RECYCLING OF PLASTICS

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DO YOU KNOW…..

- In 1839, Eduard Simon (Germany) discovered ‘Styrene’
- PVC was accidentally synthesized by German chemist Eugen Baumann in 1872
- Polyethylene was first synthesized by the German chemist Hans von Pechmann while investigating diazomethane, in 1898
- Bakelite, the first fully synthetic thermoset, was reported by Leo Baekeland using phenol and formaldehyde, in 1903
- Nylon, Teflon (polytetrafluoroethylene) and polyster were invented/discovered in DuPONT, between 1935-1950
- Expanded polystyrene (used for building insulation, packaging, and cups) was invented by Dow Chemical
- A numerous engineering plastics and high-performance plastics are synthesized in the last few decades, increasing their utility from construction sector to medical sector to machinery to consumer goods.

Courtesy : Wikipedia

PLASTICS, EVERYWHERE…..

Pics from google search

Some facts .....

- Production of plastics, world-wide increased from 1.5MT in 1950's to 335 MT in 2016
- In 2018 more than 343 million tonnes of plastic waste were generated, 90% of which was composed of post-consumer plastic waste (industrial, agricultural, commercial and municipal plastic waste)
- A large proportion of post-consumer plastic waste consists of plastic packaging
- Of all the plastic discarded so far, 14% has been incinerated and less than 10% has been recycled
- Discarded plastic causes pollution, as plastics degradation takes a long time from 450 years to 600 years
- In a study in 2018 stated that approximately 513 million tonnes of plastics wind up in the oceans every year
- India generates 3.5 MT of plastic waste annually, as per recent statistics and has joined 12 countries which are creating 52% world-wide waste
- India imports plastic scrap for recycling while only 30 % of such waste created within the country is recycled
- India is termed as one of 'The Waste Sponge', with low plastic waste production, high imports and bad waste management, in the Report of Environmental Action, published in 2023

Source : Wikipedia

Where is the plastic waste going???








Courtesy: Google images

Regulatory framework, applicable….

- Plastic Waste Management Rules, 2021, amended from time to time, published by Ministry of Environment, Forest and Climate Change (MoEFCC) provides regulatory framework for addressing plastic waste in our country
- Defines
  - ✓"**plastic**" means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate, high density polyethylene, Vinyl, low density polyethylene, polypropylene, polystyrene resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, Polybutylene terephthalate.
  - ✓"**plastic waste**" means any plastic discarded after use or after their intended use is over;

Important terminology……

- ✓ "**waste generator**" means and includes every person or group of persons or institution, residential and commercial establishments including Indian Railways, Airport, Port and Harbour and Defence establishments which generate plastic waste;
- ✓ "**Plastic waste processing**" means any process by which plastic waste is handled for the purpose of reuse, recycling, co-processing or transformation into new products;
- ✓ "**Waste management**" means the collection, storage, transportation reduction, re-use, recovery, recycling, composting or disposal of plastic waste in an environmentally safe manner;
- ✓ **"Recyclers"** means the entities who are engaged in the process of recycling of plastic waste;
- ✓ **"Extended Producers Responsibility (EPR)"** means responsibility of Producers, Importers and Brand-owners to ensure processing of their plastic packaging waste through recycling, re-use or end of life disposal (such as co-processing/Waste-to-energy/Plastic to-oil/roadmaking/industrial-composting).

Extended Producers Responsibility (EPR).....

- As per ‘Guidelines on Extended Producer Responsibility for Plastic Packaging’ in the Schedule II of the Rules, Producers, Importers and Brand Owners (PIBOs) shall have to register through the online centralized portal developed by the Central Pollution Control Board (CPCB) and declare the procedure they are following for obtaining a certificate

PWMR 2021 & CPCB website

EPR..

(c) Obligation for recycling (refer examples 1 to 3 in Annexure):

The Brand Owner shall ensure minimum level of recycling (excluding end of life disposal) of plastic packaging waste collected under Extended Producer Responsibility target, category-wise, as given below.

Minimum level of recycling (excluding end of life disposal) of plastic packaging waste

(% of Extended Producer Responsibility Target)

Plastic packaging category	2024-25	2025-26	2026-27	2027-28 and onwards
Category I	50	60	70	80
Category II	30	40	50	60
Category III	30	40	50	60
Category IV	50	60	70	80

In case of Category IV plastic packaging category (plastic sheet or like used for packaging and carry bags made of compostable plastics), the minimum level of recycling means processing plastic packaging waste for composting through industrial composting facilities.

Single Use Plastics (SUPs)

- "Single-use plastic commodity" mean a plastic item intended to be used once for the same purpose before being disposed of or recycled;
- The manufacture, import, stocking, distribution, sale and use of following single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022:-
  - ✓ (a) ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol] for decoration;
  - ✓ (b) plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers.

Courtesy: Amendment 1 to PWMR 2021 & google picture

Plastic Waste Recycling....defined in IS 14534

- IS 14534: 2021 Plastics — Guidelines for the Recovery and Recycling of Plastics Waste prescribes
  - ✓guidelines for the selection, segregation and processing of plastics waste/scrap.
  - ✓different options for the recovery of plastics waste arising from pre-consumer and post-consumer sources and their marking.
  - ✓quality requirements that should be considered in all steps of the recovery process.
  - ✓ guidelines to the manufacturers of plastic products with regard to the marking to be used on the finished product in order to facilitate identification of the basic raw materials, thus, to make sorting and recycling easier.
  - ✓Classifies source of recovery of material as
    - Pre-consumer Sources of Materials
    - Post-consumer Sources of Materials

Clause 1 and 4 of IS 14534 & PWMR 2021

IS 14534.....

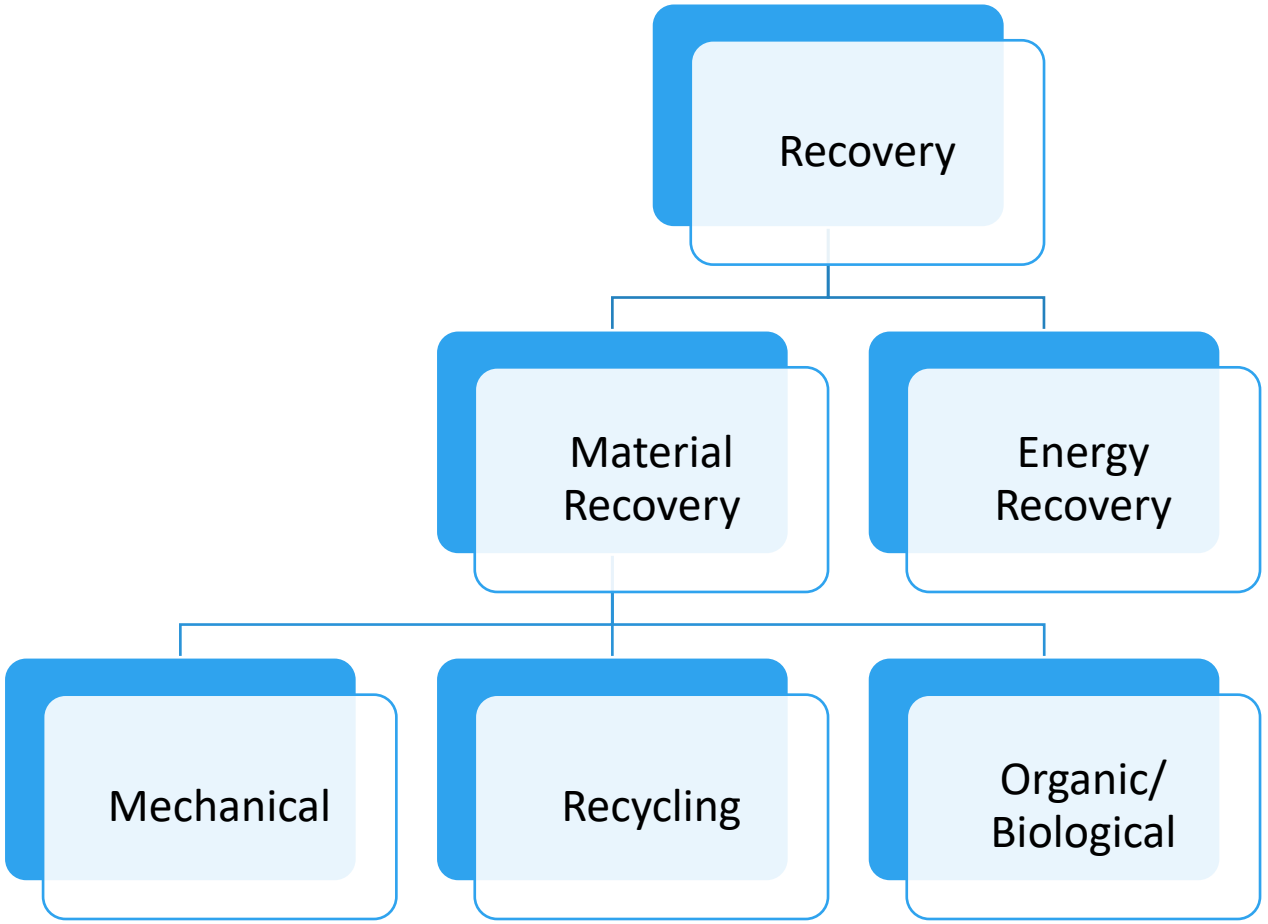
Post-consumer recyclates

- material, generated by the end-users of products, that has fulfilled its intended purpose or can no longer be used
- includes material returned from within the distribution chain
- can be disposables or warred out durable goods

Pre-consumer recyclates

- material diverted during a manufacturing process
- off-grade materials, processing purge material and scrap
- industrial and commercial products made of, or containing, plastics, including packaging and containers

Recovery…



- Implies conversion of plastic waste to useful asset
- Completes, when secondary materials, fuels or products have been manufactured, or energy has been generated
- Material recovery of plastics waste encompasses three distinct recycling routes:
  - ✓Mechanical recycling,
  - ✓feedstock or chemical recycling and
  - ✓biological or organic recycling.

Mechanical Recovery

- Includes
  - ✓ physical treatment of plastic waste into usable form, without altering its chemical structure
  - ✓ Collection → Identification → Sorting / Separating (Into types and forms of plastic) → Grinding / Shredding → Washing → Drying → Agglomerating / Mixing →Extruding / Compounding →Pelletizing
- Helps in Resource Conservation, Energy Savings & Waste Reduction
  - ✓ Sorting can be either manual or automated
  - ✓ Shredders use rotating blades to cut plastics into small particles, while granulators further reduce these particles into uniform sizes suitable for washing and subsequent processing
  - ✓ Washing equipment like hot water baths, friction washers, and chemical detergents that clean and rinse the plastic particles thoroughly are used
- Challenges in mechanical recovery are Contamination, Material Limitations and Sorting Complexity

Feedstock or Chemical Recycling

- Plastics can be depolymerized by pyrolysis process and equivalent process and fed back into the cracking process to form into their basic monomeric chemical constituents or into hydrocarbon fractions, can then be used either as polymerization, feedstock or in other useful applications and chemical processes.
- Waste generated out of mixed plastics, commingled plastics and plastics materials made out of a combination of different plastic materials are generally difficult for normal recycling (mechanical recycling).
- Mixed plastics including thermosetting plastics can be converted in to Light Diesel Oil (LDO) range of oil having useful applications.
- Evolved methane gas can be trapped and be used to produce electricity or be used as gaseous fuel.

Biological or Organic Recycling

- Applicable for compostible plastics
- "compostable plastics" means plastic that undergoes degradation by biological processes during composting to yield CO2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable or toxic residue;
- "Biodegradation" means Degradation caused by biological activity, especially by enzymatic action, leading to a significant change in the chemical structure of a material (see IS/ISO 16929).
- Compostable plastics start decomposing only after few months in industrial composting conditions
- IS /ISO 17088 : 2021 Compostable plastics - Specification (Second Revision) specifies the details of how to correctly identify compostable plastics, and compostable products made from plastics, which can be recovered by organic recycling, i.e. will disintegrate and biodegrade satisfactorily together with biowaste producing compost as an outcome, in composting or in anaerobic digestion followed by composting, and will not leave any persistent or hazardous residues.

Clause 5.2.4 of IS 14534

Energy Recovery

- One of the viable option in industries
  - ✓ for co-generation of electricity
  - ✓ Steam generation
- High calorific value
- No segregation of plastics required
- Need to comply with regulatory requirements for emissions and ash
- By direct combustion or co-combustion of plastics wastes in systems such as
  - ✓ Plasma Pyrolysis Technology (PPT),
  - ✓ municipal solid-waste incinerators
- By Co-Processing in lime and Cement Kilns

For selection of recycling options…

- Compliance to be verified with whether the option can :
  - ✓ minimize adverse environmental impact;
  - ✓ enhance the circular recycling of plastics;
  - ✓ Prove in Prior demonstration of sustainable commercial viability;
  - ✓ Secure access to viable systems for collection and quality control; and
  - ✓ Access to appropriate recycling technologies, if recyclates are intended to be used in food contact material.
  - ✓ Addressing contaminants
- Suitable traceability system for the target market may be set up as per IS/ISO 14000 series
- In recyclates, visual and aesthetic aspects often present major difficulties
- Define criteria for the acceptance of recyclate for a specific application

Clause 6 of IS 14534

Identification Marking

- Manufacturers of plastics end products from either virgin or recycled plastics shall mark the symbol at the time of processing in order to help the re-processors to identify the basic raw material

- While marking the symbol 7, the name of respective basic raw material like ABS, PPO, PC, PBT, etc, and any blend or alloy shall be indicated below the symbol.
- The product made from recycled/reprocessed plastics/regranulated plastics should be marked with appropriate symbol or marking of percentage of recycled material used based on certification of recycled content.
  - ✓ *Example*: the product containing 25 percent recycled plastic shall be marked with R25
- Audit and certification of manufacturing facilities shall be required for traceability

Clause 7.2.1 & 7.2.2 of IS 14534, PWMR 2021 & google picture

Suggestive list of items from recylates….

Product	*Material*
Trash/Garbage bags	PE
Carry bags	PE
Office supplies - File folders, binder covers, presentation folders, etc.	PVC, PE, PP
Containers for detergents, petroleum products, pallets, including reusable packaging containers	PE, PP, PS, PET
Containers for eggs, fruits and vegetable	PE, PP, PS, PET
Horticultural supplies — Planters, trays, flowerpots, nursery bags. tarpaulin	PE, PVC, PP PS
Building products — Wood substitute such as fencing, shingles, etc.	PS, PVC, PC
Municipal supplies — Garbage bins, wheel burrows, etc.	PE, PP
Carpets and floor mats, playground equipment's, jacket, T-shirts, sports-wear, geo-textiles, tool handles, footwear, luggage, etc.	PE, PP, PET, PS
Recreational equipment — Garden furniture, etc.,	PE, PP
Twine (Sutli), box strapping for packaging	PP, PE, Nylon
Pipes and fittings for cable, ducts/conduits SWR, drainage, agricultural	PVC, PE, PP)
Shoes, Sleepers	PVC
Film, sheet	PET, PVC, PE, PP
Furniture (Kitchen, shoe rack wardrobes etc.)	PET

Clause 7.5 of IS 14534

Some other Indian Standards on the subject….

- IS 14535 : 1998 Recycled plastics for the manufacturing of products – Designation
- IS 16591 (Part 1) : 2016/ISO 18263-1 : 2015 Plastics - Mixtures of polypropylene PP and polyethylene PE recyclate derived from pp and pe used for flexible and rigid consumer packaging Part 1 Designation system and basis for specification
- IS 16630 (Part 1) : 2018 Plastics - Post-consumer poly ethylene terephthalate pet bottle recyclates Part 1 Designation system and basis for specifications
- IS/ISO 17088 : 2021 Compostable plastics - Specification Second Revision
- IS 17899 T : 2022 Assessment of biodegradability of plastics in varied conditions

Our role to control plastic pollution…..

- Proper Sorting and Disposal
- Reduce Single-Use Plastics
- Know Your Plastics
- Educate Others
- Choose Recycled Products
- Stay Informed


thank you!