

# SOLID WASTE MANAGEMENT

**DEFINITION:** Solid waste are unwanted material disposed of by man, which can neither flow into streams nor escape immediately into atmosphere and causes air, water and soil pollution or any material that we discard, that is not liquid or gas, is solid waste.

## Classification of waste:

### **I. On the basis of origin:**

- a) Agricultural waste- Generated from agricultural fields like, cattle dung, plant residues etc.
- b) Domestic waste- Generated from houses
- c) Municipal waste- Generated from street sweeping, schools, offices and markets.
- d) Industrial waste- Generated from industrial process like metallurgical process etc.
- e) Hazardous waste- All type of toxic waste generated from hospitals and other units.

### **II. On the basis of nature:**

- a) Organic- Organic fertilizers etc.
- b) Inorganic- It contains metals, carbon content etc.

### **III. On the basis of burning:**

- a) Combustible- Waste which can easily burn like paper, cardboard, wood, rubber etc.
- b) Non-combustible- Not easily burn e.g. glass, tin cans, metals, aluminum, crockery etc.

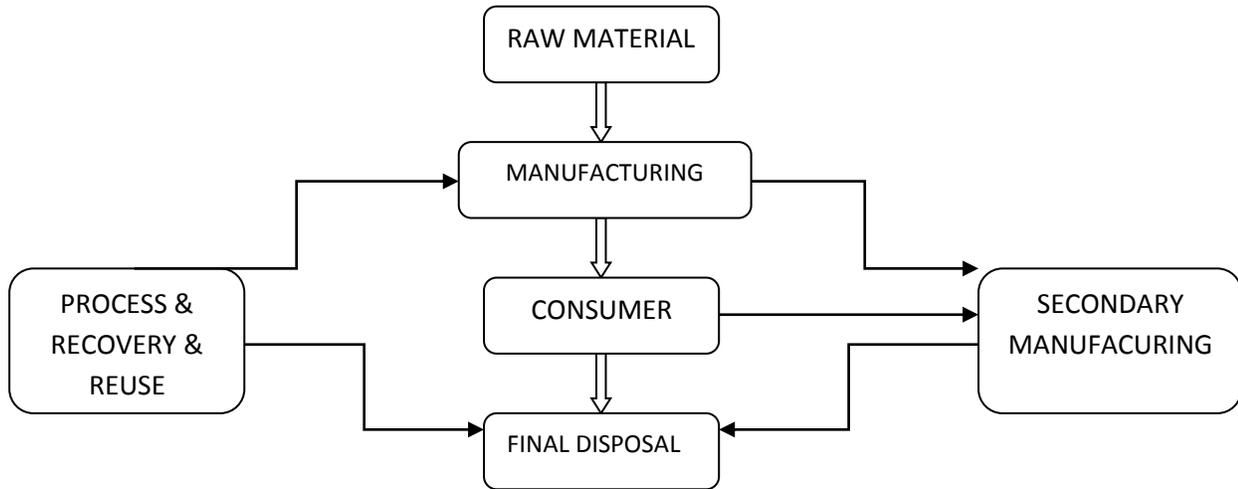
### **IV. On the basis of degradation:**

- a) Biodegradable/Putrescible- Which can easily degraded by microorganisms e.g.
- b) Non- degradable- Not easily degraded e.g. all inorganic waste, glass, plastics etc.

### **V. On the basis of kind of Material:**

- a) Garbage- Contains mainly food waste.
- b) Rubbish- These are combustible and non combustible waste excluding food material.

**Material flow and Generation of waste:**



Flow chart: Material flow and waste Generation

I. **MUNICIPAL SOLID WASTE:** MSW are generated from residential, commercial and institutional activities along with waste from street sweeping. In India, depending on the population of different cities, MSW generation varies from 0.3 to 0.5 kg/capita/day. The average composition of MSW consists of 40-51% biodegradable, 32% fine materials, 10% plastic, 7% paper etc. The calorific value of India's solid waste varies from 800 to 1000 kcal/kg.

Top six MSW generating cities in India (2016):

S.NO.	CITIES IN INDIA	POPULATION (MILLION)	WASTE GENERATION (TONNES PER DAY)
1.	Delhi	19.1	9620
2.	Mumbai	20	8600
3.	Kolkata	14.7	6000
4.	Chennai	10.1	5000
5.	Bangalore	10.4	4200
6.	Hyderabad	9.1	4000

**Source:** State Pollution Control Boards, Municipal Corporations, and UN population estimates

- In 2008, India produced 48 million tonnes of solid waste as per one estimate. By 2016, this had risen to 52 million tonnes.
- An assessment says that per capita waste generation is increasing by about 1.3 per cent annually  
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## MSW Management:

Before taking any step of method we have to think about the negative impact of wrong method of management. So it should be clear that the management method must have following points:

- The management process should be economical viable i.e. operation and maintenance.
- Cost should be suited to management process.
- It should not create any health hazards.
- It should not results any environmental impacts.
- The management techniques should be clear and compact.

## Solid waste management comprises following steps:

- i. Waste minimization technology
- ii. Collection and Handling process
- iii. Recovery and Recycling process
- iv. Ultimate Disposal.

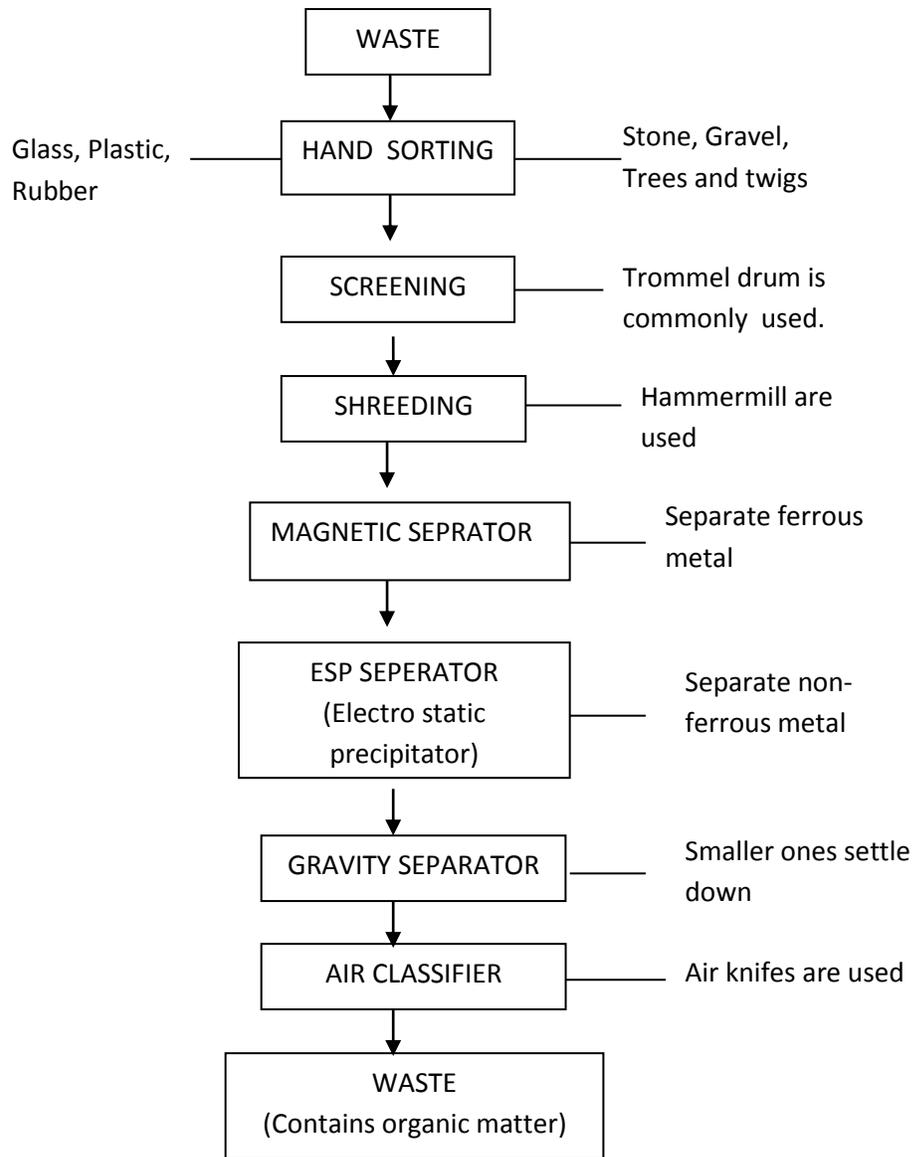
**Waste minimization technology:** The best way to minimize the waste is the control production of waste. It means reduction in extent feasible of waste i.e. generated, treated, stored and disposed by man. It contains recycling and source reduction:

- i. Step- Reduction in quantity of waste
- ii. step- Reduction in toxicity of waste
- iii. step- Both i & ii.
- iv.

**Collection and handling:** The solid waste generated in individual household is normally transferred to a community bin. House to house collection by municipal agencies is done in many cities. In India, community bin system is most widely used where storage bins, owned and maintained by municipal bodies, are provided at frequent intervals along the roadside. The solid waste, collected from different community bins, are then transported to the disposal site by a fleet of vehicles by the municipal bodies.

**Recovery and recycling:** This is a most necessary step because sometimes many useful products may throw away by the human beings that can be collected in this process and also recycle and change into various useful products. It contains three steps-

- i. Easily recyclable products: Glass and plastic.
- ii. Directly recyclable: Glass bottles and rubber.
- iii. Tough to recycle: Non degradable plastics, tins, tar etc.



**Flow chart for recycling and recovery of waste**

**Ultimate disposal:** After recycling process the remaining waste contains only organic matter and easily disposed of by many processes. It involves:

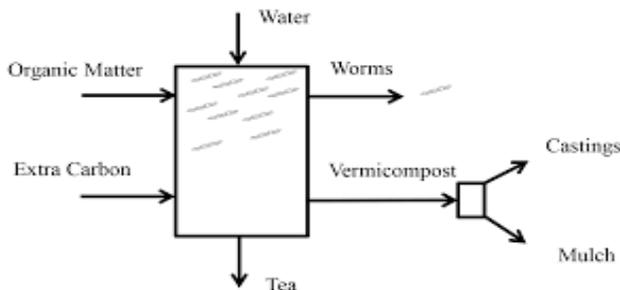
- i. Open dumping
- ii. Composting
- iii. Incineration
- iv. Landfill

**Open dumping:** This is done in low lying areas and out skirts of cities and town. Being less cost effective it is most commonly used method in India. This is not an efficient method of disposal of waste and has the following disadvantages-

- ✓ It causes great environmental damages.
- ✓ Contaminate ground water.
- ✓ Support population of flies, mosquitoes, mites etc. causes health problem.
- ✓ Causing air pollution due to noxious fumes and gases releases during decomposition of waste.

**Composting:** This is the biological process where fresh organic waste are allowed to be decomposed into humus like substances. In this process aerobic microorganism fasten the decomposition of waste under aerobic condition (presence of oxygen). the end product of the composting method converts the waste into compost which acts as good manure and increases the fertility of soil. Composting is of two types-

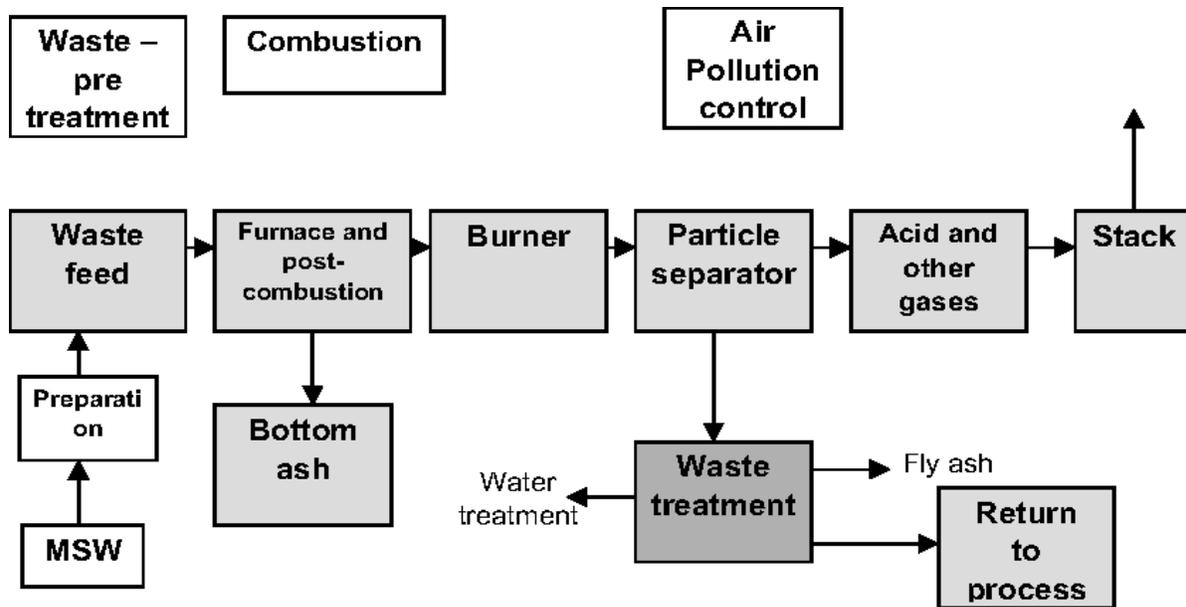
- ✓ Natural process of decomposition by small microorganism and bacteria.
- ✓ Artificial process also known as **vermicomposting**, where the earthworms feed on and degrade the organic waste and convert it into high grade, nutrient rich compost, which acts as a significant biofertilizer and soil conditioner.



Process of vermicomposting

**Incineration:** This is the preferred technique for waste management, predominantly in the developed countries because this method quickly degrade the waste without waiting for slow biological process. The device that used for incineration is called incinerator requires less space in installation. It burns waste at very high temperature at 1200 °C and converts them into

gaseous substances releasing a lot of heat. This heat can be utilized for supplementing electricity generation for domestic purpose. The only drawback with this technique is that it is expensive and disposes only combustible waste like clothes, wax, animal remains, rubbers, resins etc., resultant releases some toxic elements and heavy metals like Dioxins and furans, Cd, Pb, Hg. Harmful ash is also generated which is further dumped in the landfills.



## Design of Municipal Solid Waste Incinerator

**Landfills:** Landfills are the place where the waste is dumped properly in the pits and covered with soil layer or plastic membrane. Depending on the waste landfills are of three types-

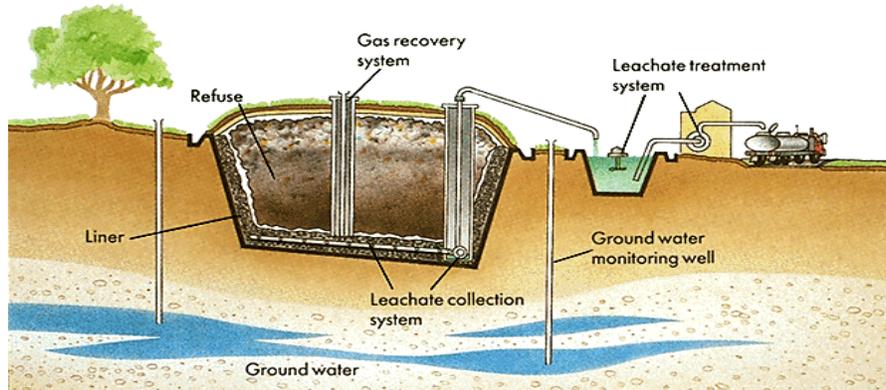
- i. Sanitary landfills- for the disposal of municipal waste
- ii. Secure landfills- for hazardous waste
- iii. Monofills- Sludge and sewage.

**Sanitary landfills,** commonly used for the disposal of municipal solid waste. In these landfills waste are compacted and spread on the layer. Each layer is covered by the layer of soil and finally covered by the soil or plastic membrane to protect the waste from rodents and flies. As compared to open dumps, this advanced method has following advantages

Advantages:

- ✓ Requires minimum land.
- ✓ Can be operated in any weather.

- ✓ Produces stable odor-free residue.
- ✓ Refuse volume is reduced by half.
- ✓ It causes less environmental damages.
- ✓ Cemented or plastic lid protect the entry of rats and other disease vector breed.
- ✓ Being biological method of waste treatment number of gases releases, can be utilized as a renewable energy source.



**An Illustration Of A Basic Sanitary Landfill System**

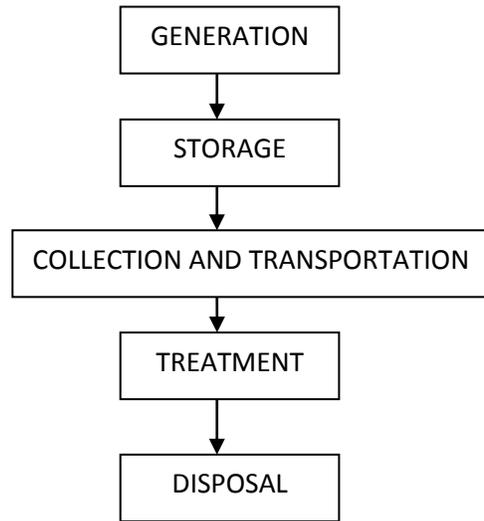
## Hazardous Waste Management

Definition: Waste that create danger to the living community, immediately or over a period of time, are called as hazardous waste. Safe collection, handling and disposal of these waste are essential and great care and caution should be taken during its management.

Classification of hazardous waste: It is classified into five categories-

- i. Chemical waste- Detergents, fertilizers, pesticides, toxic metals etc.
- ii. Radioactive waste- Nuclear weapons, cosmic rays, radioactive elements and etc.
- iii. Explosives- Releases during weapons manufacturing.
- iv. Biomedical or biological- Needles, bandages, expired medicines, human anatomical waste.
- v. Flammable waste- Organic solvents, oils, plasticizers etc.

**Management of hazardous waste:** It contains 4 steps after the generation of waste, these are as follows-



**Stages of hazardous waste management**

**Storage:** Generally the storage of hazardous waste is carried out prior to the treatment process. For storage purposes tanks, metal drums and other safe devices to be used.

**Collection and transportation:** Hauling of waste from one place to another place is called transportation. All the storage containers are transported unopened to the treatment or disposal unit. The distance between the collection points and treatment unit decides the type of collection vehicles. For short distances, storage in drums and flat bed vehicles are preferred while in case of large distances, large trucks, trailers and rail tank cars are used.

**Treatment:** Treatment process has two main objectives-

- ✓ To recover useful materials from waste.
- ✓ To prepare the waste for disposal.

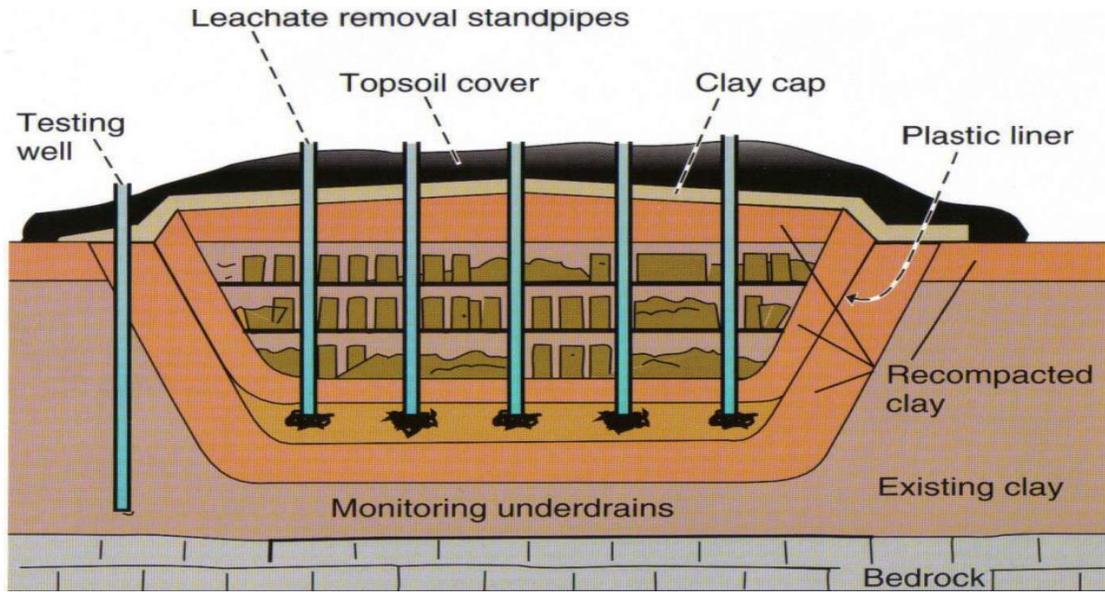
Treatment process can be done by physical and chemical means. Biological means of treatment are used very rare because of sensitivity. Treatment of hazardous waste reduces not only the volume by compaction and incineration process but also decrease the toxicity of waste through vitrification (mainly treated radioactive waste) for the safer disposal.

**Disposal:** Disposal is the final step in the waste management process. The disposal site must be far away from large population centers and where extremely deep water table found. Generally secure land filling method of disposal is adopted for hazardous waste. Secure landfills consists an artificial impermeable double liner at the bottom and cover at the top.

The following precautions must be taken during disposal of hazardous waste:

- ✓ The containers should not get damaged.
- ✓ Provision of Collection of toxic leachate from the site.

- ✓ Regular monitoring of quality and characteristics of ground water should be done.
- ✓ Avoid dumping of hazardous waste at sea because it can be dangerous to the nature of sea water and marine life.



**An Illustration Of A Basic Secure Landfill System**

**END OF VOL-I**

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**NOTE:** *E-Waste And Plastic Waste Management Rule to be covered In Volume- II.*