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PLASTIC WASTE RECYCLING TECHNIQUES

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Abstract

Plastics are inexpensive, lightweight and durable materials, which can readily be moulded into a variety of products that find use in a wide range of applications. As a consequence, the production of plastics has increased markedly over the last 60 years. However, current levels of their usage and disposal generate several environmental problems. Around 4 per cent of world oil and gas production, a non-renewable resource, is used as feedstock for plastics and a further 3–4% is expended to provide energy for their manufacture. A major portion of plastic produced each year is used to make disposable items of packaging or other short-lived products that are discarded within a year of manufacture. These two observations alone indicate that our current use of plastics is not sustainable. In addition, because of the durability of the polymers involved, substantial quantities of discarded end-of-life plastics are accumulating as debris in landfills and in natural habitats worldwide. Recycling is one of the most important actions currently available to reduce these impacts and represents one of the most dynamic areas in the plastics industry today. Recycling provides opportunities to reduce oil usage, carbon dioxide emissions and the quantities of waste requiring disposal. Here, we briefly set recycling into context against other waste-reduction strategies, namely reduction in material use through down gauging or product reuse, the use of alternative biodegradable materials and energy recovery as fuel. While plastics have been recycled since the 1970s, the quantities that are recycled vary geographically, according to plastic type and application. Recycling of packaging materials has seen rapid expansion over the last decades in a number of countries. Advances in technologies and systems for the collection, sorting and reprocessing of recyclable plastics are creating new opportunities for recycling, and with the combined actions of the public, industry and governments it may be possible to divert the majority of plastic waste from landfills to recycling over the next decades.

Index Terms: plastics recycling, plastic packaging, environmental impacts, waste management, chemical recycling, and energy recovery

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1. INTRODUCTION

1.1 General

The plastics industry has developed considerably since the invention of various routes for the production of polymers from petrochemical sources. Plastics have substantial benefits in terms of their low weight, durability and lower cost relative to many other material types. Worldwide polymer production was estimated to be 460 million metric tons per annum in the year 2016-2017 for all polymers including thermoplastics, thermoset plastics, adhesives and coatings, but not synthetic fibre. This indicates a historical growth rate of about 14 per cent p.a. Thermoplastic resins constitutes around two-thirds of this production and their usage is growing at about 7.5 per cent p.a. globally. Today, plastics are almost completely derived from petrochemicals produced from fossil oil and gas. Around 4 per cent of annual petroleum production is converted directly into plastics from petrochemical feedstock. As the manufacture of plastics also requires energy, its production is responsible for the consumption of a similar additional quantity of fossil fuels. However, it can also be argued that use of lightweight plastics can reduce usage of fossil fuels, for example in transport applications when plastics replace heavier conventional materials such as steel.

Approximately 60 per cent of plastics are used for single-use disposable applications, such as packaging, agricultural films and disposable consumer items, between 20 and 25% for long-term infrastructure such as pipes, cable coatings and structural materials, and the remainder for durable consumer applications with intermediate lifespan, such as in electronic goods, furniture, vehicles, etc. Post-consumer plastic waste generation across the India and china was 24.6 million tonnes in 2007). presents a breakdown of plastics consumption in the india during the year 2000, and contributions to waste generation This confirms that packaging is the main source of waste plastics, but it is clear that other sources such as waste electronic and electrical equipment (WEEE) and end-of-life vehicles (ELV) are becoming significant sources of waste plastics.

Because plastics have only been mass-produced for around 60 years, their longevity in the environment is not known with certainty. Most types of plastics are not biodegradable and are in fact extremely durable, and therefore the majority of polymers manufactured today will persist for at least decades and probably for centuries if not millennia. Even degradable plastics may persist for a considerable time depending on local environmental factors, as rates of degradation depend on physical factors, such as levels of ultraviolet light exposure, oxygen and temperature, while biodegradable plastics require the presence of suitable micro-organisms. Therefore, degradation rates vary considerably between landfills, terrestrial and marine environments. Even when a plastic item degrades under the influence of weathering, it first breaks down into smaller pieces of plastic debris, but the polymer itself may not necessarily fully degrade in a meaningful timeframe. As a consequence, substantial quantities of end-of-life plastics are accumulating in landfills and as debris in the natural environment, resulting in both waste-management issues and environmental damage.

Fig 1. Graphical representation of rate of plastic generation to rate of plastic recovery

2. VARIOUS SOLID WATSE AND ITS FFECTS ON HUMAN HEALTH

The safety and acceptability of many widely used solid waste management practices are of serious concern from the public health point of view. Such concern stems from both distrust of policies and solutions proposed by all tiers of government for the management of solid waste and a perception that many solid waste management facilities use poor operating procedures. Waste management practice that currently encompasses disposal, treatment, reduction, recycling, segregation and modification has developed over the past 150 years. Before that and in numerous more recent situations, all wastes produced were handled by their producers using simple disposal methods, including terrestrial dumping, dumping into both fresh and marine waters and uncontrolled burning. In spite of ever-increasing industrialization and urbanization, the dumping of solid waste, particularly in landfills, remains a prominent means of disposal and implied treatment.

Major developments have occurred with respect to landfill technology and in the legislative control of the categories of wastes that can be subject to disposal by landfilling. Even so, many landfills remain primitive in their operation. Alternative treatment technologies for solid waste management include incineration with heat recovery and waste gas cleaning and accelerated composting, but both of these technologies are subject to criticism either by environmentalists on the grounds of possible hazardous emissions, failure to eliminate pathogenic agents or failure to immobilize heavy metals, or by landfill operators and contractors on the basis of waste management economics, while key questions concerning the effects of the various practices on public health and environmental safety remain unanswered.

2.1 Various Types Of Solid Waste

a. Municipal Solid Waste (MSW):

The term municipal solid waste (MSW) is generally used to describe most of the non-hazardous solid waste from a city, town or village that requires routine collection and transport to a processing or disposal site, Sources of MSW include private homes, commercial establishments and institutions, as well as industrial facilities.However, MSW does not include wastes from industrial processes, construction and demolition debris, sewage sludge, mining waste or agricultural wastes. MSW is also called as trash or garbage. In general, domestic waste and MSW are used as synonyms.Municipal solid waste contains a wide variety of materials. It can contain food waste (like vegetable and meat material, leftover food, eggshells etc, which is classified as wet garbage as well as paper, plastic, tetra-pack, plastic cans, newspaper, glass bottles, cardboard boxes, aluminum foil, meta items, wood pieces, etc., which is classified as dry garbage. The different types of domestic wastes generated and the time taken for them to degenerate is illustrated in the table given below. India's urban population slated to increase from the current 330 million to about 600 million by 2030, the challenge of managing municipal solid waste (MSW) in an environmentally and economically sustainable manner is bound to assume gigantic proportions.

The country has over 5,000 cities and towns, which generate about 40 million tonnes of MSW per year today. Going by estimates of The Energy Research Institute (TERI), this could well touch 260 million tonnes per year by 2047

b. Hazardous Wastes:

Hazardous wastes are those that can cause harm to human and the environment.

Characteristics of Hazardous Wastes:

1. Toxic wastes:

Toxic wastes are those that are poisonous in small or trace amounts. Some may have acute or immediate effect on human or animals. Carcinogenic or mutagenic causing biological changes in the children of exposed people and animals. Examples: pesticides, heavy metals.

2. Reactive wastes:

Reactive wastes are those that have a tendency to react vigorously with air or water are unstable to shock or heat, generate toxic gases or explode during routine management. Examples: Gun powder, nitro glycerin.

3. Ignitable waste:

Are those that burn at relatively low temperatures (<60°C) and are capable of spontaneous combustion during storage transport or disposal. Examples: Gasoline, paint thinners and alcohol.

4. Corrosive wastes:

Are those that destroy materials and living tissues by chemical reactions? Examples: acids and base.

5. Infectious wastes:

Included human tissue from surgery, used bandages and hypoderm needles hospital wastes.

c. Industrial Wastes: These contain more of toxic and require special treatment.

Source of Industrial Wastes:

Food processing industries, metallurgical chemical and pharmaceutical unit's breweries, sugar mills, paper and pulp industries, fertilizer and pesticide industries are major ones which discharge toxic wastes. During processing, scrap materials, tailings, acids etc.

d. Agricultural Wastes:

Sources of Agricultural Wastes:

The waste generated by agriculture includes waste from crops and livestock. In developing countries, this waste does not pose a serious problem as most of it is used e.g., dung is used for manure, straw is used as fodder. Some agro-based industries produce waste e.g., rice milling, production of tea, tobacco etc. Agricultural wastes are rice husk, degasses, ground nut shell, maize cobs, straw of cereals etc.

e. Bio-Medical Wastes:

Bio-medical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological.

2.2COMBUSTION PROCESS/PYROLYSIS

The recovery and recycling of plastic waste disposed of in landfill has been the subject of much effort over the decades, as it is seen as a valuable resource and is high in the public's perception of what 'waste' is. Progress has been made in the mechanical recycling of post-commercial, industrial and pre-sorted post-consumer waste, but the recovery of value from low-grade mixed plastic waste has always presented technical and economic difficulties. The conversion of plastic into oil products requires the long polymer chains that are characteristic of plastics to be broken into shorter chains typical of compounds present in crude petroleum. This depolymerisation can be achieved by heating the materials to moderate or high temperatures, and zeolite catalysts (such as those frequently used in oil refineries) are helpful in increasing the rate of depolymerisation. The basic processes of depolymerisation are pyrolysis, gasification and thermal cracking. All of these processes have been in use in the coal, gas and petroleum refining industries for decades, and as such can be considered to be mature technologies. The use of plastic as a feedstock for these processes has been studied for 20 years, but its uptake has been limited by the relatively low price of oil and the lack of a credible collection infrastructure for this low-density, disperse-source feedstock. During the 1990s a series of demonstration plants were announced, only to disappear after a few years' operation. It is interesting to note that the majority of technology suppliers reported by Juniper in 20013 are no longer active in this field, having run out of money or sold the technology to organisations with access to the funds to continue process and project development.

3. RECYCLING PROCESS-FIBRE

In waste plastics recycling process, waste plastics crushing is one of the most important processes, the volume of waste plastic is reduced, which is convenient for subsequent processing. The equipment mainly includes the cutting machine and the crushing machine, whose basic principle is to destroy the material's integrity depend on the shear strength and the impact strength. Different shredder equipment has their own advantages. Relatively speaking, waste plastic crushing machine is suitable for shredding soft small, broken materials, such as PE film, beverage bottles, EPS shredding machine is suitable for crushing large lump material, rolled into a tube, extruder head materials, such as bundles of woven bags etc.

The commonly used crushing equipment has different kinds of compression type, impact type, and shears type, knock type and grind type. The choice of crushing equipment mainly depends on the type, shape and the degree of the grinding material. Different materials should be used in different crushing equipment. Hard PVC, polystyrene, organic glass, phenol formaldehyde resin, urea formaldehyde resin, polyester resin, etc. are brittle plastic. They are fragile brittle, once compressed, are very easy to broke into small pieces, this type of

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plastic is suitable for crushing And for the ductile plastic, such as polyethylene, polypropylene, poly acid amine, ABS plastic, etc., are suitable for shear type polystyrene crushing equipment, because they are easy to be effected by outside compression, bending impact and other forces. In addition, for elastic materials, soft materials, it is best to use low-temperature crushing. In addition, we should determine the extent of crushing equipment according to the need to crush the waste. If crushing the large pieces into small pieces, we should use compression, impact or cutting equipment; if putting small pieces into fine powder, we should use abrasive grinding equipment.

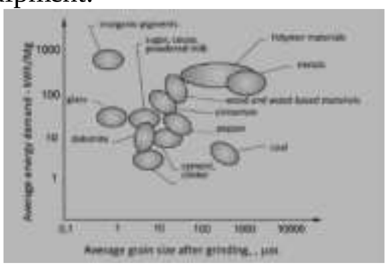

Fig 3. Grinding Size Determination

5. REVIEWS AND RESULTS

5.1 Review Of Process Options For Conversion Of Plastics Into Oil Products

5.1.1 Characteristics of plastics and oil products

Before looking at the process options for the conversion of plastic into oil products, it is worth considering the characteristics of these two materials, to identify where similarities exist, and the basic methods of conversion. The principal similarities are that they are made mostly of carbon and hydrogen, and that they are made of molecules that are formed in ‘chains’ of carbon atoms.

Crude oil is a complex mixture of hydrocarbons, which are separated and purified by distillation and other processes at an oil refinery. The majority of the crude oil is used for the production of fuels for transportation, heating and power generation. These oil products are not single components, but are a blend of components used to meet the relevant fuel specifications in the most economic manner, given the composition of the crude oil and the configuration of the oil refinery. These components have a wide range of chain lengths: gasoline has compounds with a chain length of between three and 10 carbon atoms, and diesel has compounds with a chain length of between five and 18 carbon atoms, but both contain only hydrogen and carbon.

5.2 **Comparison Of Plastic Fuel And Diesel**

Sr. No.	Properties	WPO	Diesel
1	Colour	Pale black	Orange
2	Specific Gravity at 30 °C	0.8355	0.84 to o.88
3	Gross Calorific Value (kJ/kg)	44340	46500
4	Kinematic Viscosity, cSt @ 40 °C	2.52	2.0
5	Cetane number	51	55
6	Sulphur Content (%)	<0.002	<0.035
7	Flash Point °C	42	50
8	Fire Point °C	45	56
9	Pour Point °C	< 7	6

6. CONCLUSION

In this paper, we have concluded thaturban waste is a growing concern on a global level. Scale and management issues tend todiffer between economically developing and economically developed countries. The former tend to have a scale problem in that the amount and type of waste is growing at a rapid rate per capita per annum; whilst the latter tend to have a management problem more than a scale problem in the form of inadequate waste management services. In India, there tends to be an interesting mix of both scale and management issues and this has been clearly demonstrated in the case of Mumbai. Internationally and locally the philosophy of waste management has seen a dramatic shift. Plastic is a non-destroying material and which is increasing at high rate. Plastic cannot be decomposed but it can be reduce, reuse and recycle in various forms by using techniques like Combustion/Pyrolysis and fibre grinding. All type of plastic can be treated by these techniques. The most important thing is the process does not cause any type pollution. Recycled plastic can be used in civil engineering works like in beams, walls, railway sleepers, bricks, roads. Other application were by combustion process plastic can be used as the alternative of petrol, diesel and other fuel materials.

References

[1] Austin L.G., Klimpel R.R.: The theory of grinding operations. *Ind. Eng. Chem*. 56, p. 18-29(1964).

[2] Austin L.G.: Introduction to the mathematical description of grinding as a rate process. *Powder Technology*, 5, p. 1-17 (1971-1972)

[3] Bauer W.: Untersuchung des Einzelzerkleinerungsvorganges in Schneidmühlen am Beispiel von Polypropylen. Reihe 3 - *Verfahrenstechnik*, Nr. 694. VDI Verlag, Düsseldorf 2001

[4] Bielinski M.: Materiałowa i przetwórcza charakterystyka wybranych tworzyw wtórnych. *Rozprawy nr 84*, Publishing House of ATR in Bydgoszcz 1998

[5] Błędzki A. K. (editing): Recykling materiałów polimerowych. WNT, Warsaw 1997

[6] Butzen, G. A., Adams, G. A.: Size Reduction/Granulating. Van Nostrand Reinhold Co.,