to reduce the problem of plastic waste that is suffocating the planet and contaminating the environment. Bioplastics are mainly used for disposable items, such as packaging, crockery, cutlery, pots, bowls, and straws.

Biodegradable plastic

It is a process by which a polymer material decomposes by biotic components. Microorganisms (bacteria, fungi, algae) are able to decompose the plastic polymers through intracellular and extracellular (endo- & exoenzymes) enzymatic process in a chemical reaction as a source of organic compounds and generate energy. The result of this degradation process by a number of different biotic enzymes generating energy and turning into water, carbon dioxide, biomass and other basic products of biotic decomposition. These products are non -toxic and occur normally in nature and in living organisms.

Reusable bags

This is an alternative to single-use paper or plastic bags, which can be reused many times for shopping. These come in canvas, woven plastic fibre, hemp, cotton and even leather.

Invited Aticles

IMPACT OF TOXIC POLLUTANTS FROM PLASTIC WASTES ON ENDOCRINE HEALTH OF EXPOSED ORGANISMS

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Plastics are very important component of the present world having wide range of applications. They are network of molecular monomers bound together to form macromolecules. The non-degradability and generation of toxic gases on combustion during incineration of plastics have actually made the use of plastics a concern for the present world. Their wide-range applications, flexibility of their use and the potential of plastics to be used in desired shape, colour and specification make their requirement almost exigent and extremely convenient to customers in packaging, agriculture, automobiles and biomedical industries. Moreover, with the advancement of technologies, they have become indispensable to the modern generation in terms of their uses in information technology, intelligent and smart packaging system.

Though, efforts are in progress for development of efficient and precise conversation of renewable raw materials into innovative polymeric product through recent technologies, the present world is already burdened with a huge amount of plastic wastes. The accumulation of plastic wastes due to their indiscriminate use has created continuously increasing marine pollution in rivers and at coastal regions. Plastic contains chemicals or additives to give it certain properties associated with their uses. There is a wide range of additives, but probably there are some chemicals directly associated with human health affecting the reproductive potential of individuals and acting as endocrine disruptors. Researches are presently being carried out for investigating whether intake of such chemicals of plastic debris by marine organism translates into toxic exposures for people who consume seafood contaminated with such chemicals or have food preserved in plastics. The chemicals, which are widely associated with plastic wastes, are Bisphenol, phthalates and nonylphenol additives. These chemicals are basically endocrine disruptors affecting the reproductive health. Hence, it is critical to assess if the plastic debris that thousands of animals associate with food could initiate eerie hormonal effects affecting their reproductive potential and gross reproductive health.

Bisphenol A (BPA): BPA is a monomer used to make the hard, clear plastic in polycarbonate food and beverage containers, CD cases and many other consumer products. BPA is a potent endocrine disruptor and mimics female hormone oestrogen. It leaches in variable amounts and for different lengths of time, depending on the product and conditions. Early development of fishes appear to be particularly sensitive to its effects, with a growing body of evidence for associations with hormonal changes in adults, problems in sexual orientations during birth, abnormal genetilia development in fishes, sex differentiation problems in fishes. Fishes experimentally fed with plastic contaminants have shown to have abnormal germ cell proliferation compared to fishes that are not exposed to such feed. Moreover, experiments on animals have revealed that Bisphenol A (BPA) causes various impacts on their reproductive systems, as well as increases in body weight and insulin resistance in anomal models. These have adverse effects related to current disease trends in human populations, such as increases in prostrate cancer, breast cancer, sperm count decrease, infertility associated with miscarriage, obesity and type 2 diabetes.

Phthalates (diesters of 1,2 – benzenedicarboxylic acid): Phthalates are a group of industrial chemicals used as plasticisers, which make plastics, such as PVC, more flexible or resilient. They are found in items including toys, food packaging, hoses, raincoats, shower curtains and vinyl flooring. High-molecular weight phthalates (e.g. di (2-ethylhexyl) phthalate, DEHP) are primarily used as plasticisers, but the low-molecular weight phthalates (e.g. diethyl phthalate, DEP) are used as solvents in personal care products. This means the sources of phthalates in the environment are numerous. Certain phthalates have been shown to function as endocrine disruptors, and to have anti-androgenic activity. They are not chemically bound to the plastic matrix, which means they can easily leach out of products to contaminate the environment. There is experimental evidence of negative impacts on reproductive systems of animals and these resemble human reproductive disorders, especially testicular dysgenesis syndrome, indicating a possible link between phthalate exposure and human disease.

Polybrominated diphenyl esters (PBDEs) and tetrabromobisphenol A (TBBPA): They are added to a variety of consumer products, including textiles and thermoplastics used in electronics, e.g. televisions and computers. Studies indicate that PBDEs and TBBPA have endocrine-disruptive characteristics, in particular on oestrogen and thyroid hormones, and that exposure to PBDEs impairs development of the reproductive and nervous system. The potential harmful effects of these chemicals have been documented, as has their presence in the environment and within the biological systems of wildlife and humans.

Bisphenol A and phthalates are rapidly metabolised once ingested but their concentration within the tissues varies between species for the same exposure. The bio-concentration factor is the concentration of a chemical within the tissue of the species compared with its concentration in the surrounding environment. Several studies have identified BPA leaching from products that have been thrown into landfills and entering groundwater, contaminating rivers, streams and drinking water. Because BPA breaks down slowly, the compound could build up in waters and harm fish and other aquatic life. In some cases, the concentrations exceeded the level above which it is considered toxic to aquatic biota. Plastic waste was the major type of waste in landfills with the highest levels of BPA, indicating that plastic waste was an important source of the BPA. Moreover, it has been suggested that the migration of additives from plastic to the landfill leachate depends on several factors, including the pore size of the plastic, the molecular size of the additive and the nature of the leachate, in terms of its acidity and organic content. The more industrialised countries have higher BPA concentrations in landfill leachate than less industrialised countries of the world indicating the greater use of plastics in the industrialised countries as a probable reason. If badly managed, recycling processes can cause the release of chemicals from plastics into the environment and subsequent impacts on human health. This can be the case of electronic waste, which is exported outside Europe where it is recycled in small workshops, sometimes without proper ventilation, often by burning to extract the valuable metals. Chipping and melting of plastics releases toxic chemicals, for example, copper wires are often recovered by burning the PVC, and PBDE (flame retardant) protected cables and can release toxic chlorinated and brominates dioxins (PCDD/ PBDD) and furans (PCDF/PBDF).

To conclude, it is evident that the chemical contaminants in plastic waste might create havoc affecting both the marine reproductive health and human reproductive health. Plastic waste management is a burning issue for the present world. Over 300 million metric tons of plastics are produced in the world annually and about fifty percent of this volume is for disposal applications, product that are discarded within a year of their purchase. Although there are multiple uses, its waste and the resultant pollution clogs up our rivers, oceans, lands and adversely affects the biodiversity. We need to plan for disposal of new synthetic product, implants etc which have completed their shelf life.

The International Organisation for standardization [ISO] Organisation for Economic Cooperation [OECD] and development, British specification [BS] Indian Standards [IS] need to be implemented for appropriate application and safe disposal. Presently actions are being taken for development of environmental friendly, innovative plastic items using the concept of green chemistry and safe disposal methods are also being implemented all over the world. Moreover, integrated waste management practices are to be encouraged, strengthened and supported with state of art scientific applications for the safekeeping of the marine environment and human health.

PLASTIC WASTE MANAGEMENT BY NANOTECHNOLOGY

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Plastic waste: Present scenario and future challenges

Plastics have been with us for more than a century and now they are everywhere. Its accumulation adversely affects agriculture fields, soil and water bodies thus directly affect our common crops, wild life & their habitat, aquatic life and human population. Plastics are (mostly) synthetic (human-made) materials, made from polymers, which are long molecules built around chains of carbon atoms, typically with hydrogen, oxygen, sulfur, and nitrogen filling the spaces.

R. Buckminster Fuller once said, “Pollution is nothing but the resources we are not harvesting. We allow them to disperse because we've been ignorant of their value.”

Research studies highlight that by 2025 the solid wastes will reach over 2 billion tons/ year. Incidentally, according to a study conducted around the world by the United Nations, one million plastic drinking bottles are purchased every minute, and every year we use up to 5 trillion disposable plastic bags. In total, 50% of plastic we use is of single use. The study further states that every year approximately 13 million tones of plastic leak into oceans, where they smother coral reefs and threaten vulnerable marine life. Nearly one third of the plastic packaging we use escapes collection systems, which means that it ends up clogging our city streets and polluting our natural environment, the report mentions. Explaining how plastic is threatening human and wildlife, an environmentalist mentioned that plastic makes its way into our water resources and thus into our bodies. Plastic contains a number of chemicals, which are toxic and may disrupt hormones. Moreover, the substance also serves as a magnet for other noxious elements — dioxins, metals and pesticides.

So we must have some advanced techniques to handle the plastic wastes which should not produce hazardous materials again. In recent years, several efforts related to green chemistry, environmental sustainability and pollution prevention have emerged and as a priority focus on minimization of hazardous waste. Common to all of these initiatives is the aim to replace existing processes that generate hazardous waste with new technologies that are cleaner and safer. One approach that is gaining attention is the use of nanotechnology for hazardous waste minimization. Nanotechnology as we all are very much familiar is the creation and modification of nano-particles in the scale of 1-100 nm. Nanoscale zero-valent iron (nZVI) is currently being used as a chemical reducing agent for contaminated site remediation. These are just a few examples of the various applications of nanotechnology, and since the number is continuously increasing, nanotechnology will likely to have the impact and contribute to waste minimization.

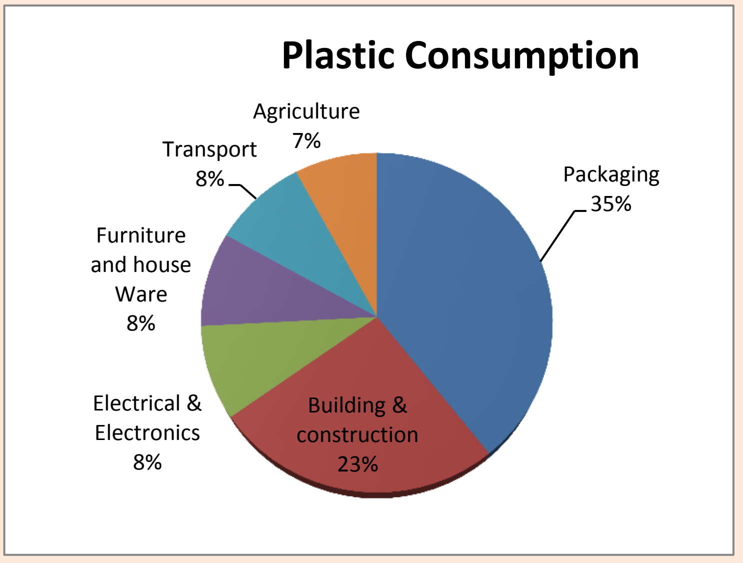

Figure **1**: Consumption of plastic in different sector of India.

An overview of the present scenario of plastic wastes in the Indian sub-continent

The present scenario in India about the consumption of plastics is depicted in the pie chart (Figure 1)

So from the pie chart, we can conclude that packaging is responsible for a little bit more than one third of total plastic consumption and so also a key factor in pollution and an open area for waste management practices.

If we look over the present scenario of plastic pollution in India, plastic wastes are producing in quantity of about 5.6 million tones/annum and 15342 tons/day. So the situation is worse.

The need for plastic waste management

As it is already mentioned, a huge amount of non-recyclable plastic (Figure 1) wastes have no doubt created environmental problems. Also their long environmental persistence has additive effects in the ocean, river, land and soil and in the body of animals and human beings.

Figure **2**: An accumulation of huge amount of plastic wastes: drinking bottles, carry bags etc. Top cities generating most plastic waste.

The report of CPCB (Central Pollution Control Board) for the year 2015 states that Delhi (689.52), Chennai (429.39), Mumbai (408.27), Bangalore (313.87) and Hyderabad (199.33) are the cities producing maximum amount of plastic waste in the country. While the metropolitan cities and tier-II and tier III cities are highly polluting, the smaller towns and hinterlands believe in doing their bit to save the environment. Kavaratti (0.24), Daman (1.16), Dwarka (1.45), Panaji (1.12) and Gangtok (2.33) generate the least amount of plastic waste in India daily.

Figure **3**: Major cities producing volume of plastic waste materials. Data is shown in the bar graph with average daily production of plastic wastes in tons.

How big a threat plastic is?

Platforms like Paris Climate Change Summit discuss carbon emission and its effects on the environment, but pollution in oceans caused due to rampant dumping of plastic waste is life-threatening. One can imagine the scale of the problem by reading these details. Roughly, 500 billion plastic bags are used around the world in a year and around 8 million tones of plastic is dumped in oceans each year, which comes roughly one truck of waste every minute. Plastic bottles are the biggest contributor in waste piling up as 1 million bottles are bought every minute throughout the world. Fifty per cent of plastic waste is single-use or disposable. Plastic waste contributes to 10 per cent of the total waste generated in the world.

Plastic waste Management- "Certainly their management in environmentally sustainable manner is a challenging task".

While the use of plastic has been found degrading the environment, this year (2018) on the World Environment Day, from academic to Government institutions all are working on the same line — "Beat Plastic Pollution". We have been approaching for *3R: Reduce, Reuse and Recycle. The 3R's formula definitely brings the human civilization towards a common point of "Beat Plastic Pollution".*

We have both conventional and new technologies for the management of plastic wastes. The conventional technology relies on the following points: Recycling, Incineration and Land Filling.

On the other hand the new technologies proceed with the following options: Fuel from waste plastic (Pyrolysis), Polymer blended bitumer, Plastic waste in cement kilns and Plasma pyrolysis technology.

Pros and Cons of common waste management processes: the Recycling

Common people have been encouraged to practice and implement the recycling of plastic materials. For example- recycling of plastic bags. The problem is with the cost. Cost for the recycling of plastic bags is higher than the cost of production of creating new plastic bags.

For the industrial view point, conversion of waste materials to energy has dual advantages. A 250 ton/ day incinerator can produce 6.5 mega watts of electricity/day and this itself can save about $ 3 million per year. Disadvantages associated with this process is burning plastic waste directly add into pollutants and finally pollution that leads to health hazards.

We have some low end plastic waste and they are definitely a major challenge; may provide the vital energy to the cement industry.

Toxins released from the non-decomposing plastic bags are a problem to the environment in various forms; living things will adversely suffer in their respective habitats.

The Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011. The Minister of State for Environment, Forest and Climate Change, Shri Prakash Javadekar, said here today that the minimum thickness of plastic carry bags has been increased from 40 microns to 50 microns. He stated that 15,000 tonnes of plastic waste is generated every day, out of which 9,000 tonnes is collected and processed, but 6,000 tonnes of plastic waste is not being collected. Shri Javadekar also said that the rules, which were admissible upto municipal areas, have now been extended to all villages. The Minister said that notifying the new Plastic Waste Management Rules is a part of the revamping of all Waste Management Rules.

Role of common people in the management of plastic wastes

According to various studies and researches, around 87 per cent people in India are concerned about the ill-effect of non-recyclable waste. An eco-friendly product, which is a complete substitute of the plastic in all uses, has not been found till date. In the absence of a suitable alternative, it is impractical and undesirable to impose a blanket ban on the use of plastic all over the country. The real challenge is to improve plastic waste management systems.

Interestingly, on the use of non-recyclable waste, 87 per cent Indians said they are concerned about the effects of non-recyclable waste on the environment, which includes plastic packaging, plastic bags and other disposable objects that cannot be recycled.

According to a study by Ipsos poll conducted between March 23 and April 6, 2018, 48 per cent Indians believe that Government investment to improve recycling would be effective; however, 40 per cent on the other hand feel that higher taxes on supermarkets and shops that use a lot of non-recyclable packaging would be effective.

On the re-use disposable items like plastic bags and plastic bottles, 50 per cent Indians said they re-use disposal items. Fifty per cent said they will buy more products made from recycled materials; 43 per cent said they will stop buying goods that have packaging that cannot be recycled and 39 per cent said they will stop going to supermarkets and shops which use a lot of packaging that cannot be recycled.

Interestingly, 28 per cent would pay extra for goods without recyclable packaging; and 24per cent said they will pay more tax so that recycling facilities can be improved.

Beating plastic pollution with the help of nanotechnology

One of the first to discuss the applications of nanotechnology for waste minimization and its potential impact on environmental sustainability was Tarek Kassim in 2005 (Kassim 2005). "Non-biodegradable plastic bags are a serious menace to natural ecosystems and present a problem in terms of disposal," says Professor Dusan Losic, ARC Future Fellow and Research Professor of Nanotechnology in the University's School of Chemical Engineering. "Transforming these waste materials through 'nanotechnological recycling' provides a potential solution for minimizing environmental pollution at the same time as producing high-added value products." Nanotechnology can impact the recycling industry in three major categories: the recycling of nanomaterials, the recycling of solid wastes by nano processing, and the improvement of existing processes in order to reduce the amount of wastes generated.

One of the principal benefits of recycling is that it reduces energy consumption by reusing raw materials that would otherwise be thrown away as trash. Recycling also helps to conserve valuable natural resources and reduces the amount of waste sent to landfills and incineration facilities. This not only lowers costs, but also helps to protect the environment by reducing (for example) greenhouse gas emissions from incinerating plastics or the leaching of toxic chemicals from landfills. But can we recycle nanomaterials or turn traditional waste into nanomaterials?

A new variant on the concept of nanoparticle recycling which has been recently garnering interest is the idea of repurposing traditional waste materials into nanomaterials (Figure4). For example, plastic bags have been used to create carbon dots, which are small carbon nanoparticles (less than 10 nm in size) with interesting optical properties and potential applications as imaging agents. These carbon dots were made by simply cutting the bags into small pieces and heating them in a solution of hydrogen peroxide.

Another waste repurposing method is to heat discarded compact discs (CDs) in a furnace along with sand to create silicon carbide nanoparticles, a nanomaterial with outstanding thermal, chemical, and mechanical properties. The use of CDs is noteworthy because, with increasing urbanization in the world, electronic waste like CDs is estimated to be accumulating at three times the rate of normal household trash.

Conclusion

Reduce, Reuse and Recycle are the best practices to beat the plastic pollution. We are reducing the use of hazardous chemicals in the manufacturing process of plastic material and moving toward the bio-degradable and eco-friendly packages. Since packages contribute about one-third in total plastic wastes. By reusing the same material, we have been minimizing their accumulation in the land, river, and sea water.

Recycling is the most popular process because it cuts total global plastic waste production. For this purpose, we already have conventional and new technologies but there are many drawbacks in terms of leaching of toxic materials into the soil and water. Also when we process plastic wastes by the older technologies, simultaneously adding toxic fumes into the atmosphere.

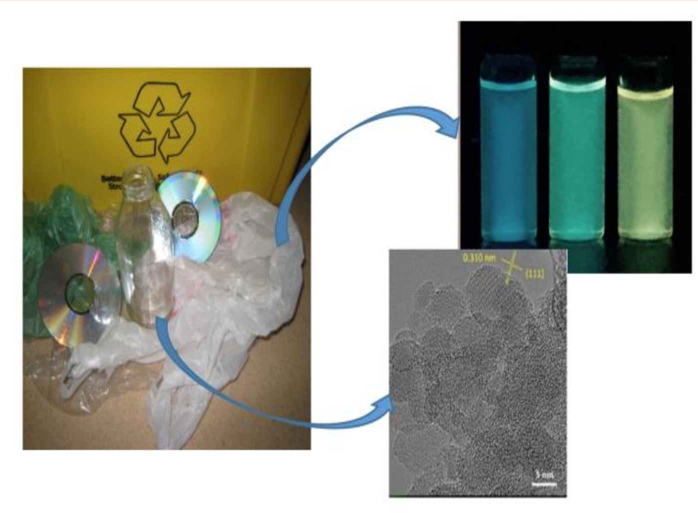

Figure **4**: Repurposing traditional waste into useful nanomaterials – glass bottles, CDs and ting plastic bags can be repurposed to create nanoparticles such a carbon dots (top, image courtesy of Bo Zhi) and silicon carbide nanoparticles (bottom, image from Li et al. 2017).

So there is a need of clean and green technology. Both of our need may get a boost by the use of nano-particles and nano-technology. Certainly this is a beginning of an era, but we are expecting good results in the near future for our planet "The Earth".

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Current news on plastics

Scientists have improved a naturally occurring enzyme which can digest some of our most commonly polluting plastics.(Science reporter, BBC News,16 April 2018)

PET, the strong plastic commonly used in bottles, takes hundreds of years to break down in the environment. The modified enzyme, known as PETase, can start breaking down the same material in just a few days. This could revolutionise the recycling process, allowing plastics to be re-used more effectively. UK consumers use around 13 billion plastic drinks bottles a year but more than three billion are not recycled.

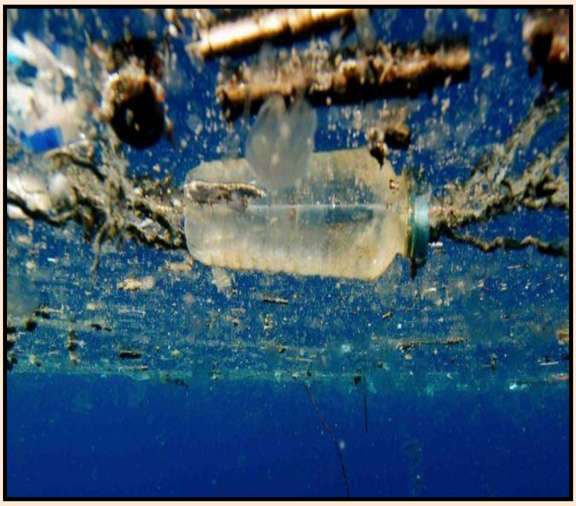

Figure 5: Plastic polluting the water
Source:https://www.bbc.com

Scientists accidentally create mutant enzyme that eats plastic bottles

Scientists have created a mutant enzyme that breaks down plastic drinks bottles – by accident. The breakthrough could help solve the global plastic pollution crisis by enabling for the first time the full recycling of bottles.

The new research was spurred by the discovery in 2016 of the first bacterium that had naturally evolved to eat plastic, at a waste dump in Japan.

Source: https://www.theguardian.com

A plastic-eating caterpillar

Larva of a common insect, *Galleria mellonella*, is able to biodegrade one of the toughest, most resilient, and most used plastics: polyethylene," says Federica Bertocchini of the Institute of Biomedicine and Biotechnology of Cantabria in Spain. A previous study (doi: 10.1021/es504038a) has shown that *Plodia interpunctella* wax worms, the larvae of dian mealmoths, can also digest plastic.

Source: https://www.eurekalert.org

Scientists investigating a plastic-eating microbe accidentally improved it

Some rare good news in the fight against plastic pollution: Scientists working with a plastic-eating microbe discovered in Japan two years ago accidentally created a mutant enzyme that sounds like an environmentalist's dream, the Guardian reports.

The enzyme breaks down the PET—polyethylene terephthalate—used in plastic bottles even more efficiently than the original microbe, which had evolved to eat the waste it encountered around an Osaka recycling plant.

Researchers, who inadvertently improved the enzyme while investigating how it evolved, say the tweaks enable it to begin digesting plastic more quickly. It now takes just a few days to start breaking down plastic, and researchers say more tweaks could make the process super-fast, reducing both plastic waste and the need to create more plastic.

"What we are hoping to do is use this enzyme to turn this plastic back into its original components, so we can literally recycle it back to plastic," says lead researcher John McGeehan at the University of Portsmouth.

Source: http://www.foxnews.com

These newly discovered bacteria can eat plastic bottles

A team of Japanese scientists has found a species of bacteria that eats the type of plastic found in most disposable water bottles.

The plastic found in water bottles is known as polyethylene terephalate, or PET. It is also found in polyester clothing, frozen-dinner trays and blister packaging.

"If you walk down the aisle in Walmart you're seeing a lot of PET," said Tracy Mincer, who studies plastics in the ocean at the Woods Hole Oceanographic Institution in Massachusetts.

Source: http://www.latimes.com

Novel plastic-eating enzyme created

(Apr 17, 2018, 12.39 PM IST)

WASHINGTON: Scientists have created an enzyme which can digest some of the most commonly polluting plastics, providing a potential solution to one of the world's biggest environmental problems.

The discovery could result in a recycling solution for millions of tonnes of plastic bottles, made of polyethylene terephthalate (PET) which currently persists for hundreds of years in the environment.

Source: https//economictimes.indiatimes.com/

Plastic-Eating Enzyme Is Accidentally Developed, Could Help Fight Pollution

Researchers in the US and Britain have accidentally engineered an enzyme which eats plastic and may eventually help solve the growing problem of plastic pollution.

https://www.ndtv.com/

Scientists hope new enzyme will 'eat' plastic pollution

(By: Bard Wilkinson, CNN

Updated 0829 GMT (1629 HKT) April 17, 2018)

Scientists have accidentally developed a plastic-eating enzyme that may be used to combat one of the world's worst pollution problems.

Researchers from Britain's University of Portsmouth and the US Department of Energy's National Renewable Energy Laboratory (NREL) made the discovery while examining the structure of a natural enzyme found in a waste recycling center a few years ago in Japan.

They say the enzyme, Ideonella sakaiensis 201-F6, is able to "eat" polyethylene terephthalate, PET, which was patented as a plastic in the 1940s and is used in millions of tons of plastic bottles.

Case Study: Collection and segregation

Producers and importers of plastics in Sweden are mandated to create recycling stations at optimal locations so that effective collection of plastic waste can take place. This contributes to a near-perfect collection and disposal rate across the country.

There are some new online waste collection services in India (www.thekabadiwala.com and www.junkart.in) that offer door-to-door collection services for recyclables. They buy waste on predetermined rates and sell it onwards to vendors who recycle, upcycle or refurbish waste.

The Ambikapur district in Chhattisgarh has implemented the successful collection and segregation at source and which is further segregated at secondary & tertiary segregation SLRM centres with the help of SHGs. This requires building infrastructure in the form of SLRM centres and IEC from general public including youth and students.

Case Study: EPR implementation

Saahas Waste Management Pvt. Ltd. Has established MoUs with large producers of plastics like Britannia and HUL. They collect post-consumer waste through aggregation centers and supply the collected scrap to either mechanical recycling centers or cement kilns for energy recovery.

Case study:Plastics in road construction

The Chhattisgarh state government in 2015 passed an order prohibiting the production and use of plastic bags in the state. In Ambikapur district, all existing plastic and polythene waste is being proposed to be used in construction of local roads.

Under the joint initiative of Indian Plastic Federation (IPF), West Bengal Pollution Control Board (WBPCB) and Kalyani municipality launched a pilot project in using plastic litter in road construction in Kalyani. Such experiments are already underway in Tamil Nadu, Karnataka and Maharashtra.

The Kolkata Metropolitan Development Authority (KMDA) also take initiative to construct roads and infrastructure around the city using plastic wastes with joint venture of Indian Center for Plastics in the Environment (ICPE).

FORTHCOMING EVENTS		
Events	**Date**	**Place & Correspondence**
10th Conference on Yeast Biology	02 August – 02 November, 2018	http://www.dbtindia.nic.in 325, School of Life Sciences, Jawaharlal Nehru University, New Delhi.
International seminar on 'Recent Trends in Science Towards Sustainable Development'	6th -7th August, 2018	Acharya Prafulla Chandra College, West Bengal, India www.apccollege.ac.in
5th International Conference on Geological and Environmental Sustainability	13th -14th August, 2018	https://geology.conferenceseries.com/ Bali, Indonesia
4th International Conference on GIS and Remote Sensing	September 27-28, 2018	https://gis-remotesensing.conferenceseries.com Berlin, Germany
International Conference on Chemical, Agricultural, Biological and Environmental Sciences (ICCABES)	13th - 14th December, 2018	http://gsrd.co/Conference2018/12/Israel/1/ICCABES/ Tel Aviv, Tel Aviv, Israel

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