Unit V

WATER POLLUTION

5.1 INTRODUCTION

- Water makes an approximate of 71% of total mass of earth. Of this only 3.5% is fresh water and remaining is in the oceans unfit for man. So we humans and all the living beings on earth's surface should rely only on this 3.5% of water. But interestingly this sparse resource water is also getting polluted. This pollution makes the water unfit to drink and also other uses of daily needs.
- On the other hand, about 80% of body mass comprises of water. Without water, there can be no physiological process in the body. Hence, we need to drink water for survival.
- Since this water directly enters the body, it decides the quality of health.
- Medical experts are of opinion that most of the health issues can be solved by providing fresh and pure drinking water. So, the drinking water we consume daily should be clean, free from pollution and other contaminants.
- Water pollution has been extensively documented as a contributor to health problems in humans and marine animal ecosystems. It has a huge impact on our lives, and if we do our part by not throwing trash or chemicals into our water supplies and drains, we can contribute to the improvement of aquatic life and of our health in general.
- Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers, and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly. If you poured a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water. The ink would still be there in the river, but in such a low concentration that you would not be able to see it. At such low levels, the chemicals in the ink probably would not present any real problem. However, if you poured gallons of ink into a river every few seconds through a pipe, the river would quickly turn black. The chemicals in the ink could very quickly have an effect on the quality of the water. This, in turn, could affect the health of all the plants, animals, and humans whose lives depend on the river.

5.1.1 Causes of Water Pollution [Dec. 17]

Water pollution is caused due to several reasons. Here are the few major causes of water pollution:

- **Sewage and Waste Water:** Sewage, garbage and liquid waste of households, agricultural lands and factories are discharged into lakes and rivers. These wastes contain harmful chemicals and toxins which make the water poisonous for aquatic animals and plants.
- **Dumping:** Dumping of solid wastes and litters in water bodies causes huge problems. Litters include glass, plastic, aluminum, styrofoam etc. Different things take different amount of time to degrade in water. They affect aquatic plants and animals.
- **Industrial Waste:** Industrial waste contains pollutants like asbestos, lead, mercury and petrochemicals which are extremely harmful to both people and environment. Industrial waste is discharged into lakes and rivers by using fresh water making the water contaminated.
- **Oil Pollution:** Sea water gets polluted due to oil spilled from ships and tankers while traveling. The spilled oil does not dissolve in water and forms a thick sludge polluting the water.
- **Acid Rain:** Acid rain is pollution of water caused by air pollution. When the acidic particles caused by air pollution in the atmosphere mix with water vapor, it results in acid rain.
- **Global Warming:** Due to global warming, there is an increase in water temperature. This increase in temperature results in death of aquatic plants and animals. This also results in bleaching of coral reefs in water.
- **Eutrophication:** Eutrophication is an increased level of nutrients in water bodies. This results in bloom of algae in water. It also depletes the oxygen in water, which negatively affects fish and other aquatic animal population.

5.1.2 Causes of River Pollution

- **Human Dumping:** Due to human dumping of waste and other harmful substances in to river water directly. Since most of the towns and cities are beside rivers, the human waste is
- **Industrial Waste Release:** Most industries release their processing waste into the rivers. This is an easy methods for them to get rid of waste. But by release of industrial sewage into river water there is severe pollution to the water.
- **Land Water Flow:** Contamination during rains due to flow of rain water from contaminated land into rivers. In-case of floods where water from river flows over surrounding lands. This flow collects all the possible waste and dump into river.
- **Air Pollution:** The air pollution is formed by disposal of harmful gases into air. This pollution from air in-turn returns to ground through rains and contaminate ground water and river waters. This indicates that the pollution we create finally reaches us in one or other way.
- **Farm Pollution:** Farming is the industry which relies largely on river water. The river water is used for irrigation. But pesticides and other toxic chemicals are used by farmers to control diseases. These toxins reach the river canals which supply water the cities and towns ahead.
- **Improper Drainage System:** Drainage system pollution, this is the form of water pollution where sewage and normal public water supply mix up. This is seen especially in cities where water is pumped from distant out places. This occurs when there is leakage of sewage water and mixing with that of pure water supplied by municipal water pipes.

  This happens when both sewage draining pipes and pure water supply pipes are passing close to each other and there are some leaks in the pipes. In course of travel in pipe lines, there are chances of any drainage system flowing nearby. This provides a chances of mixing of both waters leading to sewage water pollution. This is one of the prime reasons for infectious diseases caused due to water.
- **Groundwater Contamination:** Water on the land is absorbed by the soil. Along with water any chemicals or toxin on the land are also absorbed. This happens at places of heavy land pollution. These harmful substances on the land percolate into deep ground layers causing pollution. Thus there are many cases where ground water from bore-well were found to be harmful.
- **Plastic Waste:** Plastic is another threat adding to marine water pollution. Plastic pollution occurs due to accumulation of plastic waste for long in the seas beds as it is not decomposed fast. It is thought to be responsible for destruction of aquatic environment.
- **Due to Fisheries :** Fisheries is a part of agriculture but mainly depend on rivers. Many chemicals and drugs are used to enhance fish growth. But since these are collected with rivers. All the waste is flowed out into rivers.
- **Due to Leakage of Petroleum** and other oils from vehicles etc on to the local roads. Even from mechanic sheds this is released. These petroleum wastes are mixed with ground and other water sources.

5.2 EFFECTS OF WATER POLLUTION

- Groundwater contamination from pesticides causes reproductive damage within wildlife in ecosystems.
- Sewage, fertilizer, and agricultural run-off contain organic materials that when discharged into waters, increase the growth of algae, which causes the depletion of oxygen. The low oxygen levels are not able to support most indigenous organisms in the area and therefore upset the natural ecological balance in rivers and lakes.
- Old Roofs can cause pollution if they are not properly maintained. If water is being held on roofs the water can become polluted and then run down the home and cause more pollution to the water table.
- Swimming in and drinking contaminated water causes skin rashes and health problems like cancer, reproductive problems, typhoid fever and stomach sickness in humans.
- Industrial chemicals and agricultural pesticides that end up in aquatic environments can accumulate in fish that are later eaten by humans. Fish are easily poisoned with metals that are also later consumed by humans. Mercury is particularly poisonous to small children and women. Mercury has been found to interfere with the development of the nervous system in fetuses and young children.
- Ecosystems are destroyed by the rising temperature in the water, as coral reefs are affected by the bleaching

effect due to warmer temperatures. Additionally, the warm water forces indigenous water species to seek cooler water in other areas, causing an ecological damaging shift of the affected area.

- Human-produced litter of items such as plastic bags and 6-pack rings can get aquatic animals caught and killed from suffocation.
- Water pollution causes flooding due to the accumulation of solid waste and soil erosion in streams and rivers.
- Oil spills in the water causes animal to die when they ingest it or encounter it. Oil does not dissolve in water so it causes suffocation in fish and birds.

5.3 CONTROL MEASURES OF WATER POLLUTION

- Administration of water pollution control should be in the hands of state or central government
- Scientific techniques should be adopted for environmental control of catchment areas of rivers, ponds or streams
- Industrial plants should be based on recycling operations as it helps prevent disposal of wastes into natural waters but also extraction of products from waste.
- Plants, trees and forests control pollution as they act as natural air conditioners.
- Trees are capable of reducing sulphur dioxide and nitric oxide pollutants and hence more trees should be planted.
- No type of waste (treated, partially treated or untreated) should be discharged into any natural water body. Industries should develop closed loop water supply schemes and domestic sewage must be used for irrigation.
- Qualified and experienced people must be consulted from time to time for effective control of water pollution.
- Public awareness must be initiated regarding adverse effects of water pollution using the media.
- Laws, standards and practices should be established to prevent water pollution and these laws should be modified from time to time based on current requirements and technological advancements.

5.4 NOISE POLLUTION [May 18]

Noise pollution means an unwanted or undesirable sound that leads to physical and mental problems. Noise pollution is dependent on the loudness and frequency of the sound. In fact, when the sound exceeds its limit, it becomes fatal for human and other organisms. The noise intensity is measured in decibels or dB. A person can bear the noise up to 85 decibels, after which his hearing power can be damaged.

Normally, sounds more intense than 30 decibel are called noise. Anyway, all the sounds come under noise pollution which makes the mind turbulent or restless. In fact, any unwanted noise arising in the environment, which has adverse effects on the health of the organism, is noise pollution.

In daily life, we hear different intensity of sounds, whose level ranges from 10 to 100 decibels. Considering the side effects on human health, scientists have set the maximum sound limit, ranging from 75 to 85 dB in different countries. The World Health Organization considers the sound of 45 decibels ideal for cities. But measurement of sound in most big cities exceeds 90 decibels.

5.4.1 Sources/Causes of Noise Pollution [Dec. 17]

The sources of noise pollution are divided into two categories:

1. **Natural Sources**

   The natural environment is filled with various sounds – thunderstorms, lightning, tornado, cyclone, volcanic eruptions, earthquakes, landslides, sounds produced by animals, and rapidly falling water.

2. **Man Made Sources**

   Rapid industrialization, urbanization, use of modern means of transport, population growth, and increasing scale of human activities are some of the human factors responsible for noise pollution. Both types of noise pollution, affect sleep, listening ability, physical and mental health.

Some other sources of noise pollution are explain below :

- **Vehicular Noise:** The modern means of traffic including vehicles such as buses, trucks, scooters, cars, motorcycles, trains, aircraft, firecrackers, explosives etc, pollute the atmosphere. Sound of other automated vehicles and horn, excessive use of loudspeakers for religious purposes also generate jarring noise.

- **Industrial Noise:** Industry-businesses, factories and commercial establishments produce a variety of raucous sounds that bump into our ears and disturb our mind. Noise pollution is an integral part of the industrial environment with heavy machines used in the industries; it is on the rise with the increase in industrial urbanization.
- **Commercialisation of Residential Areas:** Even in non-industrial areas, there is noise in the surrounding environment due to printing, dyeing machines, repairing cars, grinding etc.
- **Domestic Noise:** As the houses in the cities are quite adjacent, the amount of domestic noise is increasing. The noise of radio, television, instrumentation and various types of sounds are constantly occurring around us, which cause mental health problems, stress, deafness etc. Other domestic sources include noise in the kitchen, and domestic discord including scolding, shouting, crying, etc.
- **Construction Activities:** Unbridled construction is also a reason for noise pollution outside the home. Sound pollution is also caused due to poor urban planning because industrial and residential buildings are quite close by in many cities.
- **Political Activities:** Noise pollution is also generated by dharna, demonstrations, slogans, election propaganda, processions, and rallies frequently organised in cities.
- **Noisy Hospitals:** Noise pollution also occurs in hospitals. Rocking of trolleys, wheelchairs, surgical instruments, oxygen cylinders, sounds from plants, uncontrolled conversations among patients, relatives, emergency noise and screams, mourning followed by death are some of the sources of noise pollution in medical centres.
- **Fireworks:** Fireworks are another source of pollution. Uncontrolled fireworks in festivals, fairs, or crackers after victory in matches and elections produce unbearable noise.
- **Other Reasons:** Noise pollution inside and outside the house includes car alarms, emergency services siren, machine tools, compressed air horn, equipment, electrical equipment, megaphone etc.

5.5 EFFECTS OF NOISE POLLUTION [May 18]

- Noise pollution may cause temporary or permanent hearing impairment. The most direct harmful effect of excessive noise falls on the ears. Many times, extreme noise ruptures the ear drums.
- You cannot only be deaf but can also come in the grip of deadly illnesses like impotence and cancer, besides problems such as lack of memory, concentration, and interruption in speech, irritation, irritability, stress and depression.
- The noise not only creates irritability, anger, but also accelerates the heart rate by increasing blood flow in the arteries. The constant noise increases the amount of cholesterol in the blood, which contracts blood vessels, increasing the likelihood of cardiovascular disease.
- Health experts believe that rising noise gives rise to neurological disease, nervous breakdown, hypertension, vision, dizziness, excessive sweating, exhaustion.
- As rapid noise hinders sleep, insomnia has adverse effects on human functioning. The person becomes irritable, angry, tired and tense, and he even becomes neurotic or crazy.
- Exposure to the noise of 180 decibels intensity may result in the death of man.
- Due to excessive noise, there is a decrease in the production of digestive juices.
- Noise pollution has a lot of adverse effect on infants and women, sometimes due to loud velocity of sound, women also undergo miscarriage or the foetus's heart stops and the entire behaviour of the infant can change. Children imbibe forgetful tendencies.
- The effect of noise is dangerous for animal life too. Due to continuous noise, their habitat decreases and the threatened creatures reach the brink of extinction. The most notable of the deadly effects of noise pollution is that some species of whale die due to noise.
- Noise pollution has extremely harmful effects on other organisms and vegetation. Due to frequent noise, animals and birds leave their habitat and move away. Animals and birds migrate from the forest areas near the mining areas and high traffic roads. Due to acute sound waves, birds may even stop laying eggs.

- Because of excessive noise, many violent creatures cannot find their prey, while other creatures cannot survive being hunted.
- Many microbes are destroyed by acute sound, which inhibit decomposition of wastes.

There are adverse effects of pollution on pets such as turbulence, and decrease in their milk content.

- Similarly, due to noise pollution, the growth of the vegetation is hindered; the fruits and flowers of the trees get withered and decayed.
- With excessive sound the walls of windows of the buildings are broken, the roofs rattle and get cracked.
- Due to blasts in the mining areas, or sound of jet aeroplanes sometimes high-rise buildings collapse or cracks develop in them, dams, bridges, etc.
- The sound effects of noise pollution caused by nuclear explosions spread through hundreds of kilometres so that biodiversity is threatened.
- Rocks, snowflakes and landslide incidents rise in snowy and mountainous areas.
- Because of the noise, many creatures also speak loudly, which is called Lombard Vocal Response. Their vocal intensity increases in the presence of noise. It occurs as a response to ambient noise.
- Due to excessive noise, there is a disruption in the studies of children too, as they do not get peaceful environment for study even in their homes.

5.6 MEASURES FOR PREVENTION / CONTROL OF NOISE POLLUTION

- Considering the widespread ill-effects of noise pollution, measures need to be taken to control them.
- Increasing noise pollution is very harmful for the health, efficiency and productivity of animals, organisms, flora etc. as well as the adaptation and balance of the environment.
- It has become necessary to control it and also to make people aware of this.
- Factories, which mainly produce noise pollution, should be established far away from settlements, forests, reservoirs and hilly areas.
- Settlements should not be located at least within 20 kilometres from mining areas, and airports.
- Explosives should be not used in mountainous, forest and mining areas.
- With proper maintenance of vehicles, along with the restriction of high sound horns, the use of advanced technology silencer should be used inevitably.
- Use of horn in public places (hospital, teaching institutes etc.) should be banned.
- The sound of musical instruments should be controlled to desirable limits.
- The use of sound amplifiers of high power, DJ, etc should be banned in religious, social, political events.
- There should be control over noise generated from machine and equipment.
- The use of sound absorber acoustic tiles should be encouraged in the construction of multi-storeyed buildings.
- In industrial, commercial and hospital buildings, adequate soundproof systems should be installed.
- Intensive plantation should be made in the entire building complex.
- Planting green trees along the road side reduces the intensity of noise pollution.
- Dense tree cover is very useful in the prevention of noise pollution. Such trees help in absorbing high sound waves, as well as deflecting them into the atmosphere.
- Therefore, cities, highways, industrial settlements should be fully lined with the green belt of trees.
- Protective tools (ear plugs etc.) should be provided for workers.
- Limits should be set on noise and control over noise pollution by legal provisions.
- Adequate health education on pollution should be provided through government agencies and voluntary institutions.

5.7 SOLID WASTE

- Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorised according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc); or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc).

- Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste, in 1997 it was about 48 million tonnes.
- More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are neither well equipped or well managed and are not lined properly to protect against contamination of soil and groundwater.
- Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminum foils, plastics, and other such non-biodegradable items that cause incalculable harm to the environment. In India, some municipal areas have banned the use of plastics and they seem to have achieved success. For example, today one will not see a single piece of plastic in the entire district of Ladakh where the local authorities imposed a ban on plastics in 1998.
- Other states should follow the example of this region and ban the use of items that cause harm to the environment. One positive note is that in many large cities, shops have begun packing items in reusable or biodegradable bags. Certain biodegradable items can also be composted and reused. In fact proper handling of the biodegradable waste will considerably lessen the burden of solid waste that each city has to tackle.

Garbage: The four broad categories

1. **Organic waste:** Kitchen waste, vegetables, flowers, leaves, fruits.
2. **Toxic Waste:** Old medicines, paints, chemicals, bulbs, spray cans, fertilizer and pesticide containers, batteries, shoe polish
3. **Recyclable:** Paper, glass, metals, plastics.
4. **Soiled:** Hospital waste such as cloth soiled with blood and other body fluids.

5.7.1 Various Sources of Solid Waste

Everyday, tonnes of solid waste is disposed off at various landfill sites. This waste comes from homes, offices, industries and various other agricultural related activities. These landfill sites produce foul smell if waste is not stored and treated properly. It can pollute the surrounding air and can seriously affect the health of humans, wildlife and our environment. The following are major sources of solid waste:

1. **Residential**

   Residences and homes where people live are some of the major sources of solid waste. Garbage from these places include food wastes, plastics, paper, glass, leather, cardboard, metals, yard wastes, ashes and special wastes like bulky household items like electronics, tires, batteries, old mattresses and used oil. Most homes have garbage bins where they can throw away their solid wastes in and later the bin is emptied by a garbage collecting firm or person for treatment.

2. **Industrial**

   Industries are known to be one of the biggest contributors of solid waste. They include light and heavy manufacturing industries, construction sites, fabrication plants, canning plants, power and chemical plants. These industries produce solid waste in form of housekeeping wastes, food wastes, packaging wastes, ashes, construction and demolition materials, special wastes, medical wastes as well as other hazardous wastes.

3. **Commercial**

   Commercial facilities and buildings are yet another source of solid waste today. Commercial buildings and facilities in this case refer to hotels, markets, restaurants, go downs, stores and office buildings. Some of the solid wastes generated from these places include plastics, food wastes, metals, paper, glass, wood, cardboard materials, special wastes and other hazardous wastes.

4. **Institutional**

   The institutional centers like schools, colleges, prisons, military barracks and other government centers also produce solid waste. Some of the common solid wastes obtained from these places include glass, rubber waste, plastics, food wastes, wood, paper, metals, cardboard materials, electronics as well as various hazardous wastes.

5. Construction and Demolition Areas

Construction sites and demolition sites also contribute to the solid waste problem. Construction sites include new construction sites for buildings and roads, road repair sites, building renovation sites and building demolition sites. Some of the solid wastes produced in these places include steel materials, concrete, wood, plastics, rubber, copper wires, dirt and glass.

6. Municipal Services

The urban centers also contribute immensely to the solid waste crisis in most countries today. Some of the solid waste brought about by the municipal services include, street cleaning, wastes from parks and beaches, wastewater treatment plants, landscaping wastes and wastes from recreational areas including sludge.

7. Treatment Plants and Sites

Heavy and light manufacturing plants also produce solid waste. They include refineries, power plants, processing plants, mineral extraction plants and chemicals plants. Among the wastes produced by these plants include, industrial process wastes, unwanted specification products, plastics, metal parts just to mention but a few.

8. Agriculture

Crop farms, orchards, dairies, vineyards and feedlots are also sources of solid wastes. Among the wastes they produce include agricultural wastes, spoiled food, pesticide containers and other hazardous materials.

9. Biomedical

This refers to hospitals and biomedical equipment and chemical manufacturing firms. In hospitals there are different types of solid wastes produced. Some of these solid wastes include syringes, bandages, used gloves, drugs, paper, plastics, food wastes and chemicals. All these require proper disposal or else they will cause a huge problem to the environment and the people in these facilities.

5.7.2 Treatment and Disposal of Municipal Waste

[Dec. 17]

As cities are growing in size with a rise in the population, the amount of waste generated is increasing becoming unmanageable. The local corporations have adapted different methods for the disposal of waste, open dumps, landfills, sanitary landfills, and incineration plants. One of the important methods of waste treatment is composting.

1. Open Dumps

Open dumps refer to uncovered areas that are used to dump solid waste of all kinds. The waste is untreated, uncovered, and not segregated. It is the breeding ground for flies, rats, and other insects that spread disease. The rainwater run-off from these dumps contaminates nearby land and water thereby spreading disease. In some countries, open dumps are being phased out.

2. Landfills

Landfills are generally located in urban areas where a large amount of waste is generated and has to be dumped in a common place. Unlike an open dump, it is a pit that is dug in the ground. The garbage is dumped and the pit is covered thus preventing the breeding of flies and rats. At the end of each day, a layer of soil is scattered on top of it and some mechanism, usually earth-moving equipment is used to compress the garbage, which now forms a cell. Thus, every day, garbage is dumped and becomes a cell. After the landfill is full, the area is covered with a thick layer of mud and the site can thereafter be developed as a parking lot or a park.

Landfills have many problems. All types of waste is dumped in landfills and when water seeps through them it gets contaminated and in turn pollutes the surrounding area. This contamination of groundwater and soil through landfills is known as leaching.

3. Sanitary Landfills

An alternative to landfills which will solve the problem of leaching to some extent, is a sanitary landfill which is more hygienic and built in a methodical manner. These are lined with materials that are impermeable such as plastics and clay, and are also built over impermeable soil. Constructing sanitary landfills is very costly and they are having their own problems. Some authorities claim that often the plastic liner develops cracks as it reacts with various chemical solvents present in the waste.

The rate of decomposition in sanitary landfills is also extremely variable. This can be due to the fact that less oxygen is available as the garbage is compressed very tightly. It has also been observed that some biodegradable materials do not decompose in a landfill. Another major problem is the development of methane gas, which occurs when little oxygen is present, i.e. during anaerobic decomposition. In some countries, the methane being produced from sanitary landfills is tapped and sold as fuel.

4. Incineration Plants

This process of burning waste in large furnaces is known as incineration. In these plants the recyclable material is segregated and the rest of the material is burnt. At the end of the process all that is left behind is ash. During the process some of the ash floats out with the hot air. This is called fly ash. Both the fly ash and the ash that is left in the furnace after burning have high concentrations of dangerous toxins such as dioxins and heavy metals. Disposing of this ash is a problem. The ash that is buried at the landfills leaches the area and cause severe contamination.

Burning garbage is not a clean process as it produces tons of toxic ash and pollutes the air and water. A large amount of the waste that is burnt here can be recovered and recycled. In fact, at present, incineration is kept as the last resort and is used mainly for treating the infectious waste.

5. Composting

Organic matter constitutes 35%-40% of the municipal solid waste generated in India. This waste can be recycled by the method of composting, one of the oldest forms of disposal. It is the natural process of decomposition of organic waste that yields manure or compost, which is very rich in nutrients. Composting is a biological process in which microorganisms, mainly fungi and bacteria, convert degradable organic waste into humus like substance. This finished product, which looks like soil, is high in carbon and nitrogen and is an excellent medium for growing plants. The process of composting ensures the waste that is produced in the kitchens is not carelessly thrown and left to rot. It recycles the nutrients and returns them to the soil as nutrients. Apart from being clean, cheap, and safe, composting can significantly reduce the amount of disposable garbage. The organic fertilizer can be used instead of chemical fertilizers and is better specially when used for vegetables. It increases the soil's ability to hold water and makes the soil easier to cultivate. It helped the soil retain more of the plant nutrients.

6. Recovery and Recycling

Recycling or recovery of resources is the process of taking useful but discarded items for next use. Traditionally, these items are processed and cleaned before they are recycled. The process aims at reducing energy loss, consumption of new material and reduction of landfills.

7. Pyrolysis

This is method of solid waste management whereby solid wastes are chemically decomposed by heat without presence of oxygen. This usually occurs under pressure and at temperatures of up to 430 degrees Celsius. The solid wastes are changed into gasses, solid residue and small quantities of liquid.

5.8 BIOMEDICAL WASTE

- Biomedical waste is any kind of waste containing infectious (or potentially infectious) materials. It may also include waste associated with the generation of biomedical waste that visually appears to be of medical or laboratory origin (e.g., packaging, unused bandages, infusion kits, etc.), as well research laboratory waste containing biomolecules or organisms that are restricted from environmental release. As detailed below, discarded sharps are considered biomedical waste whether they are contaminated or not, due to the possibility of being contaminated with blood and their propensity to cause injury when not properly contained and disposed of. Biomedical waste is a type of biowaste.
- Biomedical waste may be solid or liquid. Examples of infectious waste include discarded blood, sharps, unwanted microbiological culture sand stocks, identifiable body parts (including those as a result of amputation), other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body fluids, and laboratory waste that exhibits the characteristics described above. Waste sharps include potentially contaminated used (and unused discarded) needles, scalpels, lancets and other devices capable of penetrating skin.
- Biomedical waste is generated from biological and medical sources and activities, such as the diagnosis, prevention, or treatment of diseases. Common generators (or producers) of biomedical waste include hospitals, health clinics, nursing homes, medical research laboratories, offices of physicians, dentists, and veterinarians, home health care, and morgues or funeral homes. In healthcare facilities (i.e., hospitals, clinics, doctor's offices, veterinary hospitals and clinical laboratories), waste with these characteristics may alternatively be called medical or clinical waste.

- Biomedical waste is distinct from normal trash or general waste, and differs from other types of hazardous waste, such as chemical, radioactive, universal or industrial waste. Medical facilities generate waste hazardous chemicals and radioactive materials. While such wastes are normally not infectious, they require proper disposal. Some wastes are considered multi hazardous, such as tissue samples preserved in formalin.
- In India, the Bio-medical Waste (Management and Handling) Rules, 1998 and further amendments were passed for the regulation of bio-medical waste management. On 28 th Mar 2016 Biomedical Waste Management Rules 2016 were also notified by Central Govt. Each state's Pollution Control Board or Pollution control Committee will be responsible for implementing the new legislation.
- In India, there are a number of different disposal methods, yet most are harmful rather than helpful. If body fluids are present, the material needs to be incinerated or put into an autoclave. Although this is the proper method, most medical facilities fail to follow the regulations. It is often found that biomedical waste is put into the ocean, where it eventually washes up on shore, or in landfills due to improper sorting when in the medical facility. Improper disposal can lead to many diseases in animals as well as humans. For example, animals, such as cows in Pondicherry, India, are consuming the infected waste and eventually, these infections can be transported to humans through eating of the meat.
- Many studies took place in Gujarat, India regarding the knowledge of workers in facilities such as hospitals, nursing homes, or home health. It was found that 26% of doctors and 43% of paramedical staff were unaware of the risks related to biomedical wastes. After extensively looking at the different facilities, many were undeveloped in the area regarding biomedical waste. The rules and regulations in India work with The Bio-medical Waste (Management and Handling) Rules from 1998, yet a large number of health care facilities were found to be sorting the waste incorrectly. Worldwide, there are specific colored bags, bins and labels that are recommended for each type of waste. For example, syringes, needles and blood-soiled bandages should be all disposed of in a red colored bag or bin, where it will later be incinerated.

5.8.1 Categories of Biomedical Waste

Category No. 1 : Human Anatomical Waste (human tissues, organs, body parts)

Category No. 2 : Animal Waste (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals, colleges, discharge from hospitals, animal houses)

Category No. 3 : Microbiology & Biotechnology Wastes (Wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of bio-logicals, toxins, dishes and devices used for transfer of cultures)

Category No. 4 : Waste sharps (needles, syringes, scalpels, blades, glass etc. that may cause puncture and cuts. This includes both used and unused

Category No. 5 : Discarded Medicines and Cytotoxic drugs (wastes comprising of outdated, contaminated and discarded medicines)

Category No. 6 : [Soiled] Waste (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines beddings, other material contaminated with blood)

Category No. 7 : Solid Waste (wastes generated from disposable items other than the waste 5 [sharps] such as tubing's, catheters, intravenous sets etc.)

Category No. 8 : Liquid Waste (waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities)

Category No. 9 : Incineration Ash (ash from incineration of any biomedical waste)

Category No. 10 : Chemical Waste (Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides etc.)

5.8.2 Treatment of Biomedical Waste

(A) On-Site Medical Waste Treatment

1. Autoclaving

Thermal treatment is typically used for sharps and certain other types of infectious waste. An autoclave is in essence a large pressure cooker that uses high temperatures and steam to deeply penetrate all materials and kill any microorganisms. Depending on the type and amount of waste you will need to sterilize,

you can purchase an appropriately-sized autoclave for your facility. These appliances range from 100 liters to 4,000+ liters in volume for bulk waste treatment.

Modern autoclaves are also automated to minimize human involvement and therefore reduce needle-stick injuries and contamination. Decontaminated sharps and other medical waste that's been autoclaved can then be handed over to your Maryland medical waste removal vendor to be disposed of as non-infectious waste. However, keep in mind that such medical wastes as chemical waste, including chemotherapy waste, as well as pharmaceutical waste can't be decontaminated in an autoclave.

2. Chemical Treatment

Often used to deactivate liquid waste, chemical treatment is designed to decontaminate or deactivate certain wastes on site rather than packaging and sending them to a separate facility. Since liquids are highly susceptible to spills, it's typically best to have them treated as close to the generation site as possible. Chemical treatment can also be applied to some non-liquid infectious wastes, but they would typically need to be shredded first to ensure that all portions of the waste are exposed to the chemicals.

Depending on the type of waste, chemicals like chlorine, sodium hydroxide or calcium oxide can be used. However, these chemicals may often produce undesirable byproducts, as well as off-gas dangerous VOCs when applied. Chemical treatment has to be executed carefully and by knowledgeable staff. If you are not comfortable with on-site chemical treatment, an alternative is to use solidifying agents to turn liquids into solids and direct them to your medical waste removal vendor for disposal.

3. Microwave Treatment

A microwave treatment system, similar to an autoclave, also uses heat to decontaminate medical waste. These systems work best for waste that is not 100% dry or solid, as the moisture allows the heat to penetrate deeper, and the steam sterilizes. Therefore, before microwaving, most types of medical waste need to be shredded and mixed with water to achieve the desired effect. The bonus is that shredding reduces the volume of the waste, so it can later be land-filled.

(B) Off-Site Medical Waste Disposal

1. Incineration

Incineration is typically used (and often required by the state) for pathological and pharmaceutical waste. Incineration of medical waste should be preformed in a controlled facility to ensure complete combustion and minimize any negative effects for the environment. The great thing about incineration is that it kills 99% of microorganisms and leaves very minimal waste, if any.

2. Land Disposal

Land disposal is typically used for shredded, treated and decontaminated waste. In certain cases, it can also be used for hazardous waste or other untreated waste that can not be decontaminated by other means. Specialized sanitary landfill sites exit to reduce the risk of soil and water contamination and provide a safe space for medical waste disposal.

5.9 THERMAL POLLUTION

- Thermal pollution is the degradation of water quality by any process that changes ambient water temperature. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment at a higher temperature, the change in temperature decreases oxygen supply and affects ecosystem composition. Fish and other organisms adapted to particular temperature range can be killed by an abrupt change in water temperature (either a rapid increase or decrease) known as "thermal shock."

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5.9.1 Causes of Thermal Pollution

1. **Water as Cooling Agent in Power, Manufacturing and Industrial Plants :** Production and Manufacturing plants are biggest source of thermal pollution. These plants draw water from nearby source to keep machines cool and then release back to the source with higher temperature. When heated water returns to the river or ocean, the water temperature rises sharply. When oxygen levels are altered in the water, this can also degrade the quality and longevity of life in wildlife that lives underwater. This process can also wipe away streamside vegetation, which constantly depends on constant levels of oxygen and temperature. By altering these natural environments, industries are essentially helping decrease the quality of life for these marines based life forms and can ultimately destroy habitats if they are not controlled and careful about their practices.
2. **Soil Erosion:** Soil erosion is another major factor that causes thermal pollution. Consistent soil erosion causes water bodies to rise, making them more exposed to sunlight. The high temperature could prove fatal for aquatic biomes as it may give rise to anaerobic conditions.
3. **Deforestation:** Trees and plants prevent sunlight from falling directly on lakes, ponds or rivers. When deforestation takes place, these water bodies are directly exposed to sunlight, thus absorbing more heat and raising its temperature. Deforestation is also a main cause of the higher concentrations of greenhouse gases i.e. global warming in the atmosphere.
4. **Runoff from Paved Surfaces:** Urban runoff discharged to surface waters from paved surfaces like roads and parking lots can make water warmer. During summer seasons, the pavement gets quite hot, which creates warm runoff that gets into the sewer systems and water bodies.
5. **Natural Causes:** Natural causes like volcanoes and geothermal activity under the oceans and seas can trigger warm lava to raise the temperature of water bodies. Lightening can also introduce massive amount of heat into the oceans. This means that the overall temperature of the water source will rise, having significant impacts on the environment.

5.9.2 Effects of Thermal Pollution

Among recognized scientists and scholars, there are generally two schools of thought when it comes to the effects of thermal pollution. Some lean on the side of the negatives of this pollution on marine ecosystems and how it is detrimental to positive environmental practices. However, some lean towards the side that without these industries operating the way they do, then some of the most basic parts of human life would be completely obsolete. Waste water would not be able to be properly maintained, we would have no industries that could produce the goods we need, and so on. The effects of thermal pollution on ecosystems, however, greatly outweigh the benefits that industries have by participating in the act.

1. **Decrease in DO (Dissolved Oxygen) Levels:** The warm temperature reduces the levels of DO (Dissolved Oxygen) in water. The warm water holds relatively less oxygen than cold water. The decrease in DO can create suffocation for plants and animals such as fish, amphibians and copepods, which may give rise to anaerobic conditions. Warmer water allows algae to flourish on surface of water and over the long term growing algae can decrease oxygen levels in the water.
2. **Increase in Toxins:** With the constant flow of high temperature discharge from industries, there is a huge increase in toxins that are being regurgitated into the natural body of water. These toxins may contain chemicals or radiation that may have harsh impact on the local ecology and make them susceptible to various diseases.
3. **Loss of Biodiversity:** A dent in the biological activity in the water may cause significant loss of biodiversity. Changes in the environment may cause certain species of organisms to shift their base to some other place while their could be significant number of species that may shift in because of warmer waters. Organisms that can adapt easily may have an advantage over organisms that are not used to the warmer temperatures.
4. **Ecological Impact:** A sudden thermal shock can result in mass killings of fish, insects, plants or amphibians. Hotter water may prove favorable for some species while it could be lethal for other species. Small water temperature increases the level of activity while higher temperature decreases the level of activity. Many aquatic species are sensitive to small temperature

changes such as one degree Celsius that can cause significant changes in organism metabolism and other adverse cellular biology effects.

5. **Affects Reproductive Systems:** A significant halt in the reproduction of marine wildlife (although this may be true, reproduction can still occur between fish – but the likelihood of defects in newborns is significantly higher) can happen due to increasing temperatures as reproduction can happen with in certain range of temperature. Excessive temperature can cause the release of immature eggs or can prevent normal development of certain eggs.

6. **Increases Metabolic Rate:** Thermal pollution increases the metabolic rate of organisms as increasing enzyme activity occurs that causes organisms to consume more food than what is normally required, if their environment were not changed. It disrupts the stability of food chain and alter the balance of species composition.

7. **Migration:** The warm water can also cause particular species of organisms to migrate to suitable environment that would cater to its requirements for survival. This can result in loss for those species that depend on them for their daily food as their food chain

1. **Industrial Wastes :** Disposal of Industrial wastes is the major problem for soil pollution Sources: Industrial pollutants are mainly discharged from various origins such as pulp and paper mills, chemical fertilizers, oil refineries, sugar factories, tanneries, textiles, steel, distilleries, fertilizers, pesticides, coal and mineral mining industries, drugs, glass, cement, petroleum and engineering industries etc.

   Effects: These pollutants affect and alter the chemical and biological properties of soil. As a result, hazardous chemicals can enter into human food chain from the soil or water, disturb the biochemical process and finally lead to serious effects on living organisms.

2. **Urban Wastes :** Urban wastes comprise of both commercial and domestic wastes consisting of dried sludge and sewage. All the urban solid wastes are commonly referred to as refuse. Constituents of urban refuse: This refuse consists of garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. Urban domestic wastes though disposed off separately from industrial wastes, can still be dangerous. This happens because they are not easily degraded.

3. **Agricultural Practices :** Modern agricultural practices pollute the soil to a large extent. With the advancing technology, huge quantities of fertilizers, are added to

- **Proper Dumping of Unwanted Materials:** Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.
- **Production of Natural Fertilizers:** Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Ex: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.
- **Proper Hygienic Condition:** People should be trained regarding sanitary habits. Ex: Lavatories should be equipped with quick and effective disposal methods.
- **Public Awareness:** Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education. Ex: Mass media, Educational institutions and voluntary agencies can achieve this.
- **Recycling and Reuse of Wastes:** To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc should be recycled and reused. Ex: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.
- **Ban on Toxic Chemicals:** Ban should be imposed on chemicals and pesticides like DDT, BHC, etc which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.

5.11 NUCLEAR HAZARD

Nuclear hazard can be defined as the Risk or danger to human health or the environment posed by radiation emanating from the atomic nuclei of a given substance, or the possibility of an uncontrolled explosion originating from a fusion or fission reaction of atomic nuclei.

Sources of Nuclear Hazards :

The sources of radioactivity are both natural and man-made.

- **The Natural Sources Include:**
  - ➢ Cosmic rays from outer space.
  - ➢ The quantity depends on altitude and latitude; it is more at higher latitudes and high altitudes.
  - ➢ Emissions from radioactive materials from the Earth's crust.
- **Man-Made Sources Include:**
  - ➢ Mining and processing of radioactive ores.
  - ➢ Use of radioactive material in nuclear power plants.
  - ➢ Use of radioactive isotopes in medical, industrial and research applications.
  - ➢ Use of radioactive materials in nuclear weapons.

5.11.1 Effects of Nuclear Hazards

- Ionization radiations can affect living organisms by causing harmful changes in the body cells and also changes at genetic level.
- 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.
- Somatic damage includes burns, miscarriages, eye cataract and cancer of bone, thyroid, breast, lungs and skin.

5.11.2 Control of Nuclear Hazards

Following measures can help in controlling the radioactive pollution:

- Workers in nuclear plants should be provided with nuclear gadgets and safety measures against accidents.
- Leakage of radioactive elements from nuclear reactors, laboratories, transport, careless handling and use of radioactive fuels should be checked.
- There should be regular monitoring and quantitative analysis through frequent sampling in the risk areas.
- Preventive measures should be followed so that background radiation levels do not exceed the permissible limits.
- Waste disposal must be careful, efficient and effective.

EXERCISE

1. What is water pollution?
2. What are the causes of water pollution?
3. What are the effects of water pollution?
4. Explain how water pollution can be controlled?
5. What is noise pollution?
6. What are the sources of noise pollution?
7. What are effects of noise pollution?
8. Explain how noise pollution be controlled or prevented?
9. Explain the concept of Biomedical waste?
10. Explain various sources of solid waste.
11. What are the sources of soil pollution?
12. What are the sources of thermal pollution?
13. Explain how thermal pollution can be prevented?
14. What are the causes of soil pollution?
15. Explain causes and effects of nuclear hazards.
16. Explain characteristics of solid waste.
17. Explain how biomedical waste is treated?
18. Explain sources and effects of nuclear hazards.

UNIVERSITY QUESTIONS

December 2017

1. What are the main causes of water pollution? Write at least four measures to be taken for controlling water pollution **[6]**
2. What are the sources and their corresponding effects of noise pollution on human health? Explain in detail. **[6]**
3. Define the term Water Pollution. Explain BOD and Eutriphication in connection with water pollution. **[6]**
4. What are the various methods of safe disposal of wastes? Describe the process of municipal sewage treatment with a simple sketch. **[6]**

May 2018

1. What is noise pollution? What are the effects of noise pollution on children's health Enlist the engineering as well as legislative approach of curbing the noise pollution. **[6]**

June 2019

1. Explain the various causes of water pollution in brief. What is red tide phenomenon related to water pollution? **[6]**
2. What are the sources and effects of noise pollution? Explain in detail. **[6]**

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