SOLID WASTES MANAGEMENT

TYPES OF WASTES

- Solid waste: any unwanted or discarded material we produce that is not a liquid or gas.

- Municipal Solid Waste : produce directly from homes.
- Industrial Solid Waste : produced indirectly by industries that supply people with goods and services.
- Agricultural Waste and Residues
- Hazardous Waste : threatens human health or the environment because it is toxic, chemically active, corrosive or flammable.

Nuclear Waste, Biomedical Waste

Municipal solid waste

- Municipal solid waste (MSW) is generated from households, offices, hotels, shops, schools and other institutions.
- The major components are food waste, paper, plastic, rags, metal and glass, plus
- small quantities of hazardous waste, such as electric light bulbs, batteries, automotive parts and discarded medicines and chemicals.

Industrial Solid Waste

- Industrial solid waste encompasses a wide range of materials of varying environmental toxicity.

Agricultural Waste and Residues

- Expanding agricultural production has naturally resulted in increased quantities of
- livestock waste,
- agricultural crop residues and
- agro-industrial by-products.

Waste from Automobiles*:*

- includes exhaust contain various poisonous gases due to incomplete combustions of petrol in cars.
- old not working vehicles are dumped that adds more waste to the environment.

Hazardous Waste

- A **hazardous waste** is waste that poses substantial or potential threats to public health or the environment. There are four factors that determine whether or not a substance is hazardous:
- ignitability (i.e., flammable)
- reactivity
- corrosivity
- Toxicity

Hazardous waste could be incinerated in cement industry

Nuclear Waste

- The safe disposal of radioactive wastes is the problem.
- Radioactive wastes must be stored in an isolated area where they can't contaminate the environment.

Bio-Medical Waste

- It differs from other hazardous waste because of its source of generation. Spread of infection and disease through vectors (fly, mosquito, insects etc.) which affect the in -house as well as surrounding population.

- waste from different health care institute like hospitals, nursing homes involves items like
- different expired medicines,
- operational ingredients,
- used needles & syringes,
- used bandage,
- blood,
- pharmaceuticals.

Electronic Waste : A Growing Problem

- Electronic waste, e-waste, e-scrap, or Waste Electrical and Electronic Equipment (WEEE) describes loosely discarded, surplus, obsolete, or broken electrical or electronic devices.
- Electronic waste is rapidly increasing as mobiles, laptops / computers old televisions, washing machines & other electronic gadgests,……so on are replaced by new gadgets .
- Some electronic scrap components, such as CRTs, contain contaminants such as lead, cadmium, beryllium, mercury, and brominated flame retardants.
- Toxic chemicals in electronics products can reach into the land over time or are released into the atmosphere, impacting nearby communities and the environment.
- Therefore, Europe has outlawed using landfills for computer components

PLASTIC POLLUTION

- Plastics are macromolecules, formed by polymerization
- Plastics have the ability to be shaped by the application of reasonable amount of heat and pressure or any other form of forces.
- Polyethylene, polyvinyl chloride, polystyrene is largely used in the manufacturing of plastics.

  - Relatively inexpensive to produce.
  - Plastic is persistent in the environment, can do great harm.
  - Plastic material is resistance to chemicals, water and impact and is biologically inert.
  - It has good safety and hygiene properties for food packaging.
  - Excellent thermal and electrical insulation properties.
  - They are less brittle than Glass, yet they can be made equally transparent and smooth.

Disadvantages of Plastics

Do not biodegrade

A lot of energy is used in producing these bags. The plastic bags are made from non-renewable sources

Hard to Reuse, Recycle

Plastic bags do not only pollute our water but also our land

Plastic bags are harmful to wildlife and marine life & to human health

- ✓ Plastics Release Pollutants:
  - **Bisphenol A (plasticizer)**
  - Phthalates
- ✓ Plastics Absorb Hydrophobic Pollutants:
  - ✓ Polychlorinated biphenyls (PCBs)
  - ✓ Dichloro Diphenyl Trichloro ethane (DDT)

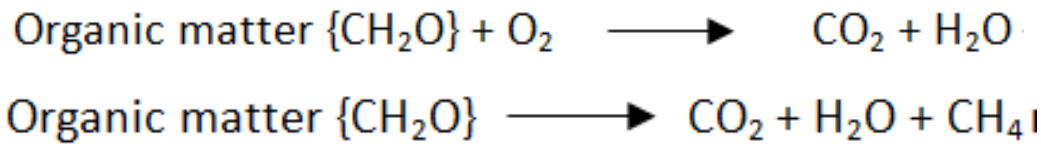
THREAT TO ANIMALS

- ✓ Discarded Plastic usually ends up within marine sources. The Pacific Ocean has one of the largest dumping ground for plastics, unknown numbers of sea birds, marine mammals and fish ingest plastics which causes a variety of negative health effects.
- ✓ Plastic toxins end up in fish, which end up on our plates, which end up inside our bodies.

TREATMENT OF SOLID WASTE

Open Dumping

- Most widespread method of solid waste disposal
- Uncontrolled disposal of waste without measures to control leachate, dust, odor, landfill gas or vermin.
- Open burning of waste is practiced at dumpsites.
- Waste is dumped along the shoreline and into the sea.

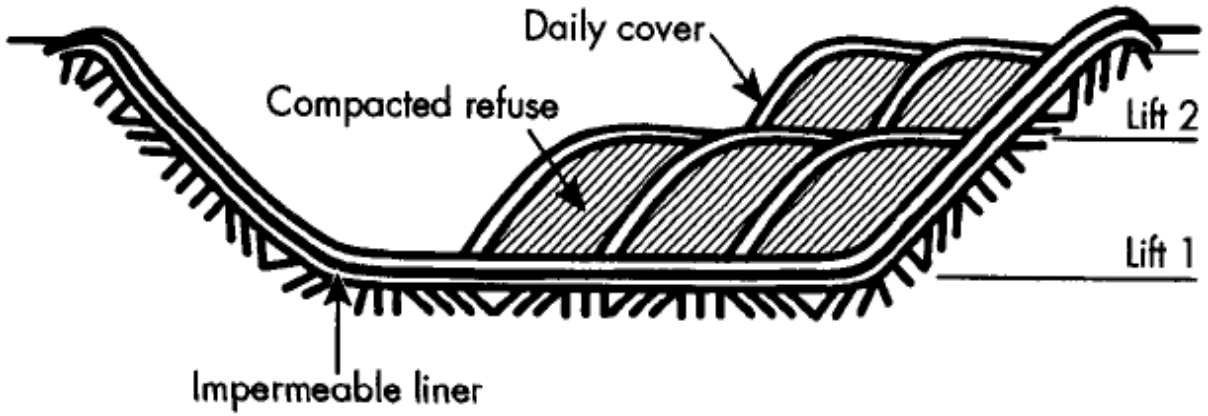


Drawbacks :

- scarcity of available land.
- build-up of landfill gas (predominantly methane), which can lead to outbreaks of fire
- and adverse health effects on workers and adjacent residents (area is surrounded by smoke).
- Usually the fire starts with unsustainable practice of open dumping of refuse and it can spread accidentally.
- Occasional fires began spontaneously from the heat given off by decomposition or by glass on open dump acting as a lens for sunlight. Flammable industrial wastes increase the danger of fire and can convert old tyres into toxic gases (dioxins and furans).

Landfills

- The sanitary landfilling operation involves numerous stages, including citing, design, operation, and closing.
- The liner is made of plastic (typically PVC) and a layer of clay that further reduces the chance of leakage into the groundwater of the liquid produced by the landfill during the decomposition of the waste.
- Typically, refuse is unloaded, compacted with bulldozers, and covered with compacted soil.
- Landfilling is the compaction of refuse in a lined pit and the covering of the compacted refuse with an earthen cover.
- The landfill is built up in units called *cells* . The daily cover is between 6 and 12 inches thick depending on soil composition , and a final cover at least 2 feet thick is used to close the landfill.



- The liquid produced is collected by pipes laid into the landfill as it is constructed.
- Gases produced by the decomposing waste must be collected and either vented or collected .
- When the landfill is full, a cover must be placed on it such that the seepage of rainwater into the landfill is minimized.
- A land fill continues to subside after the closure, so that permanent structures cannot be built onsite without special foundations.
- Closed landfills have potential uses as golf courses, playgrounds, tennis courts, winter recreation or parks and greenbelts.

<u>The disadvantages are:</u>

(i) It frequently requires longer and more costly hauls than other methods.
(ii) It requires more land than some other methods that makes it difficult to obtain suitable sites at reasonable cost in big cities.
(iii) Operational problems may occur during inclement weather, and
(iv) If proper action is not taken it causes health hazards as insects and rodents may breed.

Problem 3. Estimate the required landfill area for a community with a population of 260,000. Assume that the following conditions apply:

1. Solid waste generation $= 7.6\ \text{lb/capita} \cdot \text{day}$
2. Compacted specific weight of solid wastes in landfill $= 830\ \text{lb/yd}^3$
3. Average depth of compacted solid wastes $= 60\ \text{ft}$

Calculate area required/day for each cell (area required per day).

Solution

Determine the daily solid wastes generation rate in tons per day:

$$= \frac{(260{,}000\ \text{people})(7.6\ \text{lb/capita} \cdot \text{day})}{2000\ \text{lb/ton}} = 988\ \text{ton/day}$$

The required area is determined as follows:

$$\text{Volume required/day} = \frac{\text{Mass of SW}}{\text{sp. wt. of SW}}$$

$$\text{Area required / day} = \frac{\text{Volume of SW}}{\text{Depth of compacted SW}}$$

Energy from Landfill

- ✓ MSW contains 150-250 kg of organic carbon per ton which micro-organisms convert to landfill gas via anaerobic processes.
- ✓ Landfill gas production starts one to two years after the waste is deposited in the landfill and lasts 15-25 years.
- ✓ Consequently, 1 million tonnes of MSW generate 1.7-2.5 million m^3 of collectable methane (this data is **ONLY FOR YOUR INFORMATION, NOT TO MEMORIZE**),
- ✓ landfill gas constitutes a high-value fuel for gas engines that can be effectively used for power generation.

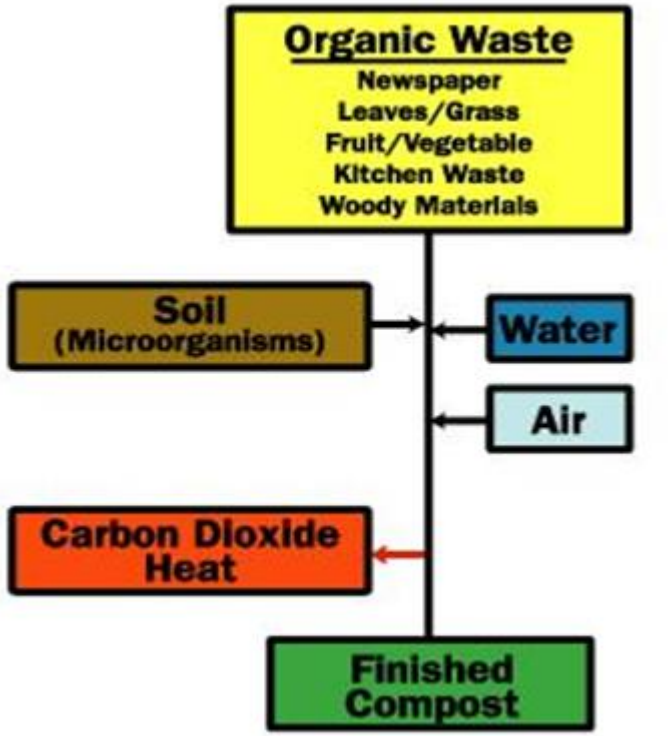
Landfill Gas Composition

THE FOLLOWING TABLE IS ONLY FOR YOUR INFORMATION, NOT TO MEMORIZE

Landfill Gas Component	Composition (by volume)
Methane (CH_4)	35-55%
Carbon dioxide (CO_2)	30-44%
Nitrogen (N_2)	5-25%
Oxygen (O_2)	0-6%
Water vapour	Saturated

Composting

- treating solid waste in which organic material (kitchen, garden *waste generated in household* sector) is broken down by microorganisms in the presence of oxygen to a point where it can be safely stored, handled and applied to the environment.
- can be done inexpensively by every household and produce a product -- finished compost or humus -- that can benefit the environment as a natural fertilizer for gardening and farming.
- Composting is a process during which microorganisms break down complex organic matter into its basic elements.



Biomass + O_2 (Aerobic/bacteria) $\rightarrow$ CO_2 + H_2O + Organic manure

Composting

- Through the process, the carbon released as the carbon dioxide, once locked up in the organic matter as sugars or more complex molecules, is made available to plants for photosynthesis.
- Can include anything except meat or dairy
- Benefits:
  - Keeps organic wastes out of landfills
  - Can be used as organic fertilizer, because it provides nutrients to the soil
  - Reduces the need for fertilizers and pesticides
  - Increases beneficial soil organisms (e.g., worms and centipedes)
  - Protects soils from erosion

Example household-sized compost pile.

- ❖ For composting a proper ratio of carbon-rich materials, or browns, and nitrogen-rich materials, or greens is mixed.
- ❖ Among the brown materials are dried leaves, straw, and wood chips. Nitrogen materials are fresh or green, such as grass clippings and kitchen refuse.
- ❖ The micro organisms require carbon as an energy source and nitrogen for the synthesis of some proteins.
- ❖ Raw materials should normally be blended to approximately 35:50 (by weight) carbon to nitrogen ratio by weight.
- ❖ The other important factor is water content. From a microbial standpoint, optimal water content should be 40 to 60% range.
- ❖ Application of the compost with either a high or low C/N ratio can have adverse effects on both the soil and the plants.
- ❖ A high C/N ratio can be corrected by dehydrated mud and a low ratio corrected by adding cellulose.

Composts (humas)

- A sweet-smelling, dark-brown, humus-like material that is rich in organic material and soil nutrients.

Waste Management Policies

I. Waste reduction and reuse

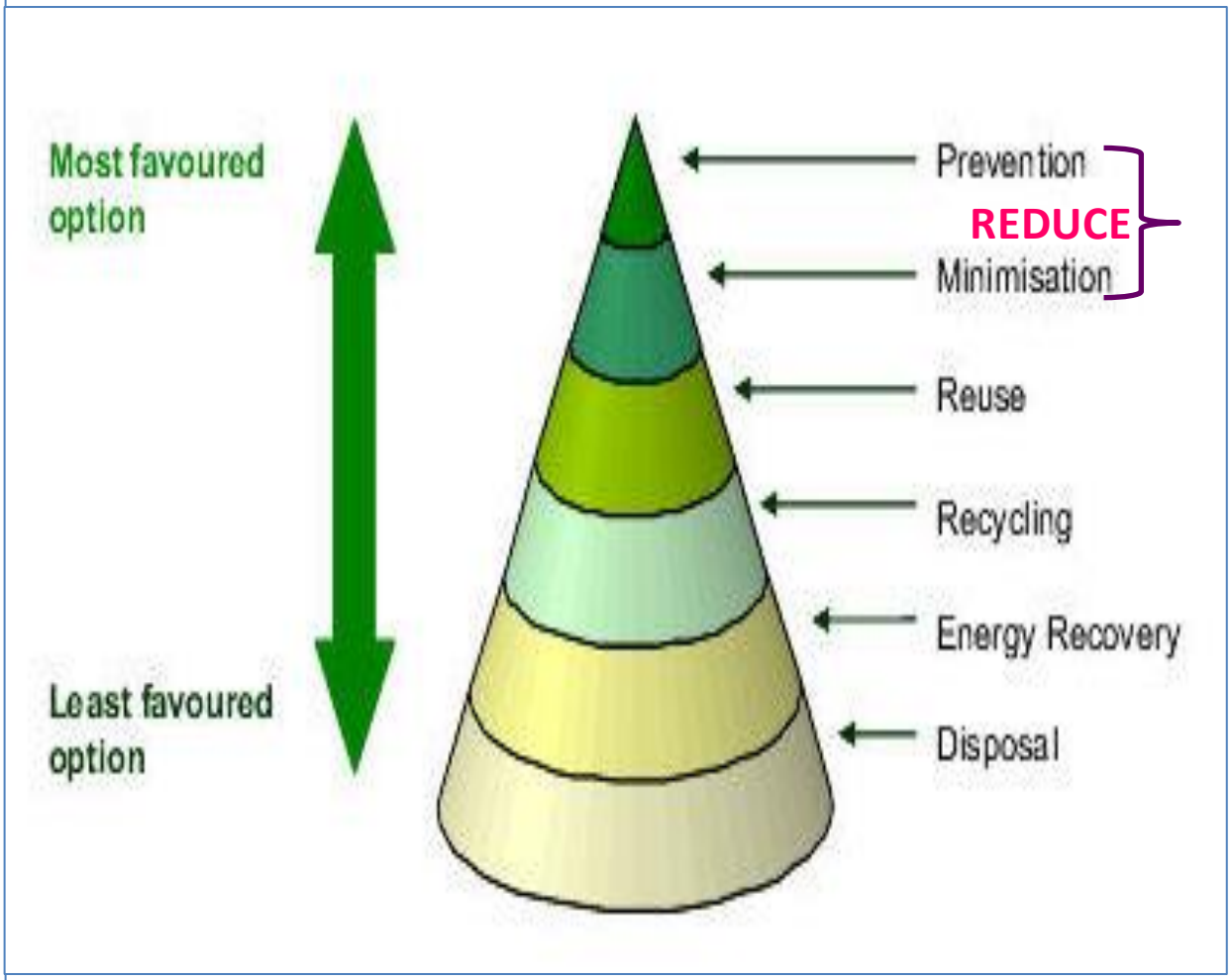
II. Recovery, Reuse and Recycling

WASTE HIERARCHY

The waste hierarchy is a guide when determining the Best Practicable Environmental Option and represents a chain of priority for waste management, extending from the ideal of prevention and reduction to the last resort of disposal.

The waste hierachy shows that *waste prevention, or attempts to generate minimum waste are the preferred options.*

Recycling and disposal of waste are lower in the waste management hierarchy, as these options both *require additional energy and resources to reduce waste levels*.



1. Waste reduction and reuse

- ✓ Waste reduction and reuse of products are both methods of waste minimization.
- ✓ They eliminate the production of waste at the source of usual generation and

Waste minimization is a process of elimination that reduces the amount of waste produced in society and helps eliminate the generation of harmful and persistent wastes,

Measures to control :

1. ***Efforts to minimize generation of waste***
2. ***Waste exchanges***
3. Resource optimization
3. Reuse of scrap material
4. Durability

2. Waste Exchange

- This is where the waste product of one process becomes the raw material for a second process.

IIT Madras Innovates Eco-Friendly Low-Cost Houses

⇒ There have been numerous efforts to build low-cost houses across the country. Most innovative among them is the method created by IIT Madras students, who have built *low-cost, eco-friendly houses* by using '*Glass Fibre Reinforced Gypsum' (GFRG) panels*.

⇒ *Gypsum (*hydrated calcium sulphate*) is generated as waste at various fertilizer plants*.

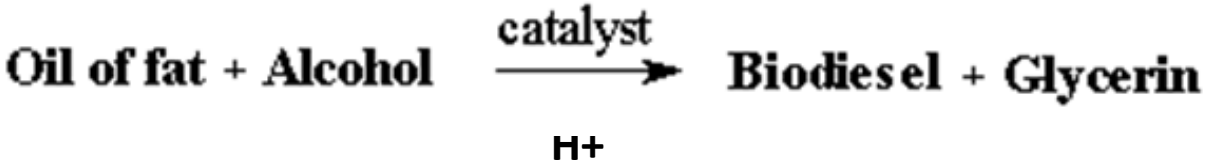
⇒ By calcining process, glass fibre is combined with gypsum plaster to produce glass fibre reinforced gypsum (GFRG) panels.

⇒ GFRG panels are made from waste gypsum (hydrated calcium sulphate) generated as waste at various fertilizer plants.

⇒ Panels are made fromGlass Fibre Reinforced Gypsum (GFRG)

Production of BIOFUEL from agricultural waste

- Bio-fuels are alternative renewable energy that has received considerable attention in the recent past
- Bio-ethanol (used as replacement to gasoline), is made from crop grains or sugarcane and
- bio-diesel, which is made from vegetable oils and animal fats. BY-PRODUCTS OF THE OIL REFINING INDUSTRY are suitable for the production of biodiesel. Byproduct glycerin is used in soap making process



Utilization of slags

- Steel plants produces slags as solid wastes
- Slags have been used historically in agriculture as lime substitute.
- Slags can be added to cement to reduce the cost without affecting the quality.

Utilization of fly ash in cement making

From the coal based thermal power stations fly ash is formed;

- fly ash is a heterogeneous material. SiO_2, Al_2O_3, Fe_2O_3 and occasionally CaO - are the main chemical components present in fly ashes.

❖ The use of fly ash can be used in cement manufacturing process.

❖ Use of fly ash eliminates the need to mine virgin materials and conserves limited land and material resources

If such useless mass could be converted into a useful product, it is the best way to deal with the waste (nothing can be better than this)

II. Recovery, Reuse and Recycling

Reduce

- to buy less and use less. (we live in a capitalist world)
- Incorporates common sense ideas like turning off the lights (reduce energy usage), rain barrels, and low-flow toilets,
- Encourage Carpool
- utilize minimal packaging

Reuse (Donate/Exchange)

By donating schools, non-profit organizations, and lower-income families

- old books
- old clothes
- old computers
- excess building materials
- old equipment to local organizations

Recycling

- Conservation of resources by converting them into new product.
- Recycling saves land, reduces the amount of solid waste, energy consumption and pollution.
- Gold, lead, nickel, steel, copper, silver, zinc, and aluminum are recyclable.
- Glass is virtually infinitely recyclable, it conserves raw materials, and reduces energy consumption
- Tires are usually allowed if they are quartered or shredded.

Problems

- Recycling does have environmental costs.
- It uses energy and generates pollution.
  - Ex. the de-inking process in paper recycling requires energy, and produces a toxic sludge that contains heavy metals.
  - But It costs less to recycle glass than to make new glass.