BHARATHIDASAN UNIVERSITY
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Programme: M.Sc., Environmental Science

Course Title: Solid and Hazardous waste Management

Course code: CC07

Unit III

Municipal Solid Waste Management

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Solid Waste Processing and Recovery

- Processing is the second fundamental function of solid waste management.
- Processing improves the efficiency of solid waste disposal and prepares solid waste for subsequent recovery of materials and energy.
- Disposal of solid wastes includes open dumps, sanitary landfills and sea disposal.
- Because of environmental problems associated with open dumps and sea disposal, the only acceptable method of solid waste disposal at present is sanitary land filling.
- The organics from solid wastes can be processed biologically to produce compost.
- Electricity can be recovered from solid waste.

Recycling

- The recovery of components for possible use as raw materials is called recycling.
- Recycling is a significant way to keep large amounts of solid waste out of landfills, conserve resources, and save energy.
- The technology of recycling involves collection, separation, preparing the material to buyer's specifications, sale to markets, processing and the eventual reuse of materials.
- Separation and collection is only the first step; if the material is not also processed and returned to commerce, then it is not being recycled.

- In many parts of the country, markets are not yet sufficiently developed to handle the growing supply of collected material.
- The materials recycled today include **aluminium**, paper, glass, plastics, iron and steel, scrap tires, and used oil. Aluminium, particularly cans, is a valuable commodity.
- Recycled paper shows up in newsprint, roofing shingles, tar paper, and insulation.
- Other recyclable paper products include old corrugated containers, mixed office waste, and high-grade waste paper.
- Contaminants must be removed from paper products before the remanufacture process can begin, however, food wastes, metal, glass, rubber, and other extraneous materials.
- The market for crushed glass, or cullet, has increased. Recycled glass is used to make fiber glass and new glass containers.

- Three types of plastic are successfully being recycled, the most common being PET (polyethylene terephthalate), or soft drink containers.

- Recycled PET is used for fiber fill in sleeping bags and ski jackets, carpet backing, **automobile** bumpers, bathtubs, floor tiles, and paintbrushes.

- HDPE plastic (high density polyethylene) is used for milk jugs and the bottoms of soft drink bottles. It can be recycled into trash cans and flower pots, among other items.

- **Polystyrene** foam is crushed into pellets and turned into plastic lumber for benches and walkways.

- Commingled plastics are recycled into fence posts and park benches.

- Iron and steel are the most recycled materials used today.
- The material is remelted and shaped into new products.
- Recycling collection methods vary, but curb side collection is the most popular and has the highest participation rates.
- It is also the most expensive way for municipalities to collect **recyclables** in their communities.
- Collection centres do not yield as many recyclables because residents must do the sorting themselves, but centres offer the most affordable method of collection.

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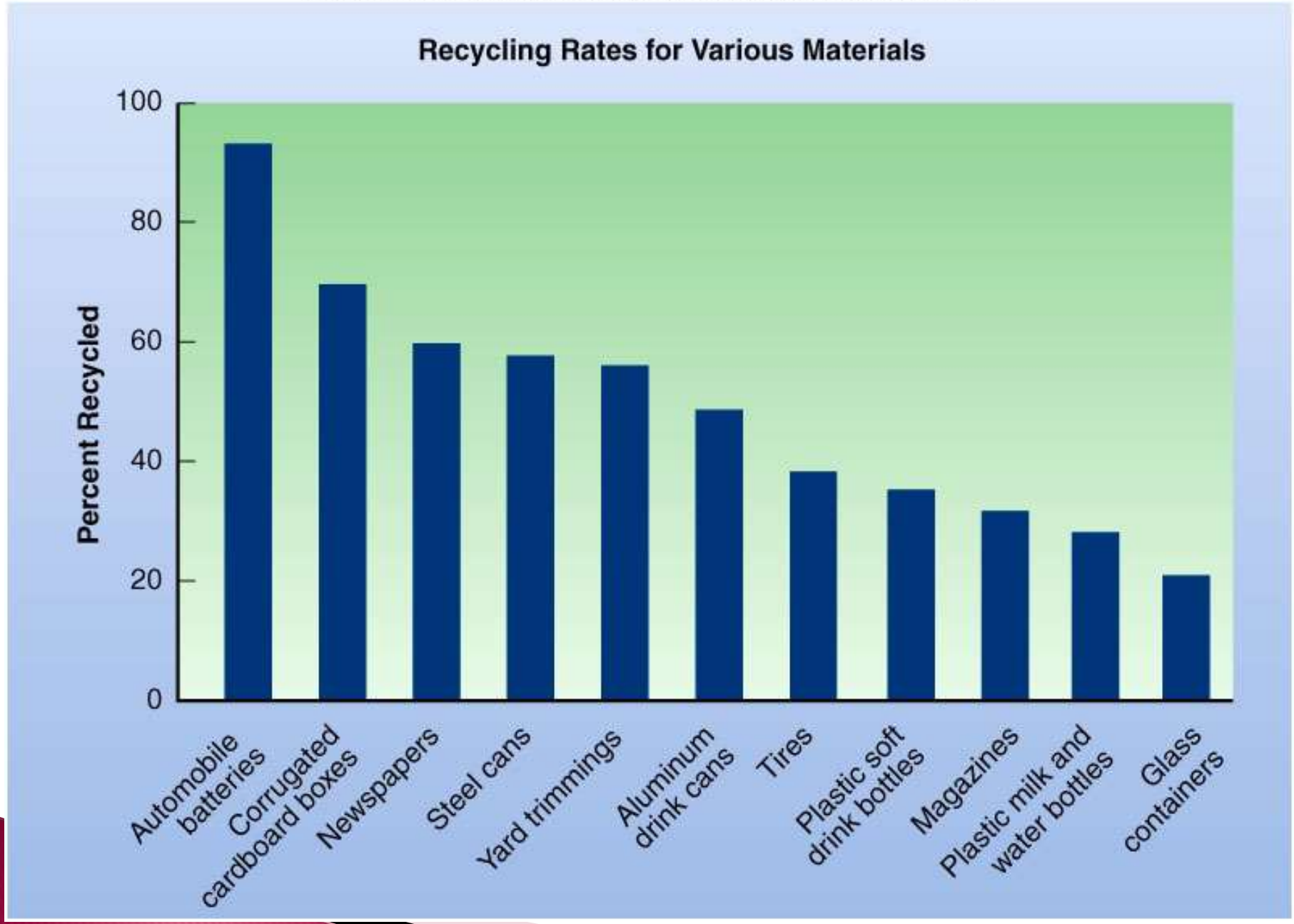


Recovery of materials for recycling

- Processing to segregate solid waste components may be done at the point of generation or at a central processing facility.

- On-site processing needs the cooperation of the waste producer:

  Homes

  Commercial establishments

  Industries

- In On-site processing, wastes are segregated into types at the point of generation.

- If On-site processing is not done segregation into components may be done at central facility.

- Unit operations in a central facility involve:
- Screening
- Air classifying
- Magnetic separations

- Size reduction using shredders, although not a segregation or separation process, is also used to produce a more uniformly sized product.

- Magnetic separation involves the use of electromagnets.

- This unit operation is used only to separate ferrous materials from the rest of the solid waste.

Screening

- Screening is a unit operation of a feed into oversize and undersize products.
- Oversize products are those that do not pass the openings of the screen.
- Undersize products are those that do pass the openings of the screen.
- Screens may be classified as primary, secondary and tertiary screens, depending on where in flow sheet the unit is located.
- The screen with the largest size opening is the primary screen.
- The trommel (A rotating cylindrical sieve or screen used for washing and sorting pieces of ore or coal.Synonym:drum) is a primary screen. They are put ahead of all separation facility.

- Feed should not be allowed simply to cascade down the length of a trommel screen, nor should it be allowed simply to centrifuge on the side.
- Cascading is due to a slow rotation, while centrifuging is due to a fast rotation.
- The ideal operation would be to allow the feed to climb up the sides of the screen and to drop when it reaches the summit of the rotation.
- Let the screen be inclined at an angle γ and let the tangential velocity of rotation be v_t .
- $M g \cos \gamma = M \frac{v_t}{r}$

Where M is the mass of solid waste, g the acceleration due to gravity , and r is the radius of the trommel screen. Solving for v_t ,

$$v_t = \sqrt{gr \cos \gamma}$$

Converting equation to angular speed ω using the relation $v_t = r\,\omega$, we obtain

$$\omega = \frac{\sqrt{gr \cos \gamma}}{\sqrt{r}}$$

Shredding

- Shredders are brute-force machines that pound, crush, pulverize and shred wastes.
- A number of types of shredders are available, but the one commonly used in recycling operations is the horizontal axis hammer mill.
- Wastes dropped into the top are pounded by hammers until they are reduced to a small enough size to fall through the bottom grate.
- As a way to help prolong the relatively short life of the hammers, wastes are often prescreened before the hammer mill to remove objects that are already sufficiently small.

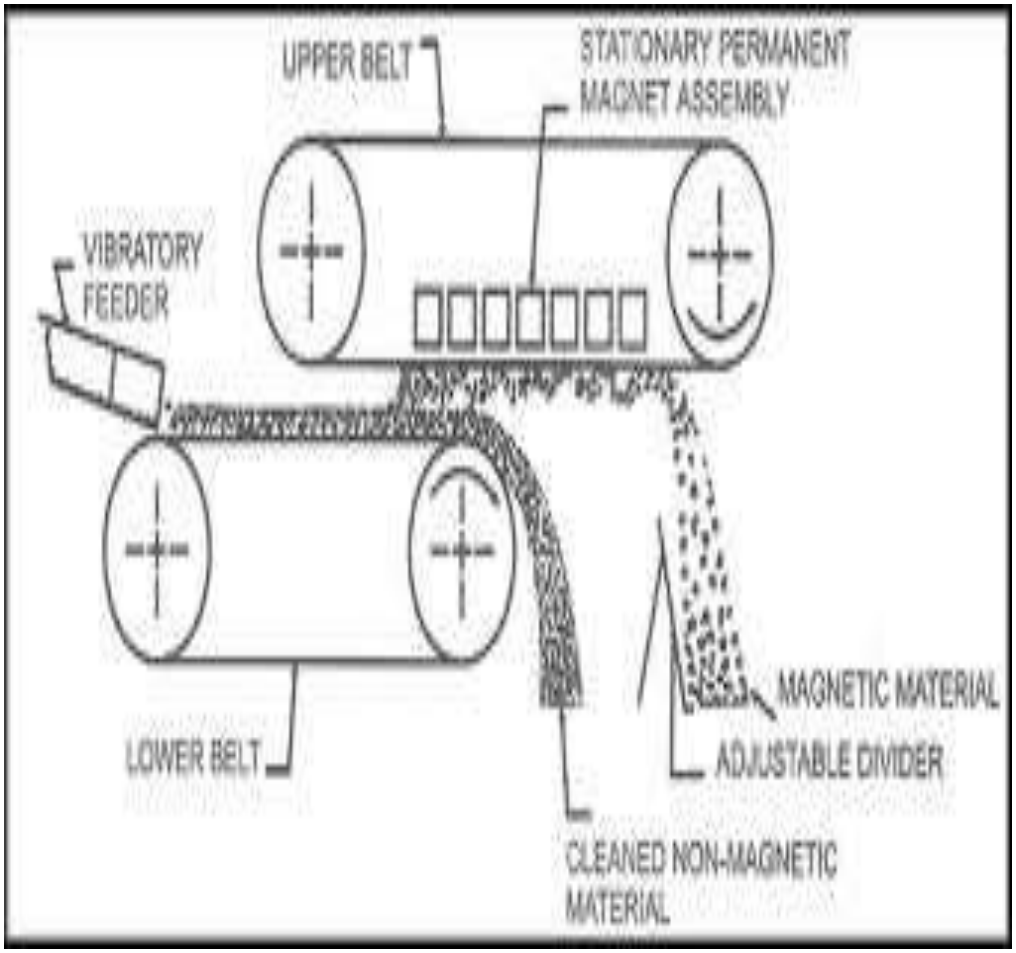
- Even if there is no materials for recovery, shredding has several advantages when used as a precursor to landfilling.

- Shredded refuse compacts better within a landfill, reducing the storage volume needed.

- Shredded waste does not need daily cover because it does not have large amount of food materials, rat and insect problems are also minimized without daily covering.

Magnetic seperators

- After materials have been broken into small enough particles, they can be passed by magnets to remove ferrous metals.
- A number of design variations are possible, but they are all similar in nature.
- Ferrous metals are picked up by the magnet and moved away from the remaining materials on the main conveyor belt.



Air classifiers

- An **air classifier** is an industrial machine which sorts materials by a combination of size, shape, and density.
- It works by injecting the material stream to be sorted into a chamber which contains a column of rising air.
- Inside the separation chamber, air drag on the objects supplies an upward force which counteracts the force of gravity and lifts the material to be sorted up into the air.
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- Due to the dependence of air drag on object size and shape, the objects in the moving air column are sorted vertically and can be separated in this manner.

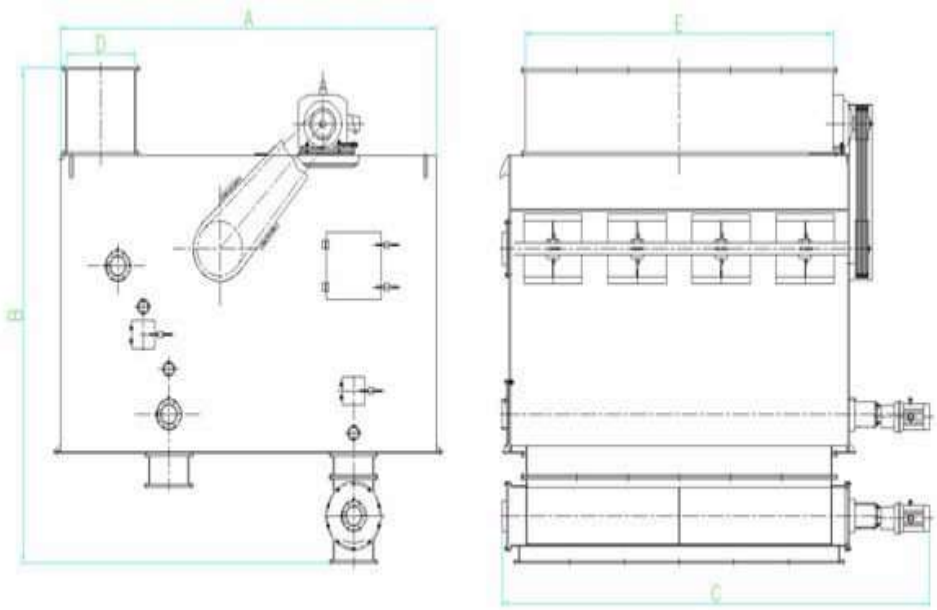
- Air classifiers are commonly employed in industrial processes where a large volume of mixed materials with differing physical characteristics need to be sorted quickly and efficiently.

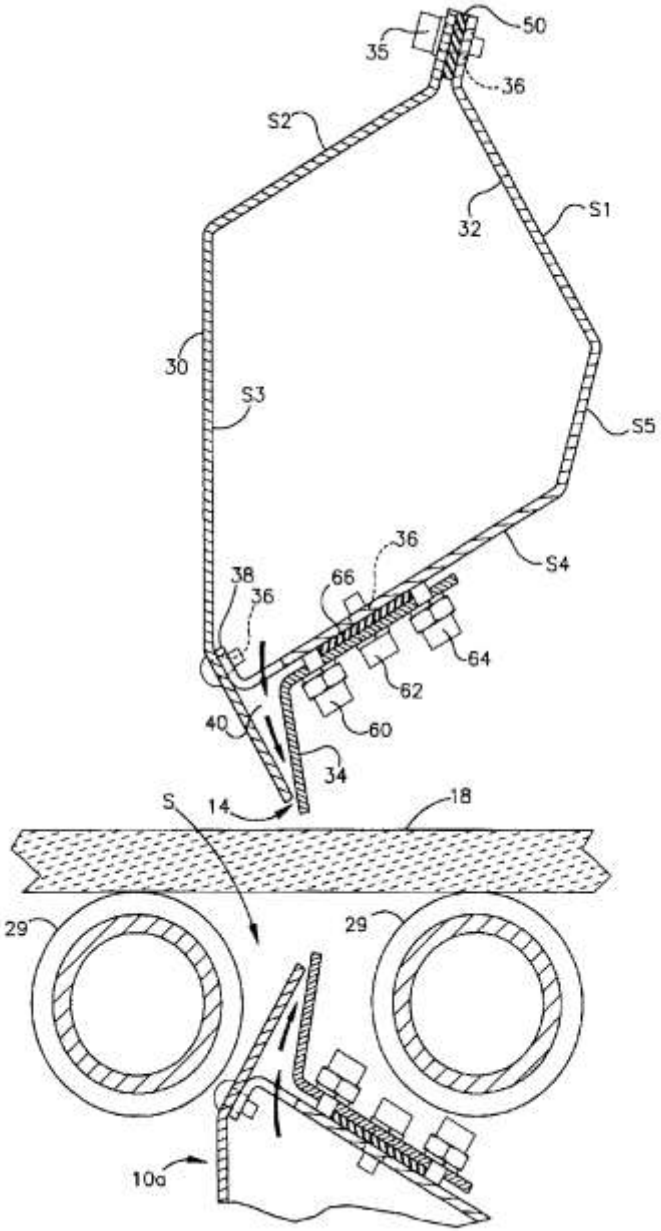
- One such example is in recycling centres, where various types of metal, paper, and plastics arrive mixed together and need to be sorted before further processing can take place.

- In one version of air classifier, called air knife, light particles such as plastic and paper are blown over barriers that separate a number of collection bins.

- Heavy particles are not affected much by air stream, so they fall into the first hopper.

Air classifiers





Economics of Recycling

- Hidden Costs:

- One reason recycling appears to be uneconomical is that some people already pay a higher cost for trash disposal than they realize.
- Some local governments pay fees to hauling companies, transfer stations, or landfills out of local tax revenue.
- That lowers the direct cost to residents and businesses, making the regular trash pickup appear to be less expensive than it really is.
- But when recycling programs begin, residents usually directly pay the full cost of recycling.
- This can distort the cost comparisons between the recycling program and disposing of trash at landfills.

Depletion Costs:

- Recycling also is economical because costs associated with future disposal are avoided.
- One of these avoided costs is for landfill depletion. Landfills have limited space, and so can receive a limited amount of trash.
- When it is full, it must be replaced by another landfill that is generally more expensive to operate and maintain.
- This is due to higher costs of complying with environmental regulations, higher expenses in sitting a new location, buying or allocating land, constructing the landfill, operational expenses, and long-term maintenance costs after the landfill is closed.
- Additionally, the new landfill may be further away than the old landfill, increasing transportation costs.
- Generally, a new landfill costs more than an older one. Paying the higher cost at a new landfill is avoided by keeping the older landfill open longer.
- Recycling and other waste-reducing methods keep the older landfill open longer.
- Because these avoided costs are not seen when people pay the bills, they do not usually think of the savings recycling produces.

Environmental Costs:

- Recycling is economical in several ways related to manufacturing processes. Recycling cuts down on waste produced by processing raw materials into usable forms.
- For example, recycling aluminium reduces mining wastes, processing wastes, and emissions produced by extracting the aluminium from the ore. Recycling usually requires less refining than raw materials.
- For example, it takes much less energy to melt down an aluminium can to make another aluminium can than to process the raw materials to make a can.
- This cuts down on chances for environmental damage and conserves our natural resources.
- With any product, the costs of cleaning up wastes and limiting emissions usually are passed on to consumers who purchase the product. But sometimes damage to the environment is not realized for years, is difficult to attribute to certain industries, or is caused by a combination of many industries.
- Acid rain is one example of this type of environmental damage. The costs of dealing with this pollution are hard to assess, but are paid for by everyone in efforts to improve the environment.

Energy Savings:

- Manufacturing products from recycled material also can save energy.
- The energy required to produce one aluminium can is equal to the energy embodied in the amount of gasoline it takes to fill the can half full.
- While recycling saves energy, that does not always mean that industries save money by using recycled materials.
- Labour costs for recycled products are often higher than those used in processing virgin material.
- Materials recovered from curb side collection, drop-off centres, and material recovery facilities must be separated, cleaned, and processed.
- Making a product from recycled material may require new or retrofitted equipment and other capital expenditures while virgin material supplies and equipment needed to produce most goods already exist.
- But since recycling saves energy, it also cuts down on pollution emitted by utilities and the companies themselves.

- When energy is used, the price of the resulting pollution is passed on to all energy consumers in their utility bills.
- Due to the new clean air law, utility companies must comply with tougher standards in reducing pollutants they release while producing energy.
- The cost of compliance is usually passed on to each energy consumer.
- If energy use is reduced by methods such as recycling, less pollution is produced.
- That reduces everyone's cost in terms of paying to reduce pollution and in limiting damage to natural resources.
- Once the long-term costs and advantages are weighed, recycling does make economic sense. Using resources wisely is always economical.

Solid waste management rules

- **Municipal solid waste (Management & Handling) Rules, 2016.** Municipal solid waste (Management & Handling) Rules, 2016 are applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solids.

* **Schedule-I :** Relates to implementation Schedule
* **Schedule-II** : Specifications relating to collection, segregation, storage, transportation, processing and disposal of municipal solid waste (MSW).
* **Schedule-III** : Specifications for land filling indicating; site selection, facilities at the site, specifications for land filling, Pollution prevention, water quality monitoring, ambient air quality monitoring, Plantation at landfill site, closure of landfill site and post care.
* **Schedule-IV** : Indicate waste processing options including; standards for composting, treated leachates and incinerations.

- As per these Rules, every municipality is responsible for providing integrated services and infrastructure facilities for solid waste management within its jurisdiction.
- Its responsibilities are defined all the way from preparing the community for segregated collection to inoffensive storage, transportation, appropriate processing and safe disposal from environmental and health point of views.

- For the collection stage, the Rules recommend door to door collection of segregated waste, as well as separate collection from slaughter houses, meat and fish markets, fruit and vegetable markets etc. with the objective of 'managing to make use of' highly biodegradable wastes.
- While horticulture waste is supposed to be collected separately and disposed off by following 'proper norms', the Rules do not clarify what these norms could be. Similarly no norms are specified for dairy waste management, instead reference is given to state laws. However, the Rules clearly prohibit open burning of any kind of waste during the collection stage.

- Emphasis on treatment
- With regard to treatment, the Rules recommend adoption of a suitable technology or a combination there of with the objectives of making use of wastes and to minimise burden on the landfill.
- For the biodegradable fraction of waste the Rules recommend treatment by composting, vermicomposting, anaerobic digestion or any other appropriate biological process so as to stabilise it.
- In other cases, options of incineration with or without energy recovery and pellatisation are also suggested. In case of any other state of-the-art technologies, the Rules recommend to get the approval of the Central Pollution Control Board before developing any project.

- Disposal
- For the last element in the supposedly integrated chain, i.e., disposal, the Rules recommend land filling of only that type of waste which is neither recyclable nor biologically processable. The Rules do not recommend land filling of mixed waste as long as it is found to be suitable for any processing.
- With regard to location of the treatment and disposal facilities, the Rules recommend integration of landfill site with the processing plant and vice versa. Among the mitigation measures, provision of impermeable liners for the landfill, leachate collection and treatment system, diversion of storm water drains and prevention of runoff into water bodies is mandatory.

Initiatives at national level

- CPCB and MoEF and other Central Ministries such as Ministry of Urban Development (MoUD) and Ministry of Non-Conventional Energy Sources (MNES) have taken initiatives to facilitate implementation of MSW rules. Some of the initiatives taken are briefly summarized as under ***Demonstration Projects*** **.**

Demonstration Projects

S.No	State	Town
1	West Bengal	North Dum-Dum New Barrakpore
2	UT Chandigarh	Chandigarh
3	Tamil Nadu	Udumalpet
4	Kerala	Kozhikode (MoEF)
5	Himachal Pradesh	Mandi
6	Andhra Pradesh	Suryapet
7	Nagaland	Kohima
8	Maharashtra	Jalna
9	Arunachal Pradesh	Itanagar
10	Sikkim	South West District
11	Tripura	Agartala
12	Gujarat	AUDA (MoEF)

Questions

- 5 marks
- Write a detailed note on the Solid waste management rules (2000).

QUESTIONS

- 2 MARKS
- What do you mean by recycling of solid wastes ?
- What materials of solid waste can be effectively recycled ?
- What are HDPE materials? Can they be recycled?
- What is shredding of solid wastes? How is it done?
- Why shredding of solid waste is done before land fill operations?

5 MARKS

- Elaborate on the recyclable rates of different materials constituting solid wastes.
- What are the unit operations performed for solid waste processing?
- What is screening ? How is it done ?
- What are shredders?Explain.
- What are Magnetic separators? Explain.

10 MARKS

- What are Air classifiers? Explain about them with a neat sketch.
- Discuss the solid waste processing involving the unit operations.
- Discuss the economics of solid waste recycling.