

19

WASTE GENERATION AND MANAGEMENT

Syllabus : Sources of waste – domestic, industrial, agricultural, commercial and other establishments.

Domestic waste : *paper, glass, plastic, rags, kitchen waste, etc.*

Industrial : *mining operations, cement factories, oil refineries, construction units.*

Agricultural : *plant remains, animal waste, processing waste.*

Municipal sewage : *Sewage, degradable and non degradable waste from offices, etc.*

e-waste : *brief idea about e-waste.*

Methods of safe disposal of waste : *Segregation, dumping, composting, drainage, treatment of effluents before discharge, incineration, use of scrubbers and electrostatic precipitators.*

Segregation of domestic waste into biodegradable and non-biodegradable by households, garden waste to be converted to compost; sewage treatment plants.

19.1 WHAT IS A WASTE ?

Waste is any substance which is discarded after primary use, or it is worthless, defective and of no use.

Ever since the human society has been evolving with huge population growth, there has been ever-increasing demand for the primary needs of food, shelter and clothing, etc. This has led to the rapidly increasing size and number of towns, cities, large agricultural fields, storage godowns, factories, interconnecting roads, railways and so on. With these, there has also been increasing use of electricity, firewood, petroleum and even nuclear energy. All this is leading to more and more human body wastes, livestock wastes, discarded equipments, agricultural wastes, etc. Efficient methods of their disposal are being continuously improved.

19.2 CATEGORIES OF WASTES

Broadly there are five major categories of waste:

- (i) **Domestic waste** given out from homes,
- (ii) **Industrial waste** given out from factories, thermal plants, etc.,
- (iii) **Agricultural waste** that is left behind after obtaining the consumable parts,
- (iv) **Municipal waste** which includes the overall waste given out from the township, and
- (v) **e-waste (electronic waste)** from electrical and electronic equipment.

19.2.1 DOMESTIC WASTE :

An average home produces the following types of wastes :

- (i) **Kitchen waste** : Several items such as :
 - Peelings of vegetables and fruits,
 - Shells taken off from ground nuts and other dry fruits, and from eggs
 - Washing of pulses, rice, etc. before cooking,
 - Any stale or rotten non-usable food items, used tea leaves
 - Any left overs in the food dishes.
- (ii) **Plastics** :
 - Plastic packings and wrappings
 - Discarded used and broken plastic objects including toys, etc.
- (iii) **Glass** :
 - Broken glass utensils, mirrors, containers, window panes, electric bulbs.
- (iv) **Rags** :
 - A huge variety of waste pieces of cloth, torn towels, handkerchiefs, etc.
 - Old bed sheets, blankets, cushions.
 - Discarded worn out clothing and footwear, curtains, and so on (Some of these are reused by the poor, or are sold off to the “raddiwalas”).
- (v) **Paper** : The daily newspapers and magazines are a very common waste (which are generally sold off to “raddiwalas” who pass them on for a variety of use). Such waste paper is even recycled for their reuse in some way in paper industry.

19.2.2 INDUSTRIAL WASTE :

There is a huge variety of industries producing different types of materials and articles. All of these use raw material and give out a lot of waste. Some of these are as follows :

- (i) **Mining operations** : There are hundreds of mines in India alone and thousands in the world, which extract copper, silver, gold, zinc, iron, coal, etc. Huge quantities of waste are produced while processing them. Such waste is usually called *mine tailing* (the left-over). The mine tailing mixed with other materials can be used for making tiles, masonry cement, etc.
- (ii) **Cement industries** : The wastes given out may be solid, liquid and gaseous.
 - The solid wastes are either used in construction activities or dumped in land-fills.
 - The liquid wastes including wash-offs are treated to remove harmful substances and then released into the rivers, ponds, lakes, or sea.
 - The gaseous wastes include the *flyash* which consists of fine solid particles of non-combustible ash carried out of a bed of solid fuel by a draft. It can be used for making a variety of building materials like bricks, concrete, roofing sheets.
- (iii) **Oil refineries** : While refining crude oil a lot of poisonous gaseous and liquid wastes are produced.
 - Gaseous waste is cleaned by passing through cleaners, and purified part is released into the atmosphere.
 - The liquid wastes are processed and suitably dumped.
- (iv) **Construction units** : These produce huge quantities of waste stones, pebbles, broken bricks, wood waste, etc. Mostly these are dumped in *landfills*. This is particularly a huge waste in large towns, and one sees heaps of landfills in the suburbs.

19.2.3 AGRICULTURAL WASTE :

Agriculture is the art of cultivating the soil, producing crops and raising livestock (farm animals). The agricultural waste mainly includes :

- **Agricultural residues** : The plant parts left after obtaining the usable portions. Much of this is used as animal feed.

- **Bagasse** is the plant residue (as of sugar cane) after extracting the sugarcane juice). These are used as fire wood or in paper industry.
- **Pesticides** and **fertilizers** collect into the soil and are washed off with the irrigation and rain water leading to river and pond pollution. Strict precautions have to be taken in their use.
- **Animal wastes** include cow dung and other faecal matter which is used in making manure.

19.2.4 MUNICIPAL WASTE :

Municipal waste includes the following :

- (i) Household discharge of excreta (faecal matter from toilets), and kitchen washings.
- (ii) Discharge from public toilets, hospitals, hotels, restaurants, offices, etc.

All this waste is carried away through sewers, and is called the **sewage**. This sewage is separated into:

- **the degradable** part (capable of being broken down chemically into non-toxic parts) and
- **the non-degradable** portion.

Septic tanks are used to degrade the degradable part. The non-degradable part is dumped or buried at safe places.

19.2.5 e-WASTE :

e-waste is the abbreviation of electronic waste. It consists of the discarded appliances using electricity, such as old computers, TVs, refrigerators, radios, cell (mobile) phones, mobile batteries, fluorescent tubes, electronic toys, medical instruments, lead-acid batteries, etc.



Fig. 19.1 Discarded cellular phones

e-waste may contain harmful substances as well as some valuable reusable material :



Fig. 19.2 A scrap dealer is burning some electronic waste equipment to extract metals from it. It is a harmful practice which gives out poisonous gases.

- **Harmful substances:** Lead, Cadmium, Mercury, *etc.*
- **Valuable materials:** Gold, Silver, Copper, *etc.*

Generation of e-waste : The e-waste is mostly generated in large cities, but as the living standards are fast improving, even the smaller cities and towns are getting flooded with electronic gadgets and thus contributing to e-waste.

Disposal of e-waste : The rag pickers and waste dealers (kabadis) obtain the discarded electronic gadgets. They remove the usable components or extract the secondary raw materials. But these recycling processes are harmful causing health problems including cancers. Burning of printed wiring boards give out harmful fumes if inhaled and certain residues which may unknowingly enter food chains via the crops cause body ailments.

Recycling : Most electronic devices contain a variety of materials including metals which can be recovered for future use, but it needs to be done very carefully under skilled supervision.

Special “e-bins” should be kept at places for dumping discarded e-waste material, and municipal agencies should make special arrangement for their final disposal.

19.2.6 SCIENCE TEACHING & RESEARCH LABORATORIES WASTES

As the country is progressing, more and more

teaching institutes and research laboratories are coming up. Their waste material is of varied nature – broken or discarded glass apparatus, condemned machines, waste chemicals, animal and plant wastes from biology laboratories, and from their culture rooms. All such waste needs to be properly disposed off either in deeply dug out pits or burnt in special enclosures.

Disposal of discarded radioactive material needs special care. Any carelessness in it can be threat to human health. A well-known case was recently reported in Delhi when the radioactive cobalt-60 was found to have been passed on to waste dealers who had dumped it in the open in a well-inhabited colony. Some affected humans badly suffered from it.



PROGRESS CHECK

1. How will you categorise the following under domestic and industrial wastes ?
Rags, used containers, old newspapers, mine tailing (left overs), flyash, kitchen waste, broken bricks.
2. What is bagasse ?
3. Name any two categories of chemicals which are washed off as wastes from agricultural fields
4. What are the two portions into which the municipal sewage is separated ?
5. In which category of wastes will you include the non-functioning discarded
 - (i) Mobile phones,
 - (ii) Thermometers,
 - (iii) Photocopying machines.

19.3 METHODS OF SAFE DISPOSAL OF WASTES

The wastes are of so many types. Their disposal also requires different suitable methods. These methods mainly include : segregation, dumping, composting, drainage, treatment of effluents, incineration, scrubbers, electrostatic precipitators, *etc.*

19.3.1 SEGREGATION

Segregation means separating the refuse mainly into three categories : **reusable**, **degradable** and **non-degradable** parts.

- **Reusable** waste includes items such as Paper (newspaper, old books, discarded exercise books, *etc.*). Can you imagine the bulk of examination answer books piling up into tons and tons of weight. All such paper can be recycled. The

metallic components also can be separated and reused.

- **Degradable** such as organic wastes (vegetable and fruit peeling, *etc.*) can be decomposed into useful manure. Such degradation involves the activity of microorganisms, so it is also called **biodegradation**.
- **Non-degradable** part such as certain plastics can be dumped.

19.3.2 DUMPING

The non-degradable waste can be put at certain places in specially dug up pits away from human habitations.

19.3.3 COMPOSTING

Composting means putting the waste organic matter to decay so that it can be used for fertilizing the agricultural land.

Method of preparing compost :

- A trench of about 5 m long, 1.5 m wide and 1.5 m deep is dug.
- A layer of well mixed refuse and waste is spread in it for about 30 cm thickness.
- This layer is fully wetted with a watery mixture of cow-dung and some mud.
- A second layer of mixed refuse is spread over the first layer till the heap rises to project above the ground level by about half a metre.

The set up is left as such for about 3 months. Then the trench is opened, its material is taken out and rearranged in conical heaps and covered by earth. About 50-60 days later the mass called **compost** is ready for application in the cultivation fields or in garden flower beds, *etc.*

Such town refuse compost is becoming quite popular. For example, in Delhi what is known as "Okhla Khad" is mainly from garbage (food waste) and human sewage (night-soil).

One of the latest method is to use *dry composting toilets*. This is hygienic and cost effective solution to human waste disposal.

19.3.4 DRAINAGE

A proper system of drains is required to carry away all kinds of fluid wastes other than sewage. If

not so done, the watery fluids would accumulate in pits and puddles and will become the breeding places for mosquitoes and other harmful insects.

19.3.5 TREATMENT OF EFFLUENTS BEFORE DISCHARGE.

The industrial and municipal waste waters are treated in *Effluent Treatment Plants* before disposing them off into water bodies. This is done in three parts :

1. **Primary treatment** : Separation of large debris by sedimentation in tanks.
2. **Secondary treatment** : The waste water is pumped into oxidation ponds where microorganisms (bacteria, algae, *etc.*) oxidise the organic matter releasing CO₂, and a solid precipitated material *sludge* is produced that can be used as manure.
3. **Tertiary treatment** involves removal of dissolved chemicals, metals or even pathogens and then the waste water is discharged into natural waters or is used for irrigation.

19.3.6 INCINERATION

Incineration is the disposal of waste by burning.

Incineration serves three main purposes:

- It reduces the volume of wastes
- Reduces weight of the waste
- Renders toxic wastes into less toxic or even non-toxic wastes.

Impact of incineration

- Releases fumes and harmful substances,

Precautions :

- Incineration should be carried out at very high temperatures
- Should be equipped with pollution control devices.
- Incinerators should be installed away from residential areas.

The left over after incineration contains about 25% of waste residue as an **ash**. The ash should be deposited in landfills.

Advantages of incineration :

- (i) The ash left over occupies much less landfill space.
- (ii) The residual bottom ash can be used for the recovery of some metals in it.

- (iii) Electricity can be generated from the heat released during burning.

19.3.7 SCRUBBERS

The scrubbers are devices to remove *gaseous* and *particulate air pollutants*. In these, the air is passed through a dry or wet packing material. Fig. 19.3 gives a diagrammatic representation of a typical scrubber. The air passing out of the scrubber is dust-free clean, as well as free of certain gaseous pollutants which get dissolved in the wet packing.

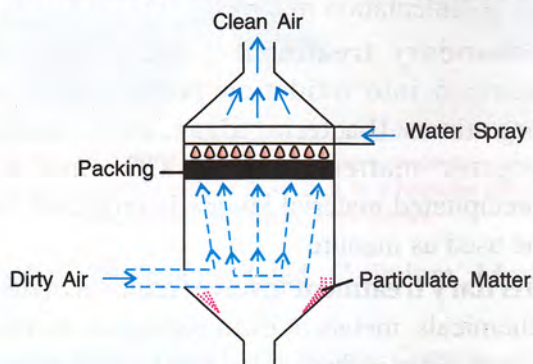


Fig. 19.3 Scrubber

19.3.8 ELECTROSTATIC PRECIPITATORS

The dirty air containing particulates is passed through a chamber containing electrically charged plates. The particles may be naturally electrically charged and as they pass through the charged plates of the precipitators they get collected on the plates

carrying opposite charge and the clean gas passes out. The electrostatic precipitators can remove upto 90% of particulate matter from thermal plants.

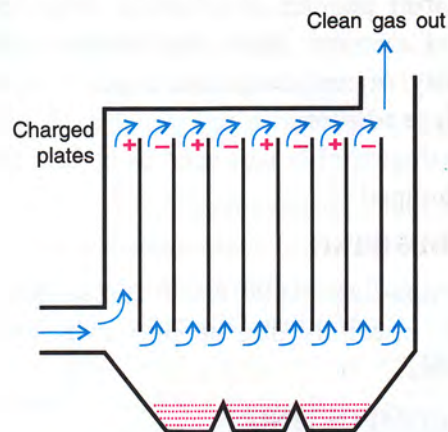


Fig. 19.4 A plate type electrostatic precipitators



PROGRESS CHECK

1. Name the three categories of wastes under segregation
2. Which categories of wastes require dumping ?
3. Is it true that composting is a useful method contributing in crop farming ?
4. What is sluge ?
5. Can incineration lead to certain kind of pollution? Yes/ No.
6. Name two types of devices used for removing particulate air pollutants.

POINTS TO REMEMBER

- Any thing discarded as of no use is a waste.
- Domestic wastes include kitchen left overs, discarded non-usuable plastic, glass, packagings, etc.
- Old newspapers constitute a large bulk of reusable waste.
- The liquid wastes from oil refineries are suitably dumped.
- Large cities and towns often have landfills in their neighbourhood for dumping construction wastes in particular.
- The metallic parts, if any, in the domestic or industrial wastes are separated out for reuse.
- Agricultural crops refuse is used as animal feed, in paper industry, making manure, etc.
- Municipal sewage includes discharges from residential and public utility places.
- Septic tanks are used to degrade the organic portion of the waste.
- Electronic (e-) waste includes a huge variety of discarded electrical items.
- e-waste has to be sorted out into harmful substances like lead, mercury and useful valuables such as silver, copper, gold, etc.
- Most e-waste contains reusable materials and can be recycled.

- *Safe disposal of municipal waste includes segregation, dumping, composting, etc.*
- *Composting is putting the waste organic matter to decay for its use as manure.*
- *Effluents (flowing out wastes) are usually treated in special treatment plants — for separating large debris, decomposing organic matter by microorganisms, to produce sludge used as manure and after removing dissolved reusable parts discharged into natural waters or fields.*
- *Incineration is the method of burning the waste to reduce the volume and weight and to remove the poisonous wastes.*
- *Scrubbers are used to remove gaseous and particulate air pollutants.*
- *Electrostatic precipitators remove particulate air pollutants by attracting them to electrically charged plates.*

REVIEW QUESTIONS

A. MULTIPLE CHOICE TYPE

1. The most convenient reusable wastes are
 - (a) Old newspapers
 - (b) Broken glass
 - (c) Flyash
 - (d) Medical instruments
2. The most rapidly increasing and much harmful waste today is
 - (a) plastics
 - (b) pesticides
 - (c) municipal sewage
 - (d) electronic waste

B. VERY SHORT ANSWER TYPE

1. Name the following :
 - (a) The solid precipitated material produced during secondary treatment of the effluent, carried out in the suffluent Treatment Plants.
 - (b) The two types of devices commonly used for removing the particulate air pollutants.
2. Mention whether the following statements are true (T) or false (F).
 - (a) Some of the electronic wastes may contain valuable metals such as gold and copper (T/F)
 - (b) Flyash is the gaseous waste of cement industry (T/F)
 - (c) Electricity is one of the primary needs of human society. (T/F)

3. Match the items in Column I with as many items as possible in Column II.

Column I	Column II
1. Cow dung	(i) Sugarcane
2. Bagasse	(ii) Raddiwalas
3. Old newspapers	(iii) Manure

C. SHORT ANSWER TYPE

1. Differentiate between degradable and non-degradable type of waste.
2. Give reasons for the following :
 - (a) Broken glass utensils are a kind of non-degradable waste.
 - (b) Landfills are coming up fast near large cities.
 - (c) Why is municipal sewage first separated into degradable and non-degradable wastes.

D. LONG ANSWER TYPE

1. Define electronic waste and list at least six items which come under this category.
2. List some of the common wastes produced in mining operation and mention how these can be reused.
3. Describe the procedure how compost is usually produced.
4. Describe the usefulness of incineration of wastes, and also mention the precautions required in it.