Week 2
Lecture 3

Anamika

Air Pollution control/ reduction efforts:

There are various air pollution control technologies and land use planning strategies available to reduce air pollution. At its most basic level land use planning is likely to involve zoning and transport infrastructure planning. In most developed countries, land use planning is an important part of social policy, ensuring that land is used efficiently for the benefit of the wider economy and population as well as to protect the environment. Efforts to reduce co pollution from mobile sources includes primary regulation (many developing countries have permissive regulations), expanding regulation to new sources (such as cruise and transport ships, farm equipment, and small gas-powered equipment such as lawn trimmers, chainsaws, and snowmobiles), increased fuel efficiency (such as through the use of hybrid vehicles), conversion to cleaner fuels (such as bioethanol, biodiesel, or conversion to electric vehicles).

Control devices: The following items are commonly used as pollution control devices by industry or transportation devices. They can either destroy contaminants or remove them from an exhaust stream before it is emitted into the atmosphere.

[a] **Particulate control**: (i) ***Mechanical collectors*** (dust cyclones, multicyclones); (ii) ***Electrostatic precipitators*** An electrostatic precipitator (ESP), or electrostatic air cleaner is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge. Electrostatic precipitators are highly efficient filtration devices that minimally impede the flow of gases through the device, and can easily remove fine particulate matter such as dust and smoke from the air stream; (iii) *Baghouses*: Designed to handle heavy dust loads, a dust collector consists of a blower, dust filter, a filter-cleaning system, and a dust receptacle or dust removal system (distinguished from air cleaners which utilize disposable filters to remove the dust); (iv) ***Particulate scrubbers***: Wet scrubber is a form of pollution control technology. The term describes a variety of devices that use pollutants from a furnace flue gas or from other gas streams. In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid, by forcing it through a pool of liquid, or by some other contact method, so as to remove the pollutants.

[b] **Scrubbers** : Baffle spray scrubber; Cyclonic spray scrubber; Ejector venturi scrubber; Mechanically aided scrubber; Spray tower; Wet scrubber.

[c] **NOX control**: Low NOX burners; Selective catalytic reduction (SCR); Selective noncatalytic reduction (SNCR); NOX scrubbers; Exhaust gas recirculation; Catalytic converter (also for VOC control).

[d] **VOC abatement**: Adsorption systems, such as activated carbon; Flares; Thermal oxidizers; Catalytic converters; Bioflllters; Absorption (scrubbing); Cryogenic condensers; Vapor recovery systems.

[e] **Acid Gas/S02 control**: Wet scrubbers; Dry scrubbers; Flue-gas desulfurization.

[fl Mercury control: Sorbent Injection Technology; Electro-Catalytic Oxidation (ECO); KFuel

[g] Dioxin and furan control

[h] **Atmospheric dispersion:** The basic technology for analyzing air pollution is through the use of a variety of mathematical models for predicting the transport of air pollutants in the lower atmosphere. The principal methodologies are: (i) Point source dispersion, used for industrial sources; (ii) Line source dispersion, used for airport and roadway air dispersion modeling (iii) Area source dispersion, used for forest fires or dust storms; (iv) Photochemical models, used to analyze reactive pollutants that form smog.

Environmental impacts of greenhouse gas pollutants: The greenhouse effect is a phenomenon whereby greenhouse gases create a condition in the upper atmosphere causing a trapping of heat and leading to increased surface and lower tropospheric temperatures. Carbon dioxide emissions from combustion of fossil fuels are a source of greenhouse gas emissions. Other greenhouse gases include methane, hydrofluorocarbons, perfluorocarbons, chlorofluorocarbons, nitrogen oxides, and ozone. Many Indian cities have poor air quality index (AQI).

AQI	Remark	Color Code	Possible Health Impacts	List of AQI
0-50	Good		Minimal impact	
51-100	Satisfactory		Minor breathing discomfort to sensitive people	
101-200	Moderate		Breathing discomfort to the people with lungs, asthma and heart diseases	
201-300	Poor		Breathing discomfort to most people on prolonged exposure	
301-400	Very Poor		Respiratory illness on prolonged exposure	
401-500	Severe		Affects healthy people and seriously impacts those with existing diseases	

AQI CATEGORY, POLLUTANTS AND HEALTH BREAKPOINTS

AQI Category (Range)	PM_{10} (24hr)	$PM_{2.5}$ (24hr)	NO_2 (24hr)	O_3 (8hr)	CO (8hr)	SO_2 (24hr)	NH_3 (24hr)	Pb (24hr)
Good (0–50)	0–50	0–30	0–40	0–50	0–1.0	0–40	0–200	0–0.5
Satisfactory (51–100)	51–100	31–60	41–80	51–100	1.1–2.0	41–80	201–400	0.5–1.0
Moderately polluted (101–200)	101–250	61–90	81–180	101–168	2.1–10	81–380	401–800	1.1–2.0
Poor (201–300)	251–350	91–120	181–280	169–208	10–17	381–800	801–1200	2.1–3.0
Very poor (301–400)	351–430	121–250	281–400	209–748	17–34	801–1600	1200–1800	3.1–3.5
Severe (401–500)	430+	250+	400+	748+	34+	1600+	1800+	3.5+

For air quality standards, please check website of Central Pollution Control Board (CPCB)

Control of water pollution

Domestic sewage: Domestic sewage is 99.9 percent pure water, while the other 0.1 percent are pollutants. Although found in low concentrations, these pollutants pose risk on a large scale. Municipal treatment plants are designed to control conventional pollutants: BOD and suspended solids. Well-designed and operated systems (i.e., secondary treatment or better) can remove 90 percent or more of these pollutants. Some plants have additional sub-systems to treat nutrients and pathogens. Most municipal plants are not designed to treat toxic pollutants found in industrial wastewater. Cities with sanitary sewer overflows or combined sewer overflows employ one or more engineering approaches to reduce discharges of untreated sewage, including: (i) utilizing a green infrastructure approach to improve storm water management capacity throughout the system, and reduce the hydraulic overloading of the treatment plant (ii) repair and replacement of leaking and malfunctioning equipment (iii) increasing overall hydraulic capacity of the sewage collection system (often a very expensive option). Industrial wastewater: Some industrial facilities generate ordinary domestic sewage that can be treated by municipal facilities. Industries that generate wastewater with high concentrations of conventional pollutants (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or other nonconventional pollutants such as ammonia, need specialized treatment systems. Some of these facilities can install a pre-treatment system to remove the toxic components, and then send the partially treated wastewater to the municipal system. Industries generating large volumes of wastewater typically operate their own complete on-site treatment systems. Some industries have been successful at redesigning their manufacturing processes to reduce or eliminate pollutants, through a process called pollution prevention. Heated water generated by power plants or manufacturing plants may be controlled with: (i) cooling ponds, man-made bodies of water designed for cooling by evaporation, convection, and radiation (ii) cooling towers, which transfer waste heat to the atmosphere through evaporation and/or heat transfer (iii) cogeneration, a process where waste heat is recycled for domestic and/or industrial heating purposes. Agricultural wastewater

Nonpoint source controls: Sediment (loose soil) washed off fields is one of the largest source of agricultural pollution. Farmers may utilize erosion controls to reduce runoff flows and retain soil on their fields. Common techniques include contour plowing, crop mulching, crop rotation, planting perennial crops and installing riparian buffers. Nutrients (nitrogen and phosphorus) are typically applied to farmland as commercial fertilizer; animal manure; or spraying of municipal or industrial wastewater (effluent) or sludge. Nutrients may also enter runoff from crop residues, irrigation water, wildlife, and atmospheric deposition.

Point source wastewater treatment: Farms with large livestock and poultry operations, such as factory farms, are called concentrated animal feeding operations or feedlots. Animal slurries are usually treated by containment in anaerobic lagoons before disposal by spray or trickle application to grassland.

Construction site storm water: Sediment from construction sites is managed by installation of: (i) erosion controls, such as mulching and hydroseeding, and (ii) sediment controls, such as sediment basins and silt fences. Discharge of toxic chemicals such as motor fuels and concrete washout is prevented by use of: (a) spill prevention and control plans, and (b) specially designed containers (e.g. for concrete washout) and structures such as overflow controls.

Urban runoff (storm water): Effective control of urban runoff involves reducing the velocity and flow of storm water, as well as reducing pollutant discharges. Local governments use a variety of storm water management techniques to reduce the effects of urban runoff. These techniques, called best management practices (BMPs), may focus on water quantity control, while others focus on improving water quality, and some perform both functions. Pollution prevention practices include low-impact development techniques, installation of green roofs and improved chemical handling (e.g. management of motor fuels & oil, fertilizers and pesticides). Runoff mitigation systems include infiltration basins, bioretention systems, constructed wetlands, retention basins and similar devices.

Sewage treatment: It is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce an environmentally safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer). Sewage collection and treatment is typically subject to local, state and federal regulations and standards. Industrial sources of sewage often require specialized treatment processes (see Industrial wastewater treatment). Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment.

(i) Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.
(ii) Secondary treatment removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne microorganisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.
(iii) Tertiary treatment is sometimes defined as anything more than primary and secondary treatment in order to allow rejection into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs). Treated water is sometimes disinfected chemically or physically (for

example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Pre-treatment: Pre-treatment removes materials that can be easily collected from the raw sewage before they damage or clog the pumps and sewage lines of primary treatment clarifiers (trash, tree limbs, leaves, branches etc.).
Screening: The influent sewage water passes through a bar screen to remove all large objects like cans, rags, sticks, plastic packets etc. carried in the sewage stream.
Grit removal: Pre-treatment may include a sand or grit channel or chamber, where the velocity of the incoming sewage is adjusted to allow the settlement of sand, grit, stones, and broken glass. These particles are removed because they may damage pumps and other equipment.

Flow equalization: Clarifiers and mechanized secondary treatment are more efficient under uniform flow conditions. Equalization basins may be used for temporary storage of diurnal or wet-weather flow peaks. Cleaning may be easier if the basin is downstream of screening and grit removal.

Fat and grease removal: In some larger plants, fat and grease are removed by passing the sewage through a small tank where skimmers collect the fat floating on the surface. Air blowers in the base of the tank may also be used to help recover the fat as a froth.

Primary treatment: In the primary sedimentation stage, sewage flows through large tanks, commonly called "pre-settling basins", "primary sedimentation tanks" or "primary clarifiers". Grease and oil from the floating material can sometimes be recovered for saponification.
Secondary treatment: Secondary treatment is designed to substantially degrade the biological content of the sewage which are derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. To be effective, the biota require both oxygen and food to live. The bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc. Secondary treatment systems are classified as fixed-film or suspended-growth systems.

Activated sludge: In general, activated sludge plants encompass a variety of mechanisms and processes that use dissolved oxygen to promote the growth of biological floc that substantially removes organic material. The process traps paniculate material and can, under ideal conditions, convert ammonia to nitrite and nitrate ultimately to nitrogen gas. Surface-aerated basins (Lagoons): Most biological oxidation processes for treating industrial wastewaters have in common the use of oxygen (or air) and microbial action. Surface-aerated basins achieve 80 to 90 percent removal of BOD with retention times of 1 to 10 days. The basins may range in depth from 1.5 to 5.0 metres and use motor-driven aerators floating on the surface of the wastewater. In an aerated basin system, the aerators provide two functions: they transfer air into the basins required by the biological oxidation reactions, and they provide the mixing required for dispersing the air and for contacting the reactants (that is, oxygen, wastewater and microbes). Biological oxidation processes are sensitive to temperature and, between $0\ ^{o}c$ and $40\ ^{c}c$, the rate of biological reactions increase with temperature.

Tertiary treatment: The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called "effluent polishing."

Filtration: Sand filtration removes much of the residual suspended matter. Filtration over activated carbon, also called carbon adsorption, removes residual toxins.

Lagooning: Lagooning provides settlement and further biological improvement through storage in large man-made ponds or lagoons. These lagoons are highly aerobic and colonization by native macrophytes, especially reeds, is often encouraged. Small filter feeding invertebrates such as Daphnia and species of Rotifera greatly assist in treatment by removing fine particulates.

Nutrient removal: Wastewater may contain high levels of the nutrients nitrogen and phosphorus. Excessive release to the environment can lead to a build up of nutrients, called eutrophication, which can in turn encourage the overgrowth of weeds, algae, and cyanobacteria (blue-green algae). This may cause an algal bloom, a rapid growth in the population of algae. The algae numbers are unsustainable and eventually most of them die. The decomposition of the algae by bacteria uses up so much of the oxygen in the water that most or all of the animals die, which creates more organic matter for the bacteria to decompose. In addition to causing deoxygenation, some algal species produce toxins that contaminate drinking water supplies. Different treatment processes are required to remove nitrogen and phosphorus.

Nitrogen removal: The removal of nitrogen is effected through the biological oxidation of nitrogen from ammonia to nitrate (nitrification), followed by denitrification, the reduction of nitrate to nitrogen gas. Nitrogen gas is released to the atmosphere and thus removed from the water. Nitrification itself is a two-step aerobic process, each step facilitated by a different type of bacteria. The oxidation of ammonia (NH3) to nitrite (N02-) is most often facilitated by Nitrosomonas spp. (nitroso referring to the formation of a nitroso functional group). Nitrite oxidation to nitrate (N03-), though traditionally believed to be facilitated by Nitrobacter spp. (nitro referring the formation of a nitro functional group), is now known to be facilitated in the environment almost exclusively by Nitrospira spp. Denitrification requires anoxic conditions to encourage the appropriate biological communities to form.

Phosphorus removal: Each person excretes between 200 and 1000 grams of phosphorus annually. Phosphorus removal is important as it is a limiting nutrient for algae growth in many fresh water systems. (For a description of the negative effects of algae, see Nutrient removal). It is also particularly important for water reuse systems where high phosphorus concentrations may lead to fouling of downstream equipment such as reverse osmosis. Phosphorus can be removed biologically in a process called enhanced biological phosphorus removal. In this process, specific bacteria, called polyphosphate accumulating organisms (PAOs), are selectively enriched and accumulate large quantities of phosphorus within their cells (up to 20 percent of their mass). When the biomass enriched in these bacteria is separated from the treated water, these biosolids have a high fertilizer value. Phosphorus removal can also be achieved by chemical precipitation, usually with salts of iron (e.g. ferric chloride), aluminum (e.g. alum), or lime.

Disinfection: The purpose of disinfection in the treatment of waste water is to substantially reduce the number of microorganisms in the water to be discharged back into the environment for the later use of drinking, bathing, irrigation, etc. The effectiveness of disinfection depends on the quality of the water being treated (e.g., cloudiness, pH, etc.), the type of disinfection being used, the disinfectant dosage (concentration and time), and other environmental variables. Cloudy water will be treated less successfully, since solid matter can shield organisms, especially from ultraviolet light or if contact times are low. Ozone is considered to be safer than chlorine because, unlike chlorine which has to be stored on site (highly poisonous in the event of an accidental release), ozone is generated onsite as needed. A disadvantage of ozone disinfection is the high cost of the ozone generation equipment and the requirements for special operators.

Odor control: Odors emitted by sewage treatment are typically an indication of an anaerobic or "septic" condition. Early stages of processing will tend to produce foul smelling gases, with hydrogen sulfide being most common in generating complaints. Large process plants in urban areas will often treat the odors with carbon reactors, a contact media with bio-slimes, small doses of chlorine, or circulating fluids to biologically capture and metabolize the obnoxious gases. Other methods of odor control exist, including addition of iron salts, hydrogen peroxide, calcium nitrate, etc. to manage hydrogen sulfide levels. Highdensity solids pumps are suitable to reduce odors by conveying sludge through hermetic closed pipe work.

Sludge treatment and disposal: The sludges accumulated in a wastewater treatment process must be treated and disposed of in a safe and effective manner. The purpose of digestion is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion, aerobic digestion, and composting. Incineration is also used albeit to a much lesser degree. The sludge is first passed through a so-called pre-thickener or main sludge thickener. This equipment dewaters the sludge. Types of pre-thickeners include: (i) centrifugal sludge thickeners; (ii) rotary drum sludge thickeners; (iii) belt filter presses. After this step, the actual digestion is done in a tank, and then the remaining solid is moved off. Sludge treatment depends on the amount of solids generated and other site-specific conditions. Composting is most often applied to small-scale plants with aerobic digestion for mid sized operations, and anaerobic digestion for the larger-scale operations.

Anaerobic digestion: Anaerobic digestion is a bacterial process that is carried out in the absence of oxygen. The process can either be thermophilic digestion, in which sludge is fermented in tanks at a temperature of 55^0C, or mesophilic, at a temperature of around 36^0 C. Though allowing shorter retention time (and thus smaller tanks), thermophilic digestion is more expensive in terms of energy consumption for heating the sludge. Anaerobic digestion is the most common (mesophilic) treatment of domestic sewage in septic tanks, which normally retain the sewage from one day to two days, reducing the BOD by about 35 to 40 percent. This reduction can be increased with a combination of anaerobic and aerobic treatment by installing Aerobic Treatment Units (ATUs) in the septic tank. co Mesophilic Anaerobic Digestion (MAD) is also the most common method for treating sludge produced at Sewage Treatment Plants. The sludge is fed into large tanks and held for a minimum of 12 days to allow the digestion process to perform the 4 stages necessary to digest the sludge. These are Hydrolysis, acidogenesis, Acetogenesis and Methanogenesis. In this process the complex proteins and sugars are broken down to form more simple compounds such as water, carbon dioxide and methane. One major feature of anaerobic digestion is the production of biogas (with the most useful component being methane), which can be used in generators for electricity production and/or in boilers for heating purposes.

Aerobic digestion: Aerobic digestion is a bacterial process occurring in the presence of oxygen. Under aerobic conditions, bacteria rapidly consume organic matter and convert it into carbon dioxide. Aerobic digestion can also be achieved by using diffuser systems or jet aerators to oxidize the sludge.

Composting: Composting is also an aerobic process that involves mixing the sludge with sources of carbon such as sawdust, straw or wood chips. In the presence of oxygen, bacteria digest both the wastewater solids and the added carbon source and, in doing so, produce a large amount of heat.

Week 2
Lecture 4

Anamika

Soil pollution

“The soil is a resource for which there is no substitute even fertilizers are not the substitute for fertile soil”.

Contamination of soil with sewage sludge, Industrial sludge, solid waste, agrochemicals and radioactive substances. Soil is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. The factors which are important for soil formation are mechanical weathering of rocks due to temperature changes and abrasion, wind, moving water, glaciers, chemical weathering activities and lichens. Climate and time are also important in the development of soils. Under ideal climatic conditions soft parent material may develop into a centimetre of soil within 15 years. Under poor climatic conditions a hard parent material may require hundreds of years to develop into soil.

Sources of soil Pollution:

Soil is the upper layer of the earth crust which is formed by weathering of rocks. Organic matter in the soil makes it suitable for living organisms. Dumping of various types of materials especially domestic and industrial wastes causes soil pollution. Domestic wastes include garbage, rubbish material like glass, plastics, polythene bags, metallic cans, paper, fibres, cloth rags, containers, paints, varnishes etc. Leachates from dumping sites and sewage tanks are harmful and toxic, which pollute the soil. Polythene does not degrade and becomes brittle in due course. It affects the porosity of the soil. Pesticides are used to kill pests that damage crops. These pesticides ultimately reach the soil and persist there for a long time. Pesticides which are persistent in nature are chlorinated hydrocarbon insecticides e.g., DDT, HCH, endrin, lindane, heptachlor, endosulfan etc. Residues of these pesticides in soils have long term effects especially under the temperate conditions.

Effect of Soil pollution:

Sewage and industrial effluents which pollute land ultimately affect human health. Various types of chemicals like acids, alkalis, pesticides, insecticides, weedicides, fungicides, heavy metals etc., in the industrial discharges affect soil fertility by causing changes in physical, chemical and biological properties. Some of the persistent toxic chemicals inhibit the non-target organisms, soil flora and fauna and reduce soil productivity. These chemicals accumulate in food chain and ultimately affect human health. Indiscriminate use of pesticides specially is a matter of concern. Sewage sludge has many types of pathogenic bacteria, viruses and intestinal worms which may cause various types of diseases. Decomposing organic matter in soil also produces toxic vapours. Radio-isotopes which attach with the clay become a source of radiations in the environment. Nitrogen and phosphorus from the fertilizers in land reach nearby water bodies with agricultural run-off and cause eutrophication. Chemicals or their degradation product from land may percolate and contaminate ground water resources.

Control of Soil Pollution:

(i) Effluents should be properly treated before discharging them on land.

(ii) Solid wastes should be properly collected and disposed off by appropriate method.

(iii) Biodegradable organic waste should be used for generation of biogas.

(iv) Cattle dung should be used for methane generation. Night-soil (human faeces) can also be used in the biogas plant to produce inflammable methane gas.

Soil Erosion in India

Soil erosion is a worldwide phenomenon, but it is especially high in Central Africa, China, India, Nepal, Australia, Spain, USA and USSR. India loses about 40,000 hectares of land every year as an effect of wind and water erosion. Damage to the topsoil is 18.5% of the total world's loss. This is due to overgrazing by livestock. The population of livestock in India is the highest in the world. Overgrazing damages the topsoil, which reduces soil fertility.

(i) Deforestation of overgrazing

Over-grazing is the main cause of soil erosion in India. Roots of grasses act as binding material and keep the soil intact, which upon grazing are destroyed.

(ii) Desertification

Loss of soil productivity by erosion of top soil results in the formation of deserts. Deserts are spreading in all continents. Desertification takes place by shifting of sand dunes by wind and .over-grazing. That desert in India is spreading at the rate of 12,000 hectares of land every year.

(iii) Shifting cultivation

Tribal communities follow the practice of cutting down trees and setting them on fire and then raising the crops on the resulting ash. This is called *Jhuming* in northeastern India. It is harmful if the Jhuming cycles are longer than ten years but short cycles destroy forests and cause soil erosion. e.g. Asia and Africa. .

(iv) Developmental activities

Large areas of fertile and productive croplands, woodlands and grasslands are lost to various developmental activities such as rapid urbanization, building of airports, industries, railways, roads, mining and construction of dams.

Noise Pollution

Introduction

"Sound is mechanical energy from a vibrating source. A type of sound may be pleasant to someone and at the same time unpleasant to others. The unpleasant and unwanted sound is called noise".

There is a wide range of sound pressures, which encounter human ear. The noise measurements are expressed as Sound Pressure Level (SPL) which is logarithmic ratio of the sound pressure to a reference pressure. It is expressed as a dimensionless unit, decibel (dB). The international reference pressure of 2×10^{-5} Pa is the average threshold of hearing for a healthy ear. Decibel scale is a measure of loudness. Noise can affect human ear because of its loudness and frequency (pitch).

Source of Noise Pollution

There are several sources of noise pollution that contribute to both indoor and outdoor noise pollution. Noise emanating from factories, vehicles, playing of loudspeakers during various festivals can contribute to outdoor noise pollution while loudly played radio or music systems, and other electronic gadgets can contribute to indoor noise pollution. The noise generated by firecrackers is much higher than the prescribed levels. The permitted noise level is 125 decibels, as per the Environment (Protection) (second amendment) Rules, 1999.

Effects of Noise Pollution

The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss often called a temporary threshold shift (TTS). Noise pollution causes the following effects:

1 **Interferes with man's communication:** In a noisy area communication is severely affected.

2 **Hearing damage:** Noise can cause temporary or permanent hearing loss. It depends on intensity and duration of sound level.

3 **Physiological and psychological changes:** Continuous exposure to noise affects the functioning of various systems of the body. It may result in hypertension, insomnia (sleeplessness), gastro-intestinal and digestive disorders, peptic ulcers, blood pressure changes, behavioural changes, emotional changes etc.

Control of Noise Pollution

There are four fundamental ways in which noise can be controlled: Reduce noise at the source, block the path of noise, increase the path length and protect the recipient. In general, the best control method is to reduce noise levels at the source.

1.*Reduction in sources of noise*: Sources of noise pollution like heavy vehicles and old vehicles may not be allowed to ply in the populated areas.

2. Noise making machines should be kept in containers with sound absorbing media. The noise path will be uninterrupted and will not reach the workers.

3. Proper oiling will reduce the noise from the machinery.

4. *Use of sound absorbing silencers*: Silencers can reduce noise by absorbing sound. For this purpose various types of fibrous material could be used.

5. Planting more trees having broad leaves.

6. *Through law*: Legislation can ensure that sound production is minimised at various social functions. Unnecessary horn blowing should be restricted especially in vehicle-congested areas.

Thermal Pollution

Introduction

“Thermal pollution is the presence of waste heat in the water which can cause undesirable changes in the natural environment”

It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its source.

Source of Thermal pollution

Heat producing industries i.e. thermal power plant, nuclear power plants, refineries, steel mills etc. are the major sources of thermal pollution. Power plants utilize only $1/3^{rd}$ of the energy provided by fossil fuels for their operation. Remaining 2.3^{rd} is generally lost in the form of heat to the water used for cooling. Excess of heat reaching to water bodies causes thermal pollution of that water bodies.

Effect of Thermal pollution

1. The dissolved oxygen content of water is decrease as the solubility of oxygen in water is decreased at high temperature.
2. High temperature becomes barrier for oxygen penetration into deep cold water
3. Toxicity of pesticide, detergent and chemicals in the effluents increases with increase in temperature.
4. The composition of flora and fauna changes because the species sensitive to increased temperature due to thermal shock will be replaced by temperature tolerant species.

Control of Thermal Pollution

Thermal pollution can be controlled by passing the heated water through a cooling pond or a cooling tower after it leaves the condenser. The heat is dissipated into the air and the water can then be discharged into the river or pumped back to the plant for reuse as cooling water. There are several ways in which thermal pollution can be reduced.

The following methods can be employed for control of thermal pollution-

1. Cooling ponds: Water from condensers is stored in ponds where natural evaporation cools the water which can then be recalculated or discharged in nearby water body.

2. Spray ponds: The water from condensers is received in spray ponds. Here the water is sprayed through nozzles where fine droplets are formed. Heat from these fine droplets is dissipated to the atmosphere.

3. Cooling towers:

a. Wet cooling tower- Hot water is sprayed over baffles. Cool air entering from sides takes away the heat and cools the water. This cool water can be recycled or discharged.

b. Dry cooling tower- The heated water flows in a system of pipes. Air is passed over these hot pipes with fans. There is no water loss in this method but installation and operation cost of dry cooling tower is many times higher than wet cooling tower.