UNIT-IV: **SOLID WASTE MANAGEMENT**: Definition of Solid waste, characteristics of solid waste, solid waste management: collection, transportation, processing treatment, disposal methods and e-waste management, 3R techniques: reduce, reuse, and recycle.

Definition

- **Solid wastes** are defined as all the discarded solid materials from municipal, industrial, and agricultural activities.
- Solid wastes are simply defined as any solid material which have reached its end of life or discarded by its owner. Municipal solid waste (MSW) commonly known as : trash or garbage, refuse or rubbish.
- **Hazardous waste** is waste that poses substantial or potential threats to public health or the environment.

Types of Solid Waste

- House hold waste that is normally termed as **Municipal Solid Waste.**
- Industrial waste is termed as a **Hazardous waste.**
- Hospital waste or **Biomedical waste** that is infectious.

SOLID WASTE

GREEN WASTE

CONSTRUCTION WASTE

Characteristics of municipal solid waste

Solid wastes are grouped or classified in several different ways. 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 and institutions. However MSW does not include wastes from industrial processes, construction and demolition debris, sewage sludge, mining wastes or agricultural wastes.

Solid-waste collection

Collecting and transporting

Solid waste collection and transport involves storage at the generation and pick-up points, pick up by the crew, trucks driving around the neighborhood, and truck transport to a transfer station or disposal point. The collection is difficult, complex and costly. Collection of solid waste typically Solid Waste Management: Its Sources, Collection, Transportation and Recycling consumes 60-80 percent of the total solid waste budget of a community. Therefore, any improvement in the collection system can reduce overall cost significantly

The problems associated with recycling are either technical or economical.

- **Plastics are difficult to recycle because of the different types of polymer resins used in their production.**
- **Since each type has its own chemical makeup different plastics cannot be recycled together.**
- **Thus separation of different plastics before recycling is necessary.**
- Similarly in recycled paper the fibers are weakened and it is difficult to control the color of the recycled product.
- Recycled paper is banned for use in food containers to prevent the possibility of contamination.
- It very often costs less to transport raw paper pulp than scrap paper.

Collection, sorting and transport account for about 90 percent of the cost of paper recycling.

- **The processes of pulping, de-inking and screening wastepaper are generally more expensive than making paper from wood or cellulose fibers.**
- Very often thus recycled paper is more expensive than virgin paper. However as technology improves the cost will come down.

Processing treatment:

Disposal of solid waste is done most commonly through an incineration process.

Incineration **is the process of burning municipal the solid waste in a properly designed furnace under suitable temperature and operating conditions.**

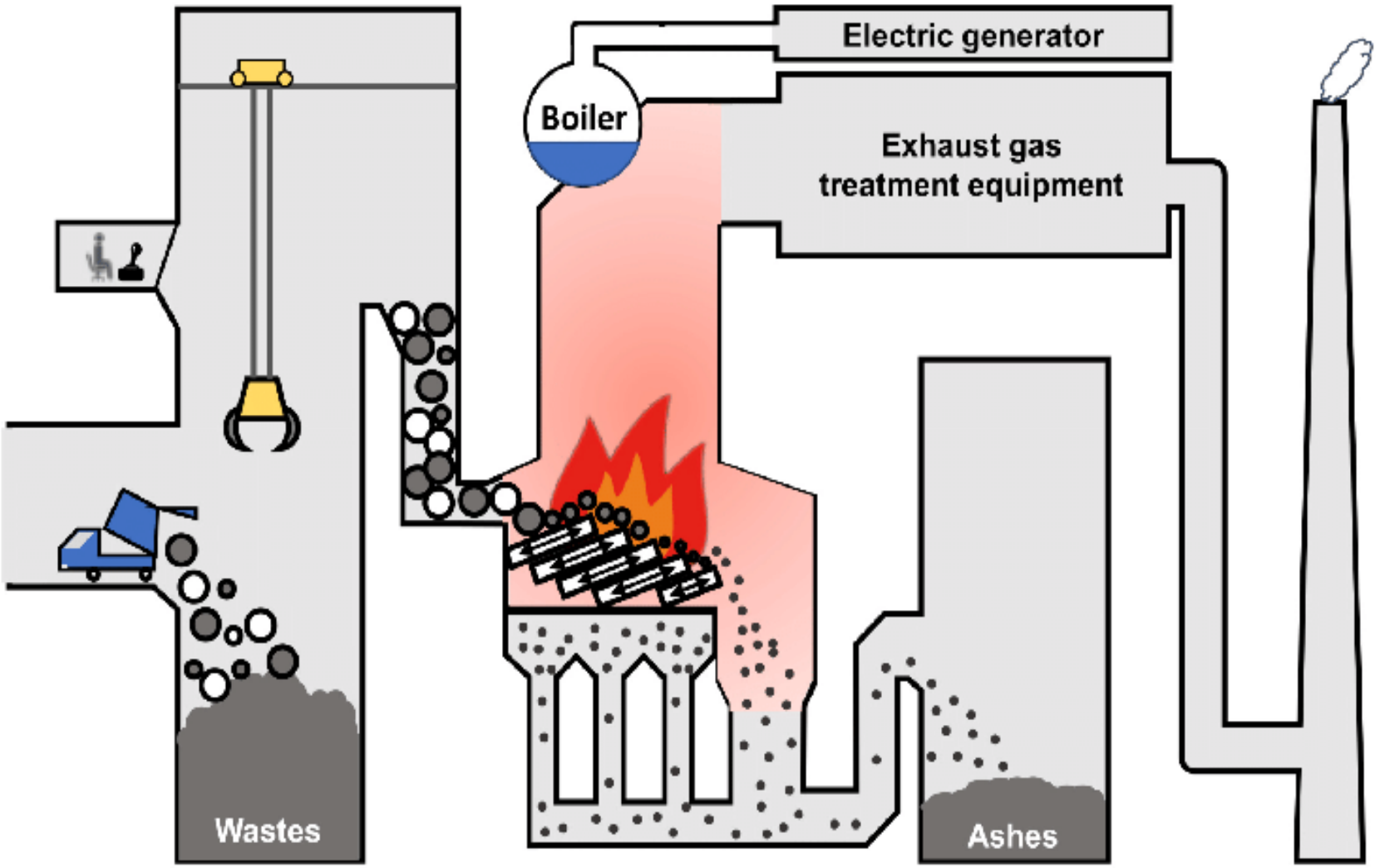
Incineration is a chemical process in which the combustible portion of the waste is combined with oxygen forming carbon dioxide and water, which are released into the atmosphere.

This chemical reaction called oxidation results in the release of heat. For complete oxidation the waste must be mixed with appropriate volumes of air at a temperature of about 815^{o}C for about one hour. Incineration can reduce the municipal solid waste by about 90 percent in volume and 75 percent in weight.

The risks of incineration however involve air quality problems and toxicity and disposal of the fly and bottom ash produced during the incineration process. Fly ash consists of finely divided particulate matter, including cinders, mineral dust and soot.

The possible presence of heavy metals in incinerator ash can be harmful. Thus toxic products and materials containing heavy metals (for example batteries and plastics) should be segregated.

Thus extensive air pollution control equipment and high-level technical supervision and skilled employees for proper operation and maintenance is required. **Thus the most effective method of solid waste management is source reduction and recycling.**

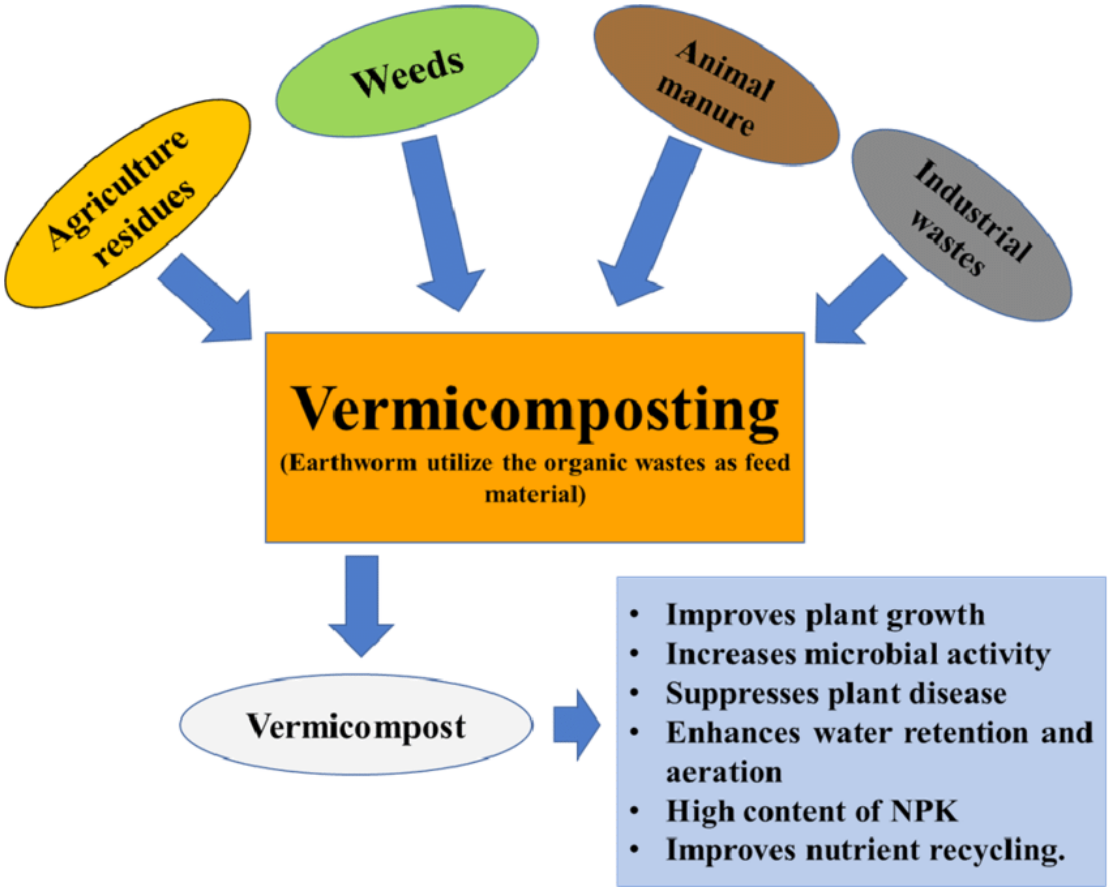

Electric generator
Boiler
Exhaust gas
treatment equipment
Wastes
Ashes

Disposal Method

Vermi – Composting

Nature has perfect solutions for managing the waste it creates, if left undisturbed. **The biogeochemical cycles are designed to clear the waste material produced by animals and plants**.

We can mimic the same methods that are present in nature. All **dead and dry leaves and twigs decompose and are broken down by organisms such as worms and insects, and is finally broken down by bacteria and fungi, to form a dark rich soil-like material called compost. These organisms in the soil use the organic material as food, which provides them with nutrients for their growth and activities**. These nutrients are returned to the soil to be used again by trees and other plants. This process recycles nutrients in nature. **This soil can be used as a manure for farms and gardens.**


Weeds
Animal manure
Agriculture residues
Industrial wastes
Vermicomposting
(Earthworm utilize the organic wastes as feed material)
Vermicompost
• Improves plant growth
• Increases microbial activity
• Suppresses plant disease
• Enhances water retention and aeration
• High content of NPK
• Improves nutrient recycling.

Steps for Vermi-Compost

- Dig a pit about half a meter square, one meter deep.
- Line it with straw or dried leaves and grass.
- Organize the disposal of organic waste into the pit as and when generated.
- Introduce a culture of worms that is now produced commercially.
- Ensure that the contents are covered with a sprinkling of dried leaves and soil everyday.
- Water the pit once or twice a week to keep it moist.
- Turn over the contents of the pit ever 15 days.
- In about 45 days the waste will be decomposed by the action of the microorganisms.
- The soil derived is fertile and rich in nutrients.

E-WASTE MANAGEMENT

Table 1: Effects of E-Waste constituent on health

Source of e-wastes	Constituent	Health effects
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (PB)	• Damage to central and peripheral nervous systems, blood systems and kidney damage. • Affects brain development of children.
Chip resistors and semiconductors	Cadmium (CD)	• Toxic irreversible effects on human health. • Accumulates in kidney and liver. • Causes neural damage. • Teratogenic.
Relays and switches, printed circuit boards	Mercury (Hg)	• Chronic damage to the brain. • Respiratory and skin disorders due to bioaccumulation in fishes.
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Hexavalent chromium (Cr) VI	• Asthmatic bronchitis. • DNA damage.
Cabling and computer housing	Plastics including PVC	Burning produces dioxin. It causes • Reproductive and developmental problems; • Immune system damage; • Interefere with regulatory hormones
Plastic housing of electronic equipments and circuit boards.	Brominated flame retardants (BFR)	• Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: • Muscle weakness; • Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	• Carcinogenic (lung cancer) • Inhalation of fumes and dust. Causes chronic beryllium disease or beryllicosis. • Skin diseases such as warts.

"E-waste" is a popular, informal name for electronic products nearing the end of their "useful life. "E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. The **hazardous content of these materials pose a threat to human health and environment.**

Discarded computers, televisions. VCRs. stereos, copiers, fax machines, electric lamps, cell phones, audio equipment and batteries if improperly disposed can leach lead and other substances into soil and groundwater. Many of these products can be reused, refurbished, or recycled in an environmentally sound manner so that they are less harmful to the ecosystem.

MANAGEMENT OF E-W ASTES

It is estimated that 75% of electronic items are stored due to uncertainty of how to manage it. These electronic junks lie unattended in houses, offices, warehouses etc. and normally mixed with household wastes, which is finally disposed off at landfills. This necessitates implement able management measures.

In industries management of e-waste should begin at the point of generation. This can be done by waste minimization techniques and by sustainable product design. Waste minimization in industries involves adopting:

1. **Volume reduction,**
2. **Recovery and reuse.**

1. Volume reduction

Volume reduction includes those techniques that remove the hazardous portion of a waste from a non-hazardous portion. These techniques are usually to reduce the volume, and thus the cost of disposing of, a waste material. The techniques that can be used to reduce waste-stream volume can be divided into 2 general categories: **source segregation and waste concentration.**

Segregation of wastes is in many cases a simple and economical technique for waste reduction. Wastes containing different types of metals can be treated separately so that the metal value in the sludge can be recovered.

Concentration of a waste stream may increase the likelihood that the material can be recycled or re-used.

2. Recovery and reuse

This technique could eliminate waste disposal costs, reduce raw material costs and provide income from a salable waste.

For example, a printed-circuit board manufacturer can use electrolytic recovery to reclaim metals from copper and tin-lead plating bath. However recycling of hazardous products has little environmental benefit- it simply moves the hazards into secondary products that eventually have to be disposed of.

Sustainable product design

Minimization of hazardous wastes should be at product design stage itself keeping in mind the following factors.

- ***Rethink the product design***: Efforts should be made to design a product with **fewer amounts of hazardous materials.**
- ***Use of renewable materials and energy****:* Bio-based plastics are plastics made with **plant-based chemicals or plant-produced polymers** rather than from petrochemicals. Bio-based toners, glues and inks are used more frequently. **Solar computers** also exist but they are **currently very expensive**.
- ***Use of re-useable materials*** : **designers could ensure the product is built for re-use, repair and/or upgradeability**.

3R TECHNIQUES: REDUCE, REUSE, AND RECYCLE

REDUCE

- REDUCE simply means living more carefully so that you have **less** rubbish to get rid of, avoiding waste is the preferable option of waste management.
- For example, use online materials, avoid using papers excessively.
- Eg. When shopping look for and purchase products with minimal packaging.

REUSE

- REUSE means to use the same item more than once, preferably many times rather than disposing of it after one use.
- For example, reuse glass for other purposes such as vases or other decorations.

RECYCLE

- RECYCLE means to process used materials into new products to save resources and energy.
- For example, papers for wrapping presents, use used paper to sketch or do calculation.