Unit

5 Environmental Pollution

For normal and healthy living a conducive environment is required by all the living beings, including humans, livestock, plants, micro-organisms and the wildlife. The favourable unpolluted environment has a specific composition. When this composition gets changed by addition of harmful substances, the environment is called polluted environment and the substances polluting it are called pollutants. **Environmental pollution can, therefore, be defined as any undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil), which can cause harmful effects on various forms of life or property.** Environmental pollution could be of various types:

■ AIR POLLUTION

It is an atmospheric condition in which certain substances (including the normal constituents in excess) are present in concentrations which can cause undesirable effects on man and his environment. These substances include gases, particulate matter, radioactive substances etc.

Gaseous pollutants include oxides of sulphur (mostly SO_2, SO_3) oxides of nitrogen (mostly NO and NO_2 or NO_x), carbon monoxide (CO), volatile organic compounds (mostly hydrocarbons) etc. Particulate pollutants include smoke, dust, soot, fumes, aerosols, liquid droplets, pollen grains etc.

Radioactive pollutants include radon-222, iodine-131, strontium-90, plutonium-239 etc.

Sources of Air Pollution

The sources of air pollution are natural and man-made (anthropogenic).

Natural Sources: The natural sources of air pollution are volcanic eruptions, forest fires, sea salt sprays, biological decay, photochemical oxidation of terpenes, marshes, extra terrestrial bodies, pollen grains of flowers, spores etc. Radioactive minerals present in the earth crust are the sources of radioactivity in the atmosphere.

Man-made: Man made sources include thermal power plants, industrial units, vehicular emissions, fossil fuel burning, agricultural activities etc. Thermal power plants have become the major sources for generating electricity in India as the nuclear power plants couldn't be installed as planned. The main pollutants emitted are fly ash and SO_2. Metallurgical plants also consume coal and produce similar pollutants. Fertilizer plants, smelters, textile mills, tanneries, refineries, chemical industries, paper and pulp mills are other sources of air pollution.

Automobile exhaust is another major source of air pollution. Automobiles release gases such as carbon monoxide (about 77%), oxides of nitrogen (about 8%) and hydrocarbons (about 14%). Heavy duty diesel vehicles spew more NOx and suspended particulate matter (SPM) than petrol vehicles which produce more carbon monoxide and hydrocarbons.

Indoor Air Pollution

The most important indoor air pollutant is radon gas. Radon gas and its radioactive daughters are responsible for a large number of lung cancer deaths each year. Radon can be emitted from building materials like bricks, concrete, tiles etc. which are derived from soil containing radium. Radon is also present in groundwater and natural gas and is emitted indoors while using them.

Many houses in the under-developed and developing countries including India use fuels like coal, dung-cakes, wood and kerosene in their kitchens. Complete combustion of fuel produces carbon dioxide which may not be toxic. However, incomplete combustion produces the toxic gas carbon monoxide. Coal contains varying amounts of sulphur which on burning produces sulphur dioxide. Fossil fuel burning produces black soot. These pollutants i.e. CO, SO_2, soot and many others like formaldehyde, benzo- (a) pyrene (BAP) are toxic and harmful for health. BAP is also found in cigarette smoke and is considered to cause cancer. A house wife using wood as fuel for cooking inhales BAP equivalent to 20 packets of cigarette a day.

Effects of air pollution: Air pollution has adverse effects on living organisms and materials.

Effects on Human Health: Human respiratory system has a number of mechanisms for protection from air pollution. Bigger particles (> 10 μm) can be trapped by the hairs and sticky mucus in the lining of the nose. Smaller particles can reach tracheobronchial system and there get trapped in mucus. They are sent back to throat by beating of hair like cilia from where they can be removed by spitting or

swallowing. Years of exposure to air pollutants (including cigarette smoke) adversely affect these natural defenses and can result in lung cancer, asthma, chronic bronchitis and emphysema (damage to air sacs leading to loss of lung elasticity and acute shortness of breath). Suspended particulates can cause damage to lung tissues and diseases like asthma, bronchitis and cancer especially when they bring with them cancer causing or toxic pollutants attached on their surface. Sulphur dioxide (SO_2) causes constriction of respiratory passage and can cause bronchitis like conditions. In the presence of suspended particulates, SO_2 can form acid sulphate particles, which can go deep into the lungs and affect them severely.

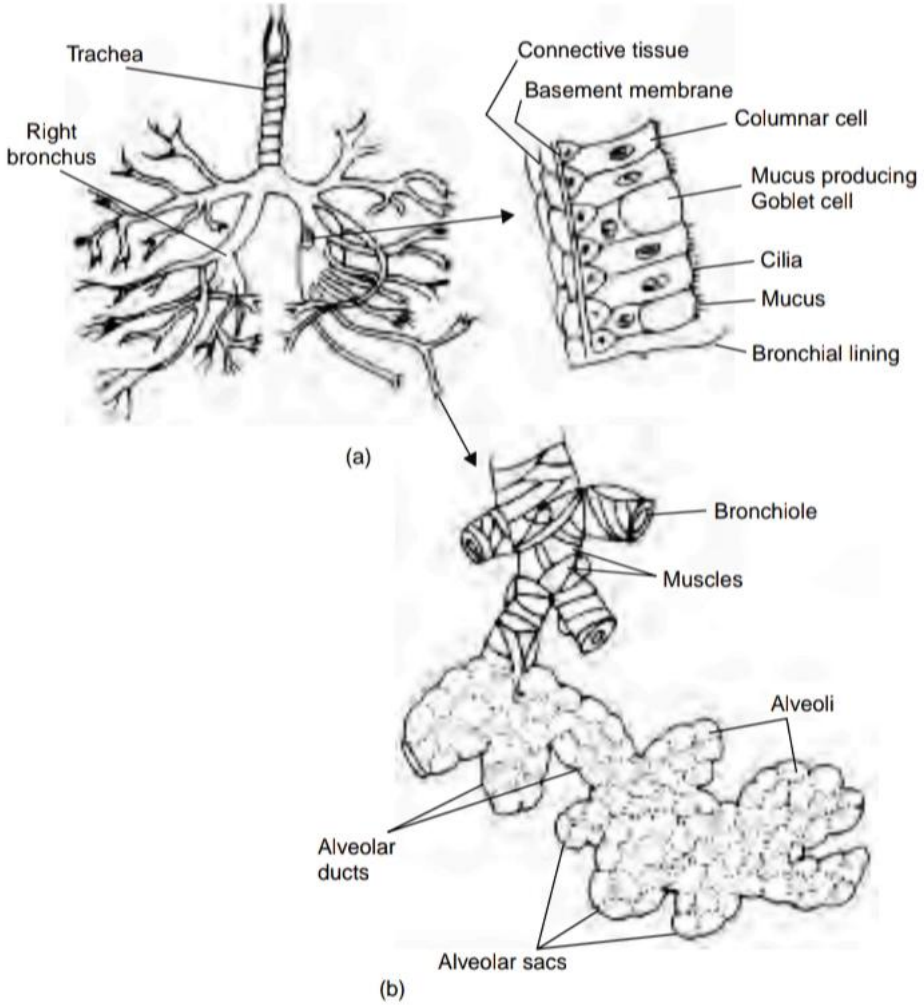

Fig. 5.1. Lower respiratory system of human beings (*a* and *b*) and cross section of bronchial lining showing cilia and goblet cells.

Oxides of nitrogen especially NO_2 can irritate the lungs and cause conditions like chronic bronchitis and emphysema. Carbon monoxide (CO) reaches lungs and combines with haemoglobin of blood to form carboxyhaemoglobin. CO has affinity for haemoglobin 210 times more than oxygen. Haemoglobin is, therefore, unable to transport oxygen to various parts of the body. This causes suffocation. Long exposure to CO may cause dizziness, unconsciousness and even death.

Many other air pollutants like benzene (from unleaded petrol), formaldehyde and particulates like polychlorinated biphenyls (PCBs) toxic metals and dioxins (from burning of polythene) can cause mutations, reproductive problems or even cancer.

Effects on Plants: Air pollutants affect plants by entering through stomata (leaf pores through which gases diffuse), destroy chlorophyll and affect photosynthesis. Pollutants also erode waxy coating of the leaves called cuticle. Cuticle prevents excessive water loss and damage from diseases, pests, drought and frost. Damage to leaf structure causes ***necrosis*** (dead areas of leaf), ***chlorosis*** (loss or reduction of chlorophyll causing yellowing of leaf) or ***epinasty*** (downward curling of leaf), and ***abscission*** (dropping of leaves). Particulates deposited on leaves can form encrustations and plug the stomata. The damage can result in death of the plant.

Effects on aquatic life: Air pollutants mixing up with rain can cause high acidity (lower pH) in fresh water lakes. This affects aquatic life especially fish. Some of the freshwater lakes have experienced total fish death.

Effects on materials: Because of their corrosiveness, particulates can cause damage to exposed surfaces. Presence of SO_2 and moisture can accelerate corrosion of metallic surfaces. SO_2 can affect fabric, leather, paint, paper, marble and limestone. Ozone in the atmosphere can cause cracking of rubber. Oxides of nitrogen can also cause fading of cotton and rayon fibres.

Control of Air Pollution

Air pollution can be minimized by the following methods:

- Siting of industries after proper Environmental Impact Assessment studies.
- Using low sulphur coal in industries
- Removing sulphur from coal (by washing or with the help of bacteria)
- Removing NO_x during the combustion process.

- Removing particulate from stack exhaust gases by employing electrostatic precipitators, bag-house filters, cyclone separators, scrubbers etc.
- Vehicular pollution can be checked by regular tune-up of engines ; replacement of more polluting old vehicles; installing catalytic converters ; by engine modification to have fuel efficient (lean) mixtures to reduce CO and hydrocarbon emissions; and slow and cooler burning of fuels to reduce NO_x emission (Honda Technology).
- Using mass transport system, bicycles etc.
- Shifting to less polluting fuels (hydrogen gas).
- Using non-conventional sources of energy.
- Using biological filters and bio-scrubbers.
- Planting more trees.

■ NOISE POLLUTION

We hear various types of sounds everyday. 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.

Sound can propagate through a medium like air, liquid or solid. Sound wave is a pressure perturbation in the medium through which sound travels. Sound pressure alternately causes compression and rarefaction. The number of compressions and rarefactions of the molecules of the medium (for example air) in a unit time is described as frequency. It is expressed in Hertz (Hz) and is equal to the number of cycles per second.

There is a wide range of sound pressures, which encounter human ear. Increase in sound pressure does not invoke linear response of human ear. A meaningful logarithmic scale has been devised. 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).

The Central Pollution Control Board (CPCB) committee has recommended permissible noise levels for different locations as given in Table 5.1.

Table 5.1 Noise standards recommended by CPCB committee

Area code	Category of Area	Noise level in dB (A) Leq	
		Day	Night
(A)	Industrial	75	70
(B)	Commercial	65	55
(C)	Residential	55	45
(D)	Silence Zone	50	40

Table 5.2. Different sounds and their sound levels on decibel scale

	Sound Level (dB)		Source of Sound
	180	—	Rocket engine
	170		
	160		
	150	—	Jet plane take off
Threshold of Pain —	140		
	130	—	Maximum recorded rock music
	120	—	Thunder cap
	110	—	Autohorn 1m away
	100	—	Jet fly over at 300 m, construction work, Newspaper press
	90	—	Motor cycle/8 m away, food blender
	80		
	70	—	Vacuum cleaner, ordinary conversation
	60	—	Air conditioning unit, 6m away, light traffic noise, 30m away
	50	—	Average living room
	40		
	30	—	Library, soft whisper
	20	—	Broadcasting studio
	10	—	Rustling leaf
Threshold of hearing —	0		

Sources of Noise Pollution: The main sources of noise are various modes of transportation (like air, road, rail-transportation), industrial operations, construction activities and celebrations (social/religious functions, elections etc) electric home appliances.

High levels of noise have been recorded in some of the cities of the world. In Nanjing (China) noise level of 105 dB has been recorded, while in some other cities of the world these levels are: Rome 90 dB, New York 88 dB, Calcutta 85 dB, Mumbai 82 dB, Delhi 80 dB, Kathmandu 75 dB.

Effects of Noise: Noise causes the following effects.

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

(*ii*) **Hearing damage:** Noise can cause temporary or permanent hearing loss. It depends on intensity and duration of sound level. Auditory sensitivity is reduced with noise level of over 90 dB in the midhigh frequency for more than a few minutes.

(*iii*) **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.

NOISE POLLUTION DURING DIWALI

Diwali is a festival of lights. Traditionally people of all ages enjoy firecrackers. Some accidents do occur every year claiming a few lives. Besides, noise generated by various firecrackers is beyond the permissible noise levels of 125 decibels as per the Environmental (Protection) (Second Amendment) Rules, 1999.

There has been a great concern over the noise levels generated during Diwali. Some measurements by certain group of researchers have also been made at various places during Diwali. It is recommended that the manufacturers of fireworks should mention the noise levels in decibels generated by individual items. The department of explosives of the Union Ministry of Commerce and Industry is entrusted with the task to ensure that the industry produces firecrackers conforming to permissible noise standards.

According to a recent test report on firecrackers produced by the National Physical Laboratory, New Delhi most of the firecrackers available in the market produce noise beyond the permissible levels of 125 decibels as per the Environment (Protection) (Second amendment) Rules, 1999. Some of them have been observed to produce noise near the threshold of pain. The details are given in Table 5.3.

Table 5.3. Noise levels generated by firecrackers

Type of firecracker	Manufacturer	Generated noise level in decibels
Atom bomb (timing bomb)	Coronation Fireworks, Sivakasi	135 ± 2
Chinese crackers (a string of 1,000 in one piece)	Sri Kaliswari Fireworks, Sivakasi	128
Chinese crackers (a string of 600 in one piece)	Sri Kaliswari Fireworks, Sivakasi	132
Nazi (atom bomb)	Coronation Fireworks, Sivakasi	135 ± 0
Magic formula (flower bomb)	Rajan Fireworks, Sivakasi	136 ± 1
Atom bomb (foiled)	Sri Kailswari Fireworks, Sivakasi	131 ± 2
Hydrogen bomb	Sri Patrakali Fireworks, Sivakasi	134 ± 2
Rajan classic dhamaka (foiled bomb)	Rajan Fireworks, Sivakasi	136 ± 0
Samrat classic bomb (deluxe)	Venkateswara Fireworks, Sivakasi	136 ± 0
Hydro foiled (bomb)	Sri Kaliswari Fireworks, Sivakasi	132 ± 2
*Three sound (bomb)	Coronation Fireworks, Sivakasi	119 ± 7
Atom bomb	Local	136 ± 0

*Cracker meeting the noise pollution standards.

Source: Test report on firecrackers, National Physical Laboratory, New Delhi, April 21, 2003

The noise levels were measured under standard conditions i.e. in areas not having noise-reflecting surfaces within a 15 metre radius. Two gadgets, for measuring sound levels were installed at a height of 1.3 metres and at a distance of 4 metres from the source of sound.

Besides mentioning the sound levels on each of the types of firecrackers or banning the production of such firecrackers which produce noise above permissible levels, it is important to educate people about the harmful effects of noise during such festivals like Diwali. It

can be done by giving public notices in the leading newspapers and messages through other mass media like radio and television.

Honourable Supreme Court in a Writ Petition (civil) of 1998 concerning noise pollution had passed the following directions as an interim measure.

The Union Government, The Union Territories as well as all the State Governments shall in particular comply with amended Rule 89 of the Environmental (Protection) Rules, 1986 framed under the Environmental (Protection) Act, 1986 which essentially reads as follows.

1. (*i*) The manufacture, sale or use of fire-crackers generating noise level exceeding 125 dB (AI) or 145 dB (C) pk at 4 meters distance from the point of bursting shall be prohibited.

   (*ii*) For individual fire-cracker constituting the series (joined fire-crackers), the above mentioned limit be reduced by 5 log 10 (N) dB, where N = Number of crackers joined together.

2. The use of fire works or fire crackers shall not be permitted except between 6.00 p.m. and 10.00 p.m. No fire works or fire crackers shall be used between 10.00 p.m. and 6.00 a.m.
3. Fire crackers shall not be used at any time in silence zones, as defined by the Ministry of Environment and Forests. Silence Zone has been defined as:

   "Silence Zone in an area comprising not less that 100 meters around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority.
4. The State Education Resource Centres in all the States and Union Territories as well as the management/principals of schools in all the States and Union Territories shall take appropriate steps to educate students about the ill effects of air and noise pollution and apprise them of directions (1) to (3) above.

Control of Noise Pollution

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 in interrupted 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 minimized at various social functions. Unnecessary horn blowing should be restricted especially in vehicle-congested areas.

■ WATER POLLUTION

Water pollution can be defined as alteration in physical, chemical or biological characteristics of water making it unsuitable for designated use in its natural state.

Sources of water pollution: Water is an essential commodity for survival. We need water for drinking, cooking, bathing, washing, irrigation, and for industrial operations. Most of water for such uses comes from rivers, lakes or groundwater sources. Water has the property to dissolve many substances in it, therefore, it can easily get polluted. Pollution of water can be caused by point sources or non-point sources. Point sources are specific sites near water which directly discharge effluents into them. Major point sources of water pollution are industries, power plants, underground coal mines, offshore oil wells etc. The discharge from non-point sources is not at any particular site, rather, these sources are scattered, which individually or collectively pollute water. Surface run-off from agricultural fields, overflowing small drains, rain water sweeping roads and fields, atmospheric deposition etc. are the non-point sources of water pollution.

Ground water pollution: Ground water forms about 6.2% of the total water available on planet earth and is about 30 times more than surface water (streams, lakes and estuaries). Ground water seems to be less prone to pollution as the soil mantle through which water passes helps to retain various contaminants due to its cation exchange capacity. However, there are a number of potential sources of ground water pollution. Septic tanks, industry (textile, chemical, tanneries), deep well

injection, mining etc. are mainly responsible for ground water pollution, which is irreversible. Ground water pollution with arsenic, fluoride and nitrate are posing serious health hazards.

Surface water pollution: The major sources of surface water pollution are:

1. **Sewage:** Pouring the drains and sewers in fresh water bodies causes water pollution. The problem is severe in cities.
2. **Industrial effluents:** Industrial wastes containing toxic chemicals, acids, alkalis, metallic salts, phenols, cyanides, ammonia, radioactive substances, etc. are sources of water pollution. They also cause thermal (heat) pollution of water.
3. **Synthetic detergents:** Synthetic detergents used in washing and cleaning produce foam and pollute water.
4. **Agrochemicals:** Agrochemicals like fertilizers (containing nitrates and phosphates) and pesticides (insecticides, fungicides, herbicides etc.) washed by rain-water and surface run-off pollute water.
5. **Oil:** Oil spillage into sea-water during drilling and shipment pollute it.
6. **Waste heat:** Waste heat from industrial discharges increases the temperature of water bodies and affects distribution and survival of sensitive species.

Effects of Water Pollution

Following are some important effects of various types of water pollutants:

Oxygen demanding wastes: Organic matter which reaches water bodies is decomposed by micro-organisms present in water. For this degradation oxygen dissolved in water is consumed. Dissolved oxygen (DO) is the amount of oxygen dissolved in a given quantity of water at a particular temperature and atmospheric pressure. Amount of dissolved oxygen depends on aeration, photosynthetic activity in water, respiration of animals and plants and ambient temperature.

The saturation value of DO varies from 8-15 mg/L. For active fish species (trout and Salmon) 5-8 mg/L of DO is required whereas less desirable species like carp can survive at 3.0 mg/L of DO.

Lower DO may be harmful to animals especially fish population. Oxygen depletion (deoxygenation) helps in release of phosphates from bottom sediments and causes eutrophication.

Nitrogen and Phosphorus Compounds (Nutrients): Addition of compounds containing nitrogen and phosphorus helps in the growth of algae and other plants which when die and decay consume oxygen of water. Under anaerobic conditions foul smelling gases are produced. Excess growth or decomposition of plant material will change the concentration of CO_2 which will further change pH of water. Changes in pH, oxygen and temperature will change many physico-chemical characteristics of water.

Pathogens: Many wastewaters especially sewage contain many pathogenic (disease causing) and non-pathogenic micro-organisms and many viruses. Water borne diseases like cholera, dysentery, typhoid, jaundice etc. are spread by water contaminated with sewage.

Toxic Compounds: Pollutants such as heavy metals, pesticides, cyanides and many other organic and inorganic compounds are harmful to aquatic organisms.

The demand of DO increases with addition of biodegradable organic matter which is expressed as biological oxygen demand (BOD). BOD is defined as the amount of DO required to aerobically decompose biodegradable organic matter of a given volume of water over a period of 5 days at 20°C. More BOD values of any water sample are associated with poor water quality. The non-biodegradable toxic compounds biomagnify in the food chain and cause toxic effects at various levels of food chain.

Some of these substances like pesticides, methyl mercury etc. move into the bodies of organisms from the medium in which these organisms live. Substances like DDT are not water soluble and have affinity for body lipids. These substances tend to accumulate in the organism's body. This process is called **bioaccumulation.** The concentration of these toxic substances builds up at successive levels of food chain. This process is called **biomagnification.** Following is the example of biomagnification of DDT in aquatic food chain:

Component	DDT concentration (ppm)
Birds	10.00
↑	↑
Needle fish	1.0
↑	↑
Minnows	0.1
↑	↑
Zooplankton	0.01
↑	↑
Water	0.000001

Toxic substances polluting the water ultimately affect human health. Some heavy metals like lead, mercury and cadmium cause various types of diseases. Mercury dumped into water is transformed into water soluble methyl mercury by bacterial action. Methyl mercury accumulates in fish. In 1953, people in Japan suffered from numbness of body parts, vision and hearing problems and abnormal mental behaviour. This disease called **Minamata disease** occurred due to consumption of methyl mercury contaminated fish caught from Minamata bay in Japan. The disease claimed 50 lives and permanently paralysed over 700 persons. Pollution by another heavy metal cadmium had caused the disease called **Itai-itai** in the people of Japan. The disease was caused by cadmium contaminated rice. The rice fields were irrigated with effluents of zinc smelters and drainage water from mines. In this disease bones, liver, kidney, lungs, pancreas and thyroid are affected.

Arsenic pollution of ground water in Bangladesh and West Bengal is causing various types of abnormalities.

Nitrate when present in excess in drinking water causes **blue baby syndrome** or **methaemoglobinemia**. The disease develops when a part of haemoglobin is converted into non-functional oxidized form.

Nitrate in stomach partly gets changed into nitrites which can produce cancer-causing products in the stomach.

Excess of fluoride in drinking water causes defects in teeth and bones called **fluorosis.**

Pesticides in drinking water ultimately reach humans and are known to cause various health problems. DDT, aldrin, dieldrin etc. have therefore, been banned. Recently, in Andhra Pradesh, people suffered from various abnormalities due to consumption of endosulphan contaminated cashew nuts.

Control of Water Pollution

It is easy to reduce water pollution from point sources by legislation. However, due to absence of defined strategies it becomes difficult to prevent water pollution from non-point sources. The following points may help in reducing water pollution from non-point sources.

(*i*) Judicious use of agrochemicals like pesticides and fertilizers which will reduce their surface run-off and leaching. Avoid use of these on sloped lands.

(*ii*) Use of nitrogen fixing plants to supplement the use of fertilizers.

(*iii*) Adopting integrated pest management to reduce reliance on pesticides.

(*iv*) Prevent run-off of manure. Divert such run-off to basin for settlement. The nutrient rich water can be used as fertilizer in the fields.

(*v*) Separate drainage of sewage and rain water should be provided to prevent overflow of sewage with rainwater.

(*vi*) Planting trees would reduce pollution by sediments and will also prevent soil erosion.

For controlling water pollution from point sources, treatment of wastewaters is essential before being discharged. Parameters which are considered for reduction in such water are-

Total solids, biological oxygen demand (BOD), chemical oxygen demand (COD), nitrates and phosphates, oil and grease, toxic metals etc.

Wastewaters should be properly treated by primary and secondary treatments to reduce the BOD, COD levels upto the permissible levels for discharge.

Advanced treatment for removal of nitrates and phosphates will prevent eutrophication. Before the discharge of wastewater, it should be disinfected to kill the disease-causing organisms like bacteria.

Proper chlorination should be done to prevent the formation of chlorinated hydrocarbons or disinfection should be done by ozone or ultraviolet radiations.

■ THERMAL POLLUTION

Thermal pollution can be defined as presence of waste heat in the water which can cause undesirable changes in the natural environment.

Causes of thermal pollution: Heat producing industries i.e., thermal power plants, nuclear power plants, refineries, steel mills etc. are the major sources of thermal pollution. Power plants utilize only 1/3 of the energy provided by fossil fuels for their operations. Remaining 2/3 is generally lost in the form of heat to the water used for cooling. Cold water, generally, is drawn from some nearby water-body, passed through the plant and returned to the same water body, with temperature 10-16°C higher than the initial temperature. Excess of heat reaching such water bodies causes thermal pollution of water.

Effects of Thermal Pollution

(*i*) The dissolved oxygen content of water is decreased as the solubility of oxygen in water is decreased at high temperature.

(*ii*) High temperature becomes a barrier for oxygen penetration into deep cold waters.

■ MARINE POLLUTION

The main sources of marine pollution are (*i*) rivers, which bring pollutants from their drainage basins, (*ii*) Catchment area i.e. coastline where human settlements in the form of hotels, industry, agricultural practices have been established, and (*iii*) oil drilling and shipment.

Most of the rivers ultimately join the ocean. The pollutants which these rivers carry from their drainage basins are finally poured into the sea. These include sewage sludge, industrial effluents, synthetic detergents, agrochemicals, solid wastes, plastics, metals and waste heat released by industries as discussed earlier.

In the sea the pollutants get diluted and the organic matter is further broken down as in river water. Still many pollutants specially the recalcitrant ones remain unchanged or are partially degraded causing marine pollution. These pollutants get biomagnified and affect fisheries and other marine life. Another important source of marine pollution is the leaking toxic substances, radioactive wastes etc. which are stored in large containers and dumped in deep sea considering sea to be a better disposal site than land.

Tankers and other shipping means, industries (petroleum, refinery, lubricating oil using industry, metal industry, paint industry), automotive wastes, refineries, ship-accidents and off shore production add to marine pollution. Tankers transporting oil contribute to oil pollution significantly. After delivering the oil through sea-route, earlier empty tankers used to be filled with water called ballast-water to maintain balance. The ballast-water containing residual oil from tankers was released into the sea on completion of return journey. Now-a-days the oil floating on the ballast water is removed in the newly designed 'load-on-top-tankers' before ballast-water is let-off.

Oil in sea water can spread over a large area of the sea, remain dispersed or get adsorbed on sediments. It can cause adverse effects on marine life.

Oil in the sea water affects sensitive flora and fauna. Phytoplankton, zooplankton, algal species, various species of invertebrates, coral reefs, fish, birds and mammals are affected by oil pollution. Fishes show mortality (death) because the fish gills get laden with oil after the slimy mucus of gills is affected. Oil disrupts the insulating capacity of feathers. Death occurs due to loss of buoyancy and subsequent drowning of birds. Leakage from oil tanker near Alaska in 1989 caused damage to coral reefs and resulted in death of about 390 thousand birds. Some important incidents of bird mortality due to oil have been reported at Brittany, France where 20 thousand birds

died due to more than 220 tonnes of oil spillage in 1978. At Elbe, Germany 500 thousand birds died in 1955. During the 1991 Gulf War 200 million gallons of oil spread in the Persian Gulf badly affected the marine ecosystem.

Control of Marine Pollution

(*i*) Toxic pollutants from industries and sewage treatment plants should not be discharged in coastal waters.

(*ii*) Run off from non-point sources should be prevented to reach coastal areas.

(*iii*) Sewer overflows should be prevented by having separate sewer and rain water pipes.

(*iv*) Dumping of toxic, hazardous wastes and sewage sludge should be banned.

(*v*) Developmental activities on coastal areas should be minimized.

(*vi*) Oil and grease from service stations should be processed for reuse.

(*vii*) Oil ballast should not be dumped into sea.

(*viii*) Ecologically sensitive coastal areas should be protected by not allowing drilling.

■ 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, 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.

Industrial wastes are the effluents discharged from chemical industries, paper and pulp mills, tanneries, textile mills, steel industries, distilleries, refineries, pesticides and fertilizer industries, pharmaceutical industries, food processing industries, cement industries, thermal and nuclear power plants, mining industries etc. Thermal power plants generate a large quantity of 'Fly ash'. Huge quantities of these wastes are dumped on soils, thus contaminating them.

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 the soils have long term effects especially under the temperate conditions.

Industrial wastes also contain some organic and inorganic compounds that are refractory and non-biodegradable. Industrial sludge may contain various salts, toxic substances, metals like mercury, lead, cadmium, arsenic etc. Agrochemicals released with the wastes of pesticide and fertilizer factories or during agricultural practices also reach the soil and pollute it.

Soil also receives excreta from animals and humans. The sewage sludge contains many pathogenic organisms, bacteria, viruses and intestinal worms which cause pollution in the soil.

The sources of radioactive substances in soil are explosion of radioactive devices, radioactive wastes discharged from industries and laboratories, aerial fall out etc. Isotopes of radium, uranium, thorium, strontium, iodine, caesium and of many other elements reach the soil and persist there for a long time and keep on emitting radiations.

Effects of Soil Pollution

Sewage and industrial effluents which pollute the soil 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.

Radioactive fallout on vegetation is the source of radio-isotopes which enter the food chain in the grazing animals. Some of these radio isotopes replace essential elements in the body and cause abnormalities e.g. strontium-90 instead of calcium gets deposited in the bones and tissues. The bones become brittle and prone to fracture.

Radioisotopes which attach with the clay become a source of radiations in the environment.

Nitrogen and phosphorus from the fertilizers in soil reach nearby water bodies with agricultural run-off and cause eutrophication. Chemicals or their degradation products from soil may percolate and contaminate ground-water resources.

Control of Soil Pollution

(*i*) Effluents should be properly treated before discharging them on the soil.

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

(*iii*) From the wastes, recovery of useful products should be done.

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

(*v*) 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.

(*vi*) Microbial degradation of biodegradable substances is also one of the scientific approaches for reducing soil pollution.

■ NUCLEAR HAZARDS

Radioactive substances are present in nature. They undergo natural radioactive decay in which unstable isotopes spontaneously give out fast moving particles, high energy radiations or both, at a fixed rate until a new stable isotope is formed. (Fig. 2.5.7)

The isotopes release energy either in the form of gamma rays (high energy electromagnetic radiation) or ionization particles i.e. alpha particles and beta particles. The alpha particles are fast moving positively charged particles whereas beta particles are high speed negatively charged electrons. These ionization radiations have variable penetration power. (Fig. 5.5)

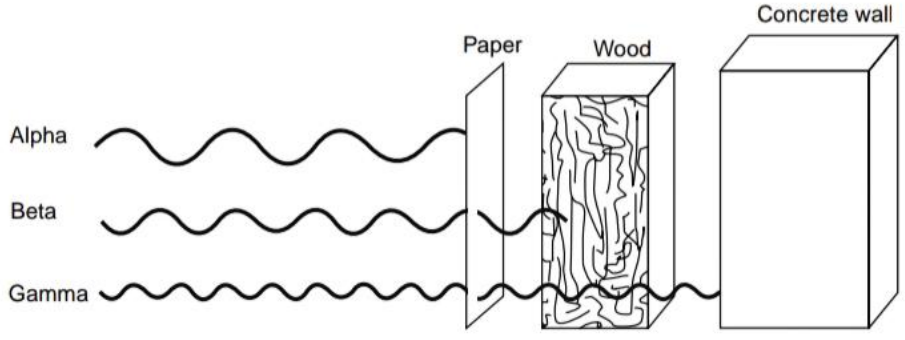

Fig. 5.5 Variable penetration power of ionisation radiations emitted by radioisotopes.

Alpha particles can be interrupted by a sheet of paper while beta particles can be blocked by a piece of wood or a few millimeters of aluminium sheet. The gamma rays can pass through paper and wood but can be stopped by concrete wall, lead slabs or water.

Primary & Secondary pollutant

Definition:

A **primary pollutant** is an air pollutant emitted directly from a source.

A **secondary pollutant** is not directly emitted as such, but forms when other pollutants (primary pollutants) react in the atmosphere.

Examples of a secondary pollutant include ozone, which is formed when hydrocarbons (HC) and nitrogen oxides (NOx) combine in the presence of sunlight; NO2, which is formed as NO combines with oxygen in the air; and acid rain, which is formed when sulfur dioxide or nitrogen oxides react with water.