



Sri
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SAIRAM
DIGITAL RESOURCES

YEAR
II

SEM
IV

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ENVIRONMENTAL SCIENCE AND ENGINEERING

UNIT NO 2

ENVIRONMENTAL POLLUTION

- Thermal pollution, Nuclear hazards -
Solid waste management : causes,
effects and control measures of
municipal solid wastes

SCIENCE & HUMANITIES



THERMAL POLLUTION

DEFINITION

Addition of excess undesirable heat to water that makes it harmful to man, animals or aquatic life is called thermal pollution. The increase in temperature decreases the dissolved oxygen/oxygen supply and affects ecosystem composition.

SOURCES (OR) CAUSES OF THERMAL POLLUTION

- i) Nuclear power plants
- ii) Coal-fired power plants
- iii) Industrial effluents
- iv) Domestic sewage
- v) Hydro-electric power

SOURCES (OR) CAUSES OF THERMAL POLLUTION

i) Nuclear power plants

- It includes drainage from hospitals, research institutes, and nuclear experiments & explosions discharges toxic radio nuclides into nearby water streams.
- Emissions from nuclear reactors and processing installation are also responsible for increasing the temperature of water bodies.
- Heated effluents from power plants discharged at 10° C higher than the receiving water affects the aquatic flora and fauna.

SOURCES (OR) CAUSES OF THERMAL POLLUTION

ii) Coal-fired power plants

- Coal-fired power plants constitute the major sources of thermal pollutants.
- Their condenser coils are cooled with water from nearby lakes or rivers and discharge the hot water back to the stream increasing the temperature of nearby water to about 15°C.
- The heated effluents decrease the dissolved oxygen content of water. It results in killing of fish and other marine organisms.

SOURCES (OR) CAUSES OF THERMAL POLLUTION

iii) Industrial effluents

- Industries generating electricity like coal powered and nuclear powered plants, require huge amounts of cooling water for heat removal.
- Other industries like textile, paper and pulp, sugar also release heat in water but to a much lesser extent.
- The discharged water from the stream-electric power industry using turbo generators will have a higher temperature ranging from 6°C to 9°C than the receiving water.
- It results in the increase of stream temperature to a level at which natural dissipation of heat will be inefficient.

SOURCES (OR) CAUSES OF THERMAL POLLUTION

iv) Domestic sewage

- It is commonly discharged into rivers, canals or streams with or without waste treatment which has higher temperature than receiving water.
- The municipal sewage normally has a higher temperature than the receiving water. It decreases the content of dissolved oxygen and the demand of oxygen increases. This will set up the anaerobic condition resulting in release of foul and offensive gases in water. The marine organisms which depend on dissolved oxygen will die out.

v) Hydroelectric power:

- ❖ Apart from electric power industries, various factories with cooling requirements contribute to thermal loading.

EFFECTS OF THERMAL POLLUTION

1. Reduction in amount of dissolved oxygen
2. Increase in Toxicity
3. Interference with biological activities
4. Direct mortality
5. Migration of fishes
6. Change in the ecosystem
7. Change in metabolic activities

EFFECTS OF THERMAL POLLUTION

1. Reduction in amount of dissolved oxygen

- The dissolved oxygen content of water is decreased as the solubility of oxygen in water is decreased at high temperature.
- This can severely affect aquatic plants and animals as they depend on dissolved oxygen for photosynthesis.

2. Increase in Toxicity

- The rising temperature increases the toxicity of the poison present in water. Toxicity of pesticides, detergents and chemicals in the effluents increases with increase in temperature.
- A 10° C rise in temperature doubles the toxic effect of potassium cyanide causing massive mortality of fish.

EFFECTS OF THERMAL POLLUTION

3. Interference with biological activities

- ❖ The temperature changes totally disrupt the entire ecosystem like controlling respiratory rates, digestion, excretion and overall development of aquatic organisms.

4. Direct mortality:

- Unutilized heat in water is responsible for direct mortality of aquatic organisms.
- The increase in temperature exhausts the microorganisms and shortens their lifespan. The eggs of fish may hatch early or fail to hatch at all causing decrease in population. Above a particular temperature death occurs to fish due to failure in respiratory system, nervous system process.

EFFECTS OF THERMAL POLLUTION

5. Migration of fishes

Some of the less tolerant fishes migrate to cooler areas due to thermal pollution.

6. Change in the ecosystem

The composition of flora and fauna of the ecosystem will change because the species sensitive to increased temperature due to thermal shock will be replaced by temperature tolerant species.

7. Change in metabolic activities

Metabolic activities of aquatic organisms increase at high temperature and require more oxygen, whereas oxygen level falls under thermal pollution.

CONTROL MEASURES OF THERMAL POLLUTION

1. Cooling towers
2. Cooling ponds
3. Spray ponds
4. Artificial lakes

CONTROL MEASURES OF THERMAL POLLUTION

1. Cooling towers

- It transfers some of the heat from hot water to the surrounding atmosphere by the process of evaporation.
- It is used to dissipate the recovered waste heat to eliminate the problems of thermal pollution.

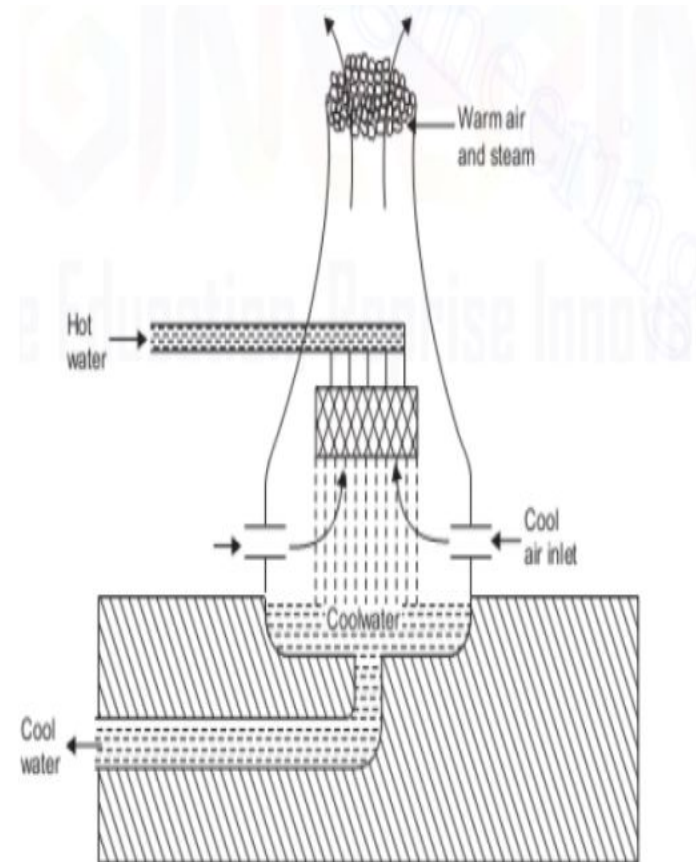
Types of cooling towers

- Wet cooling tower
- Dry cooling tower

CONTROL MEASURES OF THERMAL POLLUTION

Wet cooling tower

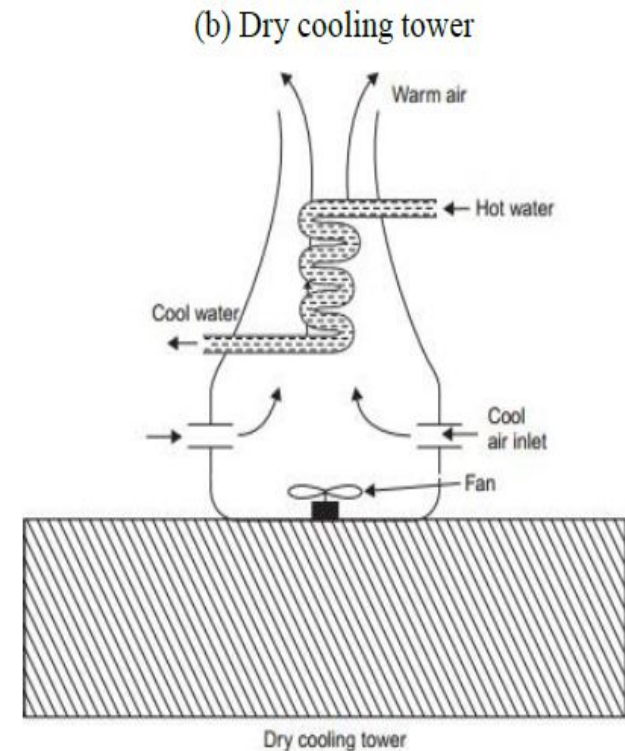
- Hot water coming out from the condenser is allowed to spray over baffles.
- Cool air with high velocity is passed from sides, which takes away the heat and cools the water.
- This cool water can be recycled or discharged. Large amount of water is lost through evaporation.



CONTROL MEASURES OF THERMAL POLLUTION

Dry cooling tower

- Hot water is allowed to flow in long spiral pipes. Cool air, with the help of a fan, is passed over these hot pipes, which cools down the hot water.
- This cool water can be recycled.
- There is no water loss in this method but installation and operation cost of a dry cooling tower is many times higher than wet cooling tower.



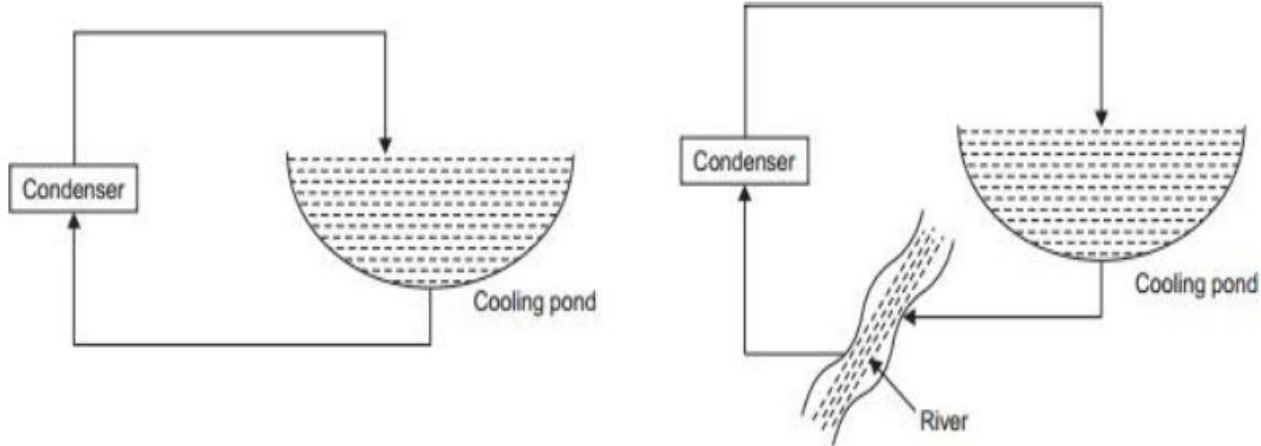
CONTROL MEASURES OF THERMAL POLLUTION

2. Cooling ponds

- The cooling pond receives thermal energy in the water from the thermal plant condensers and water from condensers is stored in ponds.
- Energy is dissipated mainly through evaporation (natural evaporation cools the water). Once the water has cooled in the pond, it is reused by the plant or discharged in a nearby water body.
- New water is added to the system to replace the water lost through evaporation. It is the simplest method of cooling thermal discharges.
- Heated effluents maximize the dissipation of heat to the atmosphere & minimize the water area and volume. This warm water wedge acts like a cooling pond.

CONTROL MEASURES OF THERMAL POLLUTION

2. Cooling ponds

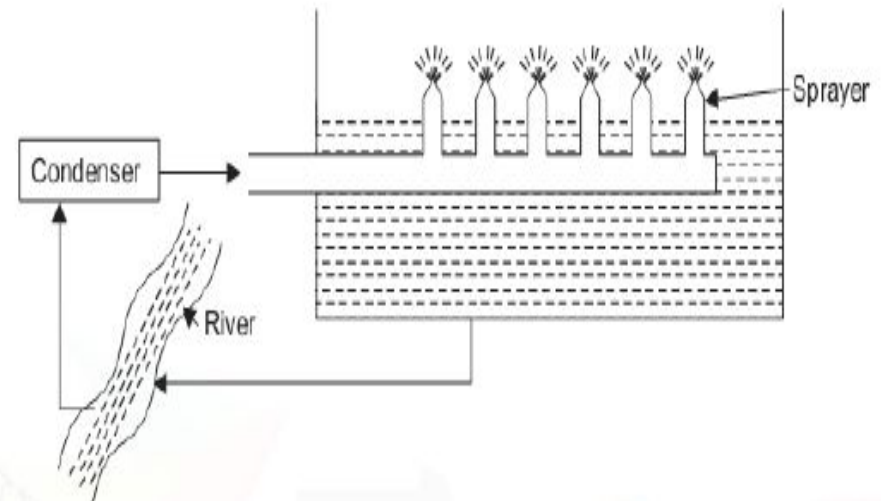
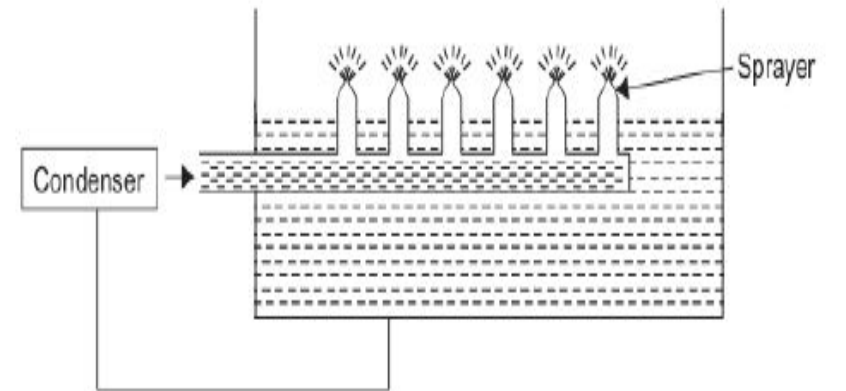


Dissipation of heat by cooling ponds.

CONTROL MEASURES OF THERMAL POLLUTION

3. Spray ponds

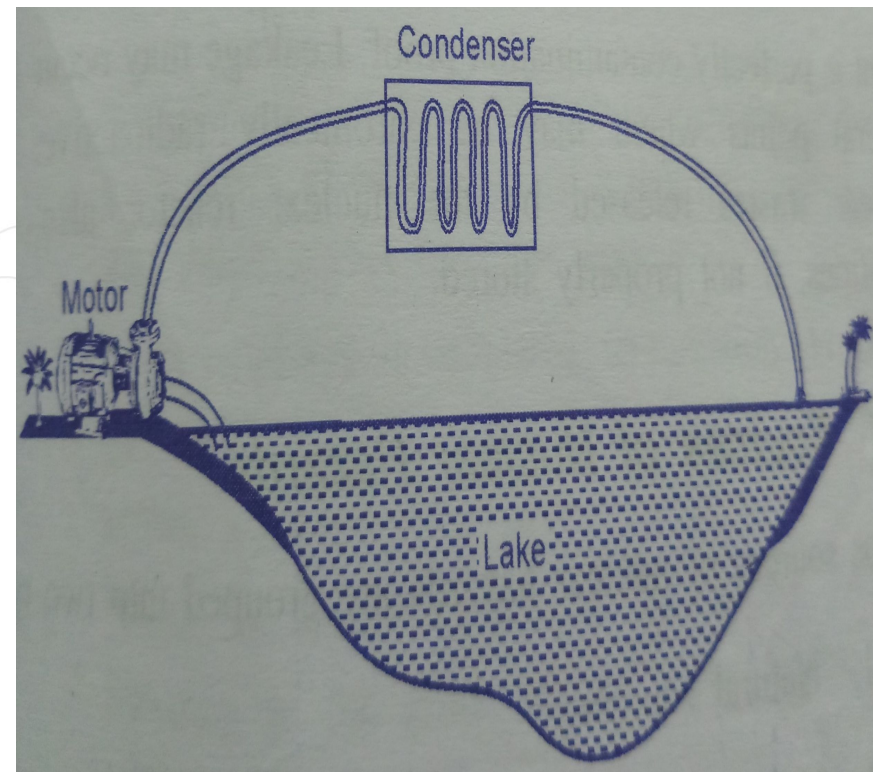
- The water from condensers is received in spray ponds.
- Here the water is sprayed through nozzles where fine droplets are formed.
- Excess heat from these fine droplets is dissipated to the atmosphere.



CONTROL MEASURES OF THERMAL POLLUTION

4. Artificial lakes:

- Man made bodies of water which offer possible alternatives to once-through cooling.
- Heated effluents can be discharged into the lake at one end & water for cooling purposes may be withdrawn from the other end.
- The heat is eventually dissipated through evaporation.



NUCLEAR HAZARDS (OR) NUCLEAR POLLUTION

(OR) RADIOACTIVE POLLUTION

INTRODUCTION

Nuclear energy is used to produce clean electric power. The energy released in the splitting of nuclei in the atoms is used to generate electricity. The fuel used in nuclear plants, being radioactive, is dangerous and the waste materials are hazardous. The nuclear wastes released by the nuclear reactor also emit radiations if not stored properly.

DEFINITION

Nuclear pollution is defined as the physical pollution of air, water or land by radioactive substances emitting harmful radiations which can cause health hazards to living beings.

SOURCES (OR) CAUSES OF NUCLEAR HAZARDS

- Natural sources
- Man-made or Anthropogenic sources

1. Natural sources

- Space - Emits cosmic rays.
- Solar rays
- Soil, rocks, air, water, food, radon-222 etc. also contain one or more radioactive substances.

SOURCES (OR) CAUSES OF NUCLEAR HAZARDS

2. Man-made sources

- Nuclear power plants
- Nuclear accidents
- Weapons of mass destruction
- Laboratories

SOURCES (OR) CAUSES OF NUCLEAR HAZARDS

2. Man-made sources

i) Nuclear power plants

- Every nuclear power plant produces a few kilograms of highly radioactive wastes.
- Many of these wastes have a long half life period and will continue to emit radiations for many years if not disposed properly.

ii) Nuclear accidents

- Accidents happening in a nuclear reactor may lead to the leakage of radioactive materials which can cause serious health concerns.
- Eg: Chernobyl reactor meltdown in 1986, Fukushima daiichi leakage in 2011.

SOURCES (OR) CAUSES OF NUCLEAR HAZARDS

2. Man-made sources

iii) Weapons of mass destruction

- Many developed countries have the technology to prepare nuclear weapons.
- Use of these weapons can pollute the environment and can have devastating effects.
Eg: Atomic Bomb dropped on Hiroshima and Nagasaki.

iv) Laboratories

- X-rays are widely used in hospitals.
- Radioactive materials are used in cancer therapy and treatment.

EFFECTS OF NUCLEAR HAZARDS

- Radioactive radiation affects the cells in the body and the function of glands and organs.
- People suffer from blood cancer and bone cancer if exposed to doses around 100 to 1000 roentgens.
- Radioactive iodine (I^{131}) accumulates in thyroid gland and causes thyroid cancer. Strontium-90 can replace calcium in the bones and causes leukemia or cancer of bone marrow. Ionizing radiations can also induce various types of cancer.
- Genetic damage is caused by radiations, which induce mutations in the DNA, thereby affecting genes and chromosomes. The damage is often seen in the offsprings and may be transmitted upto several generations.

EFFECTS OF NUCLEAR HAZARDS

- Acute radiation sickness is marked by vomiting, bleeding of gums, mouth ulcers.
- Internal bleeding and blood vessel damage may show up as red spots on the skin.
- Somatic damage including burns, miscarriages, eye cataract etc can happen if a person is exposed to radiation beyond permissible limits.
- Low level exposure can result in temporary decrease in red blood cell count, mild radiation sickness etc.

CONTROL MEASURES OF NUCLEAR HAZARDS

- Nuclear devices should not be exploded in the air. It should be exploded underground.
- Location of nuclear power plants should be carefully done after studying long term and short term effects. It should be located in a place where the density of the population is very less.
- Better operator training and better instrumentation to avoid nuclear accidents.
- Fission reactions should be minimized as the rate of decay of radionuclides and subsequent emission of radiations are unaltered by man.
- Leakage of radioactive elements from nuclear reactors, laboratories, transport, careless handling and use of radioactive fuels should be checked.

CONTROL MEASURES OF NUCLEAR HAZARDS

- Regular inspection of areas of nuclear activities for radiation level.
- Workers in nuclear plants should be provided with nuclear gadgets and safety measures against accidents.
- Nuclear medicines and radiation therapy should be applied when absolutely necessary with minimum doses.
- Extreme care should be exercised in the disposal of industrial wastes contaminated with radionuclides.
- Use of high chimneys and ventilations at the working place seems to be an effective way for dispersing radio pollutants.

CONTROL MEASURES OF NUCLEAR HAZARDS

- Proper disposal of wastes like deep ocean disposal, deep geological burial from both laboratories and nuclear power plants, should be done.
- Public should be made aware about various hazards of nuclear radiation and should be educated about the precautionary measures to be taken, in case of a radioactive fall out.

NUCLEAR HAZARDS (OR) NUCLEAR POLLUTION

(OR) RADIOACTIVE POLLUTION

DISPOSAL OF RADIOACTIVE WASTES (NUCLEAR HAZARDS)

Since nuclear wastes are extremely dangerous, disposal is strictly controlled by international agreement.

CLASSIFICATION OF RADIOACTIVE WASTES

- High level wastes (HLW)
- Medium level wastes (MLW)
- Low level wastes (LLW)

CLASSIFICATION OF RADIOACTIVE WASTES

1.High level wastes (HLW)

Ex: Spent nuclear fuel

- HLW have a very high radioactivity per unit volume.
- They have to be cooled and stored for several decades before disposal.
- Since they are too dangerous, they must be contained either by converting them into inert solids (ceramics) and then buried deep into earth or stored in deep salt mines.

CLASSIFICATION OF RADIOACTIVE WASTES

2. Medium level wastes (MLW)

Ex: Filters, reactor components, etc.

- MLW is solidified and is mixed with concrete in steel drums before being in deep mines or below the sea bed in concrete chambers.

3. Low level wastes (LLW)

Ex: Solids or liquids contaminated with traces of radioactivity.

- LLW are disposed off in steel drums in concrete-lined trenches.

SOLID WASTE MANAGEMENT (OR) WASTE SHED MANAGEMENT

INTRODUCTION

- With rapid increase in population growth and urbanization, there has been a substantial increase in the generation of solid waste and contamination of air, water and land resources.
- The solid wastes from different municipalities, not managed properly, have been creating problems for human health and environment.
- Some of the solid wastes have been proved to be extremely toxic and infectious.

SOLID WASTE MANAGEMENT (OR) WASTE SHED MANAGEMENT

- The uncontrolled dumping of such wastes have not only brought about an increasing number of incidents of health hazards but also causing the surface and groundwater contamination and thus posing serious environmental threat to the human beings.
- Management of solid waste is therefore very important to minimize the adverse effects of solid wastes.

DEFINITION

Solid Waste Management is defined as the discipline associated with control of generation, storage, collection, transport or transfer, processing and disposal of solid waste materials.

TYPES AND SOURCES OF SOLID WASTES

Depending upon the nature, solid wastes can be classified into

- **Urban (or) Municipal wastes**
- **Industrial wastes**
- **Hazardous wastes**

TYPES AND SOURCES OF SOLID WASTES

1. Urban (or) Municipal wastes

Sources of Urban (or) Municipal wastes

Urban (or) Municipal wastes include the following wastes.

i) Domestic wastes:

It contains a variety of materials thrown out from the homes.

Examples: Polyethylene bags, empty metal and aluminium cans, scrap metals, glass bottles, waste paper, cloth/rags, food waste etc.,

TYPES AND SOURCES OF SOLID WASTES

1. Urban (or) Municipal wastes

Sources of Urban (or) Municipal wastes

ii) Commercial wastes:

It includes the wastes coming out from the shops, markets, hotels, offices, institutions, etc.,

Examples: Waste paper, packaging material, cans, bottles, polyethylene bags, peanut shells, eggshells, tea leaves etc.,

iii) Construction wastes:

It includes the wastes of construction materials.

Examples: Debris and rubbles, wood, concrete etc.,

TYPES AND SOURCES OF SOLID WASTES

1. Urban (or) Municipal wastes

Sources of Urban (or) Municipal wastes

iv) Biomedical wastes:

It includes mostly the waste organic materials.

Examples: Anatomical wastes, pathological wastes, infectious wastes, etc.,

Examples: Polyethylene bags, scrap metals, glass bottles, etc.,

TYPES AND SOURCES OF SOLID WASTES

Types and Characteristics of Urban (or) Municipal wastes

i) Biodegradable wastes:

The urban solid waste materials that can be degraded by microorganisms are called biodegradable wastes.

Examples: Food, vegetables, tea leaves, egg leaves, dry leaves, etc.,

ii) Non-biodegradable wastes:

The urban solid waste materials that cannot be degraded by microorganisms are called non-biodegradable wastes.

TYPES AND SOURCES OF SOLID WASTES

2.Source and Characterisation of Industrial wastes

→ The main sources of industrial wastes are chemical industries, metal and mineral processing industries.

Examples:

- i) **Nuclear power plants:** It generates radioactive wastes.
- ii) **Thermal power plants:** It produces fly ash in large quantities.
- iii) **Chemical industries:** It produces large quantities of hazardous and toxic materials.
- iv) **Other industries:** Packaging material, organic wastes, rubbish, acids, alkalis, scrap metals, plastic, glass, wood, rubber, oils, paints, dyes, etc.,

TYPES AND SOURCES OF SOLID WASTES

3. Hazardous wastes

Wastes that cause a substantial danger immediately or over a period of time to human, plant or animal life is called hazardous waste.

Sources of Hazardous wastes

- ❖ Chemical manufacturing companies, petroleum refineries, paper mills, smelters, radioactive substances, biological wastes and other industries.

TYPES AND SOURCES OF SOLID WASTES

Types and Characteristics of Hazardous wastes

i) **Toxic wastes:** These are poisonous even in very small or trace amounts.

- **Acute toxicity:** These wastes have immediate effect on humans or animals causing death.
- **Chronic toxicity:** These wastes have long term effects slowly causing irreparable harm to the exposed persons. It is much more difficult to determine.

ii) **Reactive wastes:** These wastes react vigorously with air, water, heat and generate toxic gases.

Examples: Gun powder, nitroglycerine, etc.,

TYPES AND SOURCES OF SOLID WASTES

Types and Characteristics of Hazardous wastes

iii) **Corrosive wastes:** These wastes destroy materials and living tissues by chemical reactions.

Examples: Acids and bases

iv) **Radioactive wastes:** These are from nuclear power plants and persist in the environment for thousands of years.

v) **Infectious wastes:** It causes infection to others.

Examples: Used bandages, human tissue from surgery, hypodermic needles, etc.,

vi) **Heavy metals:** Lead, mercury and arsenic are hazardous substances.

EFFECTS OF SOLID WASTE MANAGEMENT

1. Municipal solid wastes heap up on the roads due to improper disposal systems.

This produces

foul smell and breeds various types of insects and infectious organisms besides spoiling the

aesthetics of the site.

2. Due to improper disposal of municipal solid wastes on the road side and their immediate surroundings, biodegradable materials undergo decomposition.

3. It runs off with rain water and mixes with the nearby water bodies causing water pollution.

EFFECTS OF SOLID WASTE MANAGEMENT

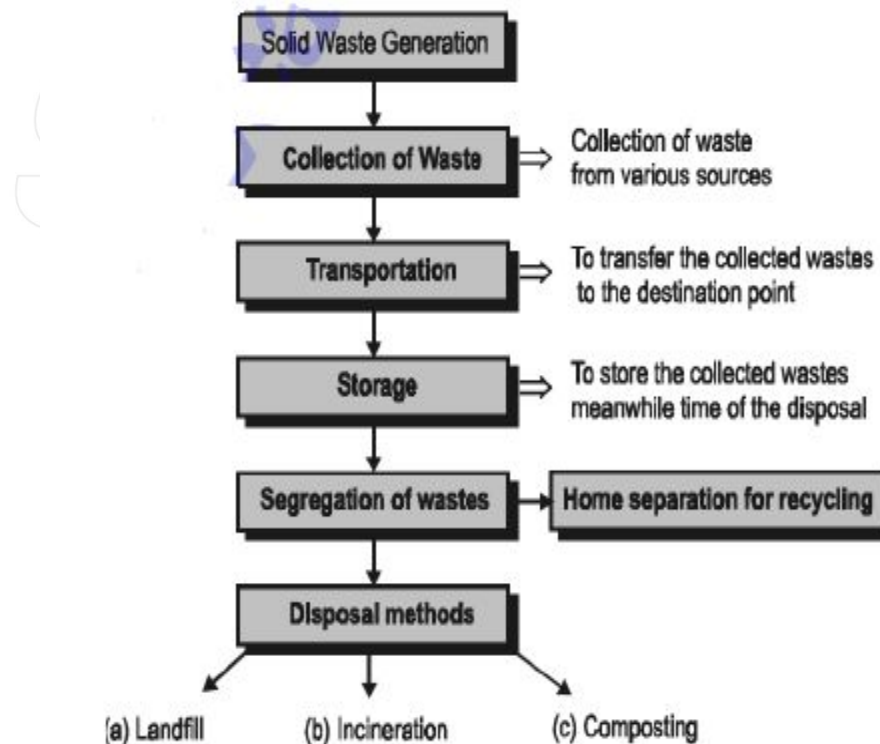
4. Burning of solid wastes leads to air pollution.
5. Non-biodegradable solid wastes such as polythene, plastic release toxic gases when burnt, hence resulting in air pollution.
6. Radioactive substances present in solid waste cause a number of diseases in human beings.

PROCESS OF SOLID WASTE MANAGEMENT (OR) PROCESS OF PREVENTING SOLID WASTE GENERATION IN URBAN AREAS (OR) WASTE SHED MANAGEMENT

Different steps in solid waste management are

- a) Collection
- b) Segregation
- c) Storage
- d) Transportation
- e) Processing
- f) Disposal

PROCESS OF SOLID WASTE MANAGEMENT (OR) PROCESS OF PREVENTING SOLID WASTE GENERATION IN URBAN AREAS (OR) WASTE SHED MANAGEMENT



STEPS INVOLVED IN SOLID WASTE MANAGEMENT (OR) WASTE SHED MANAGEMENT

Two important steps of solid waste management is as follows:

1. **Reduce, Reuse and Recycle (3R)**
2. **Discarding wastes**

1. Reduce, Reuse and Recycle (3R)

Reduce the usage of raw materials:

Reduction in the use of raw materials will correspondingly decrease the production of waste.

- i) Reduced demand for any metallic product will decrease the mining of their metal and cause less production of waste.

STEPS INVOLVED IN SOLID WASTE MANAGEMENT (OR) WASTE SHED MANAGEMENT

Reuse of waste materials:

The refillable containers which are discarded after use can be reused.

- i) Villagers make casseroles and silos from waste paper and other waste materials.
- ii) Making rubber rings from the discarded cycle tubes which are used by the newspaper vendors, instead of rubber bands, reduces the waste generation during manufacturing of rubber bands.

STEPS INVOLVED IN SOLID WASTE MANAGEMENT (OR) WASTE SHED MANAGEMENT

Recycling of materials:

Recycling is the reprocessing of discarded materials into new useful products.

- i) Formation of some old type products e.g. old aluminium cans and glass bottles are melted and recast into new cans and bottles.
- ii) Preparation of automobiles and construction materials from steel cans.
- iii) Preparation of cellulose insulation from paper.

The above processes save money, energy, raw materials and reduce pollution.

STEPS INVOLVED IN SOLID WASTE MANAGEMENT (OR) WASTE SHED MANAGEMENT

2. Discarding wastes

Following methods can be adopted for discarding solid wastes.

Methods of disposal of solid waste

- i) Landfill
- ii) Incineration(Thermal process)
- iii) Composting

Methods of disposal of solid waste

i) Landfill

- Solid wastes are placed in a sanitary landfill system in alternative layers of 80cm thick refuse, covered with earth fill of 20 cm thickness.
- This method involves spreading the solid waste on the ground, compacting it and then covering it with soil at suitable intervals.
- After two or three years, solid waste volume shrinks by 25-30% and the land is used for parks, roads and small buildings.
- Land-fill structure is built either into the ground or on the ground into which the waste is dumped.

Methods of disposal of solid waste

i) Landfill

Advantages:

- Simple & economical.
- Segregation not required.
- Landfills can be used for other purposes.
- Natural resources are returned to soil & recycled.
- Converts low-lying marshy waste-land into useful areas.

Disadvantages:

- Large area is required.
- Transportation costs are heavy.
- Bad odours, if landfills are not properly managed.
- The land filled areas will be the sources of mosquitoes and flies and hence insecticides and pesticides are to be applied at regular intervals.
- Causes fire hazard due to the formation of methane in wet weather.

Methods of disposal of solid waste

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Methods of disposal of solid waste

ii) Incineration (or) Thermal Process:

- It is a hygienic method of disposing solid waste.
- It is more suitable if the waste contains more hazardous material and organic content.
- It is a thermal process and is very effective for detoxification of all combustible pathogens. In this method the municipal solid wastes are burnt in a furnace called incinerator.
- The combustible substances such as paper, rubbish, garbage, dead organisms and the non-combustible matter such as glass, porcelain, metals are separated before feeding to incinerators.

Methods of disposal of solid waste

ii) Incineration (or) Thermal Process:

- The non-combustible materials can be left out for recycling and reuse.
- The wet waste is dried in a preheater from where it is taken into a large incinerating furnace called destructors which can incinerate about 100 to 150 tons per hour.
- The left out ashes, clinkers from incinerators accounts for 10 to 20% which need further disposal by sanitary landfill.
- The heat from the incinerator is used for producing electricity through turbines. The temperature maintained in the combustion chamber about 700°C and increased to 1000°C when electricity is to be generated.

Methods of disposal of solid waste

ii) Incineration (or) Thermal Process:

Advantages:

- The clinker can be used for other purposes; residue is only 20-25%.
- It requires very little space.
- Cost of transportation is not high as incinerators are within city limits.
- Safest from a hygienic point of view.
- An incinerator of 300 tons per day can generate 3MW of power.

Disadvantages:

- Its capital & operating cost is high.
- Needs skilled personnel.
- Needs further disposal of smoke & dust to reduce air pollution.

Methods of disposal of solid waste

iii) Composting:

- It is another popular method practiced in many cities in our country.
- In this method, bulk organic waste is converted into fertile manure by biological action.
- The separated compostable waste is dumped in underground earthen trenches in layers of 1.5 m and is finally covered with earth of about 20 cm and left over for decomposition.
- Sometimes certain microorganisms such as actinomycetes are introduced for active decomposition.

Methods of disposal of solid waste

iii) Composting:

- Within 2 to 3 days biological action starts, the organic matters are being destroyed by actinomycetes and lot of heat is liberated increasing the temperature of the compost by about 75°C and finally the refuse is converted to powdery brown coloured odourless mass known as humus and has a fertilizing value which can be used for agricultural field.
- The compost contains a lot of nitrogen essential for plant growth apart from phosphates and other minerals.

Methods of disposal of solid waste

iii) Composting:

- World Health Organisation (WHO) has set up a compost plant in New Delhi in 1981 with capacity of 90 to 100 tons of waste every day.
- The prepared compost was supplied to nurseries, kitchen, gardens and horticulture department.
- The composting technology is widely employed in developing countries.

Methods of disposal of solid waste

iii) Composting:

Advantages:

- When the manure is added to soil, it increases water retention & ion exchange capacity of soil.
- Industrial solid wastes can also be treated.
- Manure can be sold, thus it reduces the cost of disposing of wastes.
- Recycling occurs.

Disadvantages:

- The non-consumables have to be disposed separately.
- No assured market, as it does not reach farmers.

VIDEO LINKS

THERMAL POLLUTION- <https://youtu.be/YUsuQHxWnq0>

NUCLEAR POLLUTION- https://youtu.be/uU3kLBo_ruo

SOLID WASTE MANAGEMENT- <https://youtu.be/1CSm4GG2VrU>