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Plastic Waste Menace and Conceptualisation of Domestic Level Disposal

Satyam Tripath[1], Abhishek Yadav[1], Shivam Bhask [1], Yashwendra Singh[1] and Dr. Dinesh Chand [2],
[1]students (B. Tech.),
[2]Professor,
SOCE, Galgotias University, Gr. Noida(UP) India

***Abstract*:- Plastic waste is a very common problem in day to day life and it has grown out of proportion over the years in last few decades. If plastic waste is not getting serious attention for its disposal today, it will become a huge problem for the future generations due to its non-biodegradability. Generally, the plastic wastes consisting items like polythene, water bottles, packets, sachets and other kinds of plastics, particularly of small packaging formats, used in day to day life by billions of households and warrant its better designing and proper disposal to avoid plastic menace. The plastic waste let off uncared which also gets its way into drains, sewage, on the road and parks etc. usually become major causes logging and urban flooding as well as death of street animals. If the plastic wastes captured and disposed off at household level itself than the plastic waste volume may not only get reduced significantly but also the costs of its transportation and recycle would become cheap and easy. Ultimately this concept will certainly result in solving the major environmental problems.**

Thus, in this paper an attempt has been made to develop the concept to make easy the household collection of plastic wastes so as to protect the environment and make it healthy.

Key Words: Plastic Waste, Single-use, polyethylene, polypropylene, landfill, incineration, small packaging format

INTRODUCTION

Plastic, a polymeric material has very large molecules. It is estimated that more that 300 million tons of plastics are produced every year and 50% of which are single use[1]. In Western part of Europe, approximately 92 kilograms of plastic per capita per year are consume with further increase against world-wide use about 35 kilograms per person. The largest amount of plastic waste comes from the packaging industry-75% generated by households and 25% by industry and commerce [2]. Due to their low cost, manufacture simplicity, versatility and impervious nature, plastics are utilised in a mess of products of various scale, including paper clips and spacecraft. Plastics have many uses within the medical field also, with the introduction of polymer implants and other medical devices derived a minimum of partially from plastic. The field of cosmetic surgery isn't named to be used of plastic materials, but rather the meaning of the word plasticity, with reference to the reshaping of flesh. The articles used include anything from plastic screws and hangers to bigger plastic decorative parts, electric wires, flooring, wall covering, waterproofing etc.

UN estimated that every year the world uses 500 billion of plastic bags. Half of it is 'single-use' or 'disposable items' such as grocery bags, cutlery, packaging materials, wrappers and straws [3].

In developing nations, one third of plastic is utilised in packaging and an equal amount in buildings applications viz pipes, plumbing or vinyl siding and other uses include automobiles (up to 20% plastic), furniture, toys etc. The applications of plastic for various purpose may differ from country to country.

Un-Plastic Collective (UPC) co-founded by the CII, UNEP and WWF-India conducted a study to eliminate waste plastic menace and move towards a circular economy. In this report, it was indicated that globally, over 8.3 billion MT of plastic has been produced since 1950, and about 60 per cent of that has ended up in landfills or in the natural environment. The report stated that India generates 9.46 million MT of waste plastic yearly. Of which 40 per cent, remains uncollected; 43 per cent of total consumption is used for packaging, mostly single-use. The Chairman UPC said that all concerns put focus efforts on collaborative approaches and maximize synergies to un-plastic the country in a time-bound manner [4].

PLASTIC WASTES IN INDIA

India generates 15 million MT of plastic waste every year but only one fourth of this is recycled due to lack of a functional solid waste management system. This leads to burden on the landfills and poor socio-economic conditions of the waste pickers, mostly women, children (5). However, the volume of plastic waste generated seems suspiciously low as compared with the data of Plastindia Foundation—a body of major associations, organizations and institutions connected with plastics business. The Foundation estimates that India consumed 16.5 million MT of plastic in 2017-18 alone. About 43 % of India's plastics are used in packaging and are single-use plastic according to industry body, FICCI. Consumption has clearly outstripped India's capacity to recycle (4).

According to a report (September 2017) by the Central Pollution Control Board (CPCB), which extrapolated data from 60 major cities, the country generates around 25,940 MT of plastic waste a day. About 94 per cent of this comprises thermoplastic like PET (polyethylene terephthalate) and PVC (polyvinyl chloride), which is recyclable. The remaining are non-recyclable which belongs to thermoset and other categories of plastics such as sheet moulding compound (SMC), fibre reinforced plastic (FRP) and multi-layer thermocol (6).

The FICCI has estimated that the consumption of plastic in India is about 11 kgs average per capita. As per CPCB reports, plastic material contributes to 8% of the total solid waste, with Delhi producing the maximum quantity followed by Kolkata and Ahmedabad. The Ministry of Petroleum and Natural gas suggests increase of plastic consumption in India and would be 20 kgs in annual per capita by 2022. The major

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growth attributed by the use of plastics in manufacturing firms, construction industries and products delivery services, is a priority to handle and pack things comfortably due to its light weight, cost effectiveness and strength.

Recent study reveals that 15000 MT of plastic waste generated every day by 60 major cities alone in India. About 6000 MT remain uncollected which pose a huge problem to the daily life in these cities. On "Independence Day" in 2019 Honorable Prime Minister Narendra Modi had echoed in his speech, India's commitment and ambitious plan to put a complete stop to 'single-use plastic' by 2022.

Plastics are typically organic polymers of high molecular mass and sometimes contain other substances. Plasticity is that the general property of all materials which may deform irreversibly without breaking but, within the class of mould-able polymers, this happens to such a degree that their actual name derives from this specific ability. The plastic is made up of various chemical elements and is a highly pestilent and non-biodegrade material in the natural environment. Plastic is a material created by human but it's also something that can't be destroyed. Generally, the waste created which contains also plastic material, ultimately chokes stray animals to death, obstructing flow in drains, sewer system and only leads to mess like clogged drains leading to city floods while the plastic in the fields blocks germination, preventing ground water recharge by rainwater. Now, the answer is quite positive. It is comprehensively concluded that the plastic wastes are deadly non- environment friendly being non-decompose. If destroyed by burning process, it causes air pollution consisting highly toxic gases like phosgene, carbon monoxide, chlorine, sulphur dioxide, nitrogen oxide etc. They also consume massive energy and other natural resources, depleting the environment in numerous ways. As we know that presently, use of plastic like wrappers of betel nuts, chocolates, chips, hand bags, cold drink bottles water bottles, chips packet, plastic bags etc is inevitably important for making easy carrying and preserving things. The plastic materials and its all other forms create significant space in environmental and economics. So it is tough to either impose complete ban or 'Say NO' to the use of these things when they have occupied an important space in our life. Perhaps, banning plastics may not be feasible as being substitute of natural resources like wood, paper at a great extent. Thus, it would be appropriate to collect the plastic wastes yourself and help to government to recycle it in very economical way. Reuse of plastic wastes for civil construction works is one of similar way. The plastic waste is subjected to the various basic processes like collection, transportation & shorting, cleaning, shredding and storage & processing for reuse. The plastic waste such as carry bags, cups, polythene, polyethylene (PE), polypropylene (PP), polystyrene (PS) etc. up to 60µ thickness can be used.

ENVIRONMENTAL IMPACT, THE CHALLENGES AND OPTIONS

There are various documented incidences of the impact of plastic on ecosystems and wildlife starting publications in 1980s on plastic's adverse impacts. However, the world's first synthetic plastic called Bakelite was invented in NY in 1907 by Leo Baekeland who termed it as 'plastics'. The study by Rochman et al. (2016) reveals the impacts of plastic debris on marine animal life. Despite many documented evidences, it has been widely accepted that the complete extent of impacts on ecosystems is yet to be known. The entanglement cases are reported for about 344 species which include all sea turtle species, two-thirds of seal and one-third of whale species, one-quarter of seabirds. Such cases are mostly involving plastic rope and netting and abandoned fishing gear. However, entanglement by other plastics like packaging materials are also noticed (7).

The two most significant stumbling blocks are material variability and the costs associated with identifying and separating waste plastics into recognisable grade ranges and to put into valuable 'second-use' applications. Plastics are highly engineered products manufactured in sophisticated and highly controlled manufacturing operations to meet clear specifications for the manufacturing and specific end-use applications. For example, polyethylene is produced using numerous different technologies in a wide range of densities and molecular weights. The resulting materials are designed to suit thousands of specific applications, ranging from assorted films, blown/rotationally/injection moulded bottles, sealing caps, oil tanks, specialised gas & potable water pipe grades through ultra-high molecular weight polyethylene often used in biomedical applications. Furthermore, end users can also add their own functional additives and may use two or more very different plastics in a product. (e.g. composite films).

As a result, single-use plastics with known properties and additives are the easiest to reuse, assuming they can be collected and reprocessed cost effectively. However, in many cases it is not cost effective to collect waste plastics due to low volumes and material diversity. Technically it is possible to separate most mixed plastics into recognisable streams, but commercially this is currently only economically feasible for higher value plastics (e.g. PET or the HDPE used in bottles). The effective recycling depends upon knowledge of the characteristics of the materials separated, having a well-organised collection infrastructure which can consistently gather the desired products as well as method of reprocessing of the plastic waste to produce a product suitable for re-use.

There are two extremes on the recycling continuum; at one end of the scale is the factory which reprocesses its own off-spec products, and at the other end of the scale is material such as the plastic blend found in domestic black bag waste which can contain large numbers of different polymers which are often contaminated. Variability and the investment cost of separation equipment are key reasons why only 25% of domestic plastic waste and 40% of bottles are recycled(8).

Using plastic have shown hope in terms of using plastic waste in road construction. i.e. plastic-bitumen, plastic roads. Plastic roads mainly use plastic carry bags, disposable cups and PET bottles that are collected from garbage dumps as important ingredients of the construction materials. By using plastic waste as modifier, we can reduce the quantity of bitumen and sand by their weight, hence decreasing the overall cost of construction. At 5% optimum modifier

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content, strength of modified concrete we found to see the times greater than the plain bitumen concrete. Plastic increases the melting point of the bitumen which is favourable point for road laying in hot regions. As rainwater does not seep through because of the plastic modifier in the bitumen, the road development in regions having heavy rainfall become advantageous and require lesser road repairs.

PROPERTIES OF PLASTIC

The general properties of plastics depend upon the its structure and make it useful materials for different purposes as narrated below:

1. ***Strength:*** The plastics are adequately strong to hold load of structural members. By reinforcing with various fibrous materials, the strength of plastics can be increased further.
2. ***Fire and Weather Resistant:*** As plastics are made from phenolic resins, they can be a good weather resistant but certain plastic are affected by ultraviolet light. Plastic being organic in nature, are combustible and the resistance to fire temperature depends upon the plastic structure. However, phenol formaldehyde and urea formaldehyde plastics are known fire proofing materials.
3. ***Durability, Ductility and Dimensional Stability:*** Plastics generally possess enough durability, provided they offer sufficient surface hardness. But termites and rodents can attack to thermoplastic varieties of plastic. It, usually, have low ductility causing sudden failure of plastic structural members and it does not go under plastic deformations and maintains its shape.
5. ***Chemical, Heat, Moisture and Heat Resistance:*** Plastics is great moisture resistance, chemicals & solvents and good corrosion resistance. Plastics are used to carry chemicals.

The plastics are poor electrical & heat conductors and are used as thermal insulators. The property depends upon variety of plastics used.

6. ***Melting Point****:* Different types of plastic have different melting points depending on their chemical makeup e.g. PVC melts at between 1600 and 2100 C, HDPE between 2100 and 2700 C and different types of polypropylene melt between 200 and 280 C. But melting point is lowers with impurity or thermo-plastics (9).
7. ***Other Properties:*** The plastics have other qualities namely available in variety of colors, both opaque and transparent; easy in operations like drilling, sawing, punching, clamping etc ; clean, light and shining, don't need any finish such as painting, polishing etc.; possess good optical and sound absorption qualities.

BASKET OF THE RIGHT SOLUTIONS

New approaches and systemic solutions: There is urgent need for the commercial brands, governments, NGOs and celebrities, to join together and promote the various solutions. Adopting reusable packaging is part of the answer. The shopping bags, water bottles and coffee cups have become popular purchases for those trying to do their bit. Moreover, plastic film can keep food fresher for longer, and wrappers ensure medical equipment is safe for patients. In many cases, it wouldn't be hygienic, convenient or feasible to go fully reusable.

Various initiatives were undertaken to minimise the impacts of the problem, from taking plastic wastes out of ocean to collect litter from beaches. However, the three best known major international efforts for the ocean clean-ups combined together with was less than 0.5 percent of 8 million MT of plastic wastes that enter the ocean in a year. This means looking upstream to redesign a plastics system that works in such a way the plastic material never ends up as waste.

Further, the challenge is that when post use plastic packaging becomes dispersed and distributed throughout the world with billions of customers, generally are often tiny, lightweight, it become difficult to collect and individually aren't worth that much. Thus, to rethink the way we make and use plastics and come up with new approaches and systemic solutions.

Designing the Better Use and Circular Materials

There is need that the designers and materials scientists to reinvent the types of plastic packaging in "small packaging formats" like shampoo sachets, wrappers, straws, tea/coffee cup lids etc. that are hardly collected & recycled and usually end up in landfill, incinerators or in the environment. This account for about 10 percent of all plastic packaging.

The Circular materials seeks ways to make all plastic packaging recyclable by inventing better solutions than conventional packaging. Usually, many plastic films aren't just made of one type of polymer but numerous materials all mixed up for obtaining diverse functions which also make common packaging items non-recyclable. The principles of a circular economy are used to guide the research and development process and inspire further to adopt, scale and integrate into a working plastics industry.

1. *Packaging inspired by nature*: The invention is required to create a recyclable material that can replace complex multi-layered packaging that is non-recyclable.
2. *Recyclable packaging, with help from magnets:* M/s Aronax Technologies, Spain applied a magnetic additive to a material, creating better air and moisture insulation and making it suitable to protect sensitive products (i.e., coffee and medical products), while still being possible to recycle. The additive is small, plate-like particles of silicates and iron oxide which will provide plastics with much better abilities to block gases such as oxygen, but can be identified and separated at the recycling stage.
3. *Packaging from food waste:* Working together, Packaging companies in US made a compostable high-performance material from renewable materials, agricultural by-products and food waste to pack a broad range of products from food items to laundry detergent.
4. *'Plastic' made from wood:* The VTTT Research Centre, Finland has created a compostable multi-layer material from agricultural and forestry by-products, which could be used for stand-up food pouches for products (i.e. muesli, nuts, dried fruit and rice).

The by-products from wood contain cellulose, the most abundant renewable polymer on the planet, making this new material an environment friendly alternative to fossil fuel-based, multi-layered plastic packaging.

5. *Compostable coatings:* The Fraunhofer ISC, Würzburg has developed a coating with silicate and bio-polymers that can be used in many food packaging applications, protecting against premature degradation and is fully compostable. The

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new coatings can improve the performance of bio-based and biodegradable packaging.

Circular economy transitions and Creating system-level change

Clean-ups continue to play an important role in dealing with the consequences of the waste plastic crisis, but more must be done. There is urgent need of solutions that address the root causes of the problem.

In 2016, the Ellen MacArthur Foundation (EMAF) released the first New Plastics Economy report, which provided the alarming and widely shared statistic that if we don't change the way, we make and use plastic, the oceans could contain more plastics than fish weight by 2050. In fact, the recycling symbol has been in use for over 40 years, but just 14 % of plastic packaging is being collected and merely 2 % is properly recycled. The reports have stressed upon change in such mindset and the redesign of the plastics system in line with the principles of a circular economy.

The rest is lost during the recycling process, or goes to lower value goods. About 11 leading brands, retailers and packaging companies are working towards using 100 percent reusable, recyclable or compostable packaging by 2025 after the announcement in Davos. Together, these bold commitments, having the right policy incentives and demonstrators of radical innovation, provide us a chance of creating a workable plastics system (10).

Innovative Approaches

The scientist should work on developing applications for diverse and varying blends of plastics, and is also evaluating novel low-cost plastic separation technologies. If these technological developed and commercialised, it could significantly increase the volume of available recycled plastic. Most currently available recovered plastic streams will almost certainly be a mixture of different polymers, different grades, and different colours. This is especially plastics in domestic waste streams.

Presently, the market for lower value mixed plastic is limited with much being exported to low labour cost economies where manual separation of higher value fractions is feasible, and where residues can be used in other applications such as fuels. However other applications may be developed to utilize lower grade mixed plastics such as:

Powder Impression Moulding (PIM): A process where low value and even highly diverse plastic blends can potentially be used to create a range of moulded items. UK's 2K Manufacturing is working on this process for developing the hoarding panels.

Encapsulation: Using the recycled plastic as a "former" which is then encapsulated by a thin layer of higher value plastic enabling the product to have the appearance and the performance of the higher value encapsulated plastic.

Fibre Plastic Composites (FPC): Composites can contain a wide range of both plastics fibres from high value PET with carbon nano-tubes to low value wood and other waste cellulosic fibres combined with mixed polyolefins. This has significantly grown since early 1990's in the US.

M/s Impact Solution are actively developing FPC formulations and applications for low value plastic blends and using these in combination with low value, difficult to recycle waste fibres for example low tech outdoor applications including decking and fencing, formulations suitable for wood replacement in internal applications such as skirting and other non-structural uses, focusing upon the low value plastic obtained via a mass treatment of un-segregated domestic black bag waste.

Many technologies exist which facilitate the separation of mixed waste plastic into fractions of various purities and values, but its economic is yet to be proved.

However, developments in large scale, more efficient processes for handling un-segregated waste will change both these economics and the availability of plastic waste. Thus, all plastic waste should view as a valuable resource and to develop techniques and processes that convert these materials into ever higher value products

DOMESTIC PLASTIC WASTE DISPOSAL MACHINE

The concept of Domestic Plastic Waste Disposal Machine (DPWDM) is based on melting point of plastic waste by heating and collection of plastics in melted consolidated form. The volume of melted plastic wastes is small in volume and thus easy to collect and transport to the processing industries. For melting and consolidation of plastic waste, temperature plays an important role. The temperature should be around 300 degree Centigrade on which machine should operate without any emissions of pollutants. Thus, the material selection for making the machine become important. There are many materials option those can be used for the high temperature heating safely but Stainless Steel is one of the economical materials which can be withstand at the higher temperature upto 500'C. So the inner body is to be made up of Stainless Steel with non-sticking material coating and heating arrangement. For controlling the temperature in the machine, a vacuum tube named MAGANATROM will be provided which help to maintain the temperature at 250'C to 300'C. The machine may be operated on one of the modes of energy supply like domestic electric power, solar energy, induction/microwave-based systems. The machine may be fitted with auto operation and stop mechanism and it would be capable to process of all plastic items particularly of small format which are usually thrown to dust bin or in open.

CONCLUSION

The plastic waste has posed a big problem not only in India but also worldwide. Many countries are clueless on solution of this problem and make countries un-plastic. There is only one solution to the problem of plastic waste that is recycled and reused to the scale of its use and generation. This system may also be deployed at domestic level as well as at commercial establishment.

The above concept will be helpful to the circular economy and the government agencies responsible for cleanliness in India and elsewhere. By using the above conceptualised machine at household level, the plastic waste in smaller format used for packaging of household items will become more useful for recycle and reuse without worrying for

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collection and transport. This may be part of waste collection supply chain already existing. In addition, it may give us an opportunity to use more plastic without making negligible damage to Environment. Further, it is expected to reduce almost 40% of plastic waste coming out from housing and commercial complexes.

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