ENVIRONMENTAL POLLUTION

UNIT II

DEFINITION

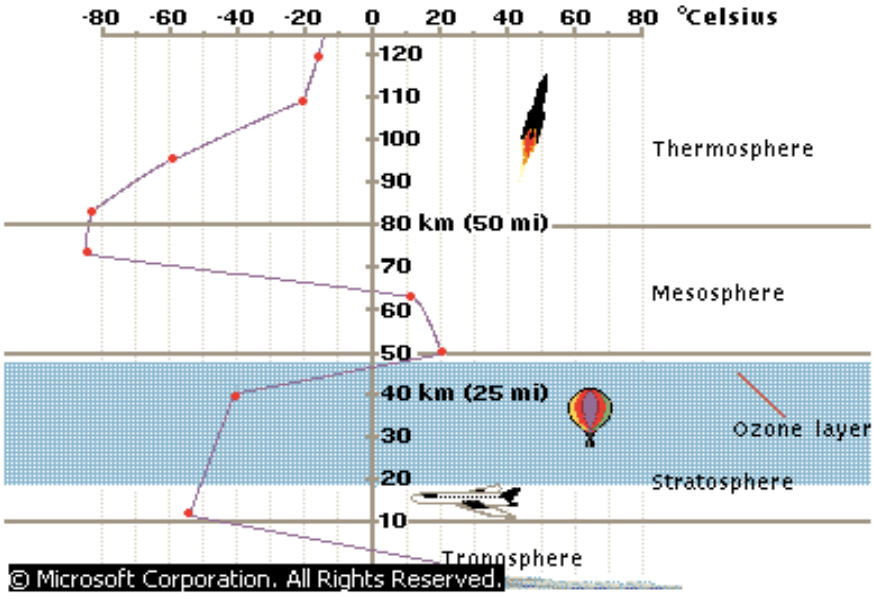
Environmental pollution can, therefore, be defined as any undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil), which can cause harmful effects on various forms of life or property.

AIR POLLUTION

CHEMICAL COMPOSITION OF ATMOSPHERE

Atmosphere is the cover of air that envelopes the earth is known as the atmosphere. It extends up to 500 kms from the earth surface. The atmosphere is highly essential for all living organisms. It comprises of 78% of Nitrogen, 21% of Oxygen and 1% of other gases.

Structure of atmosphere can be classified into 3 types.



(a) Troposphere: It stretches between 10 - 18 kms from the earth surface. It contains 75% of the atmospheric air mass. Also contained in this is moisture.

(b) Stratosphere: Stretching between 18 - 25 Kms from the earth surface, it is rich in Ozone gas, free from moisture and clouds. It prevents Ultra Violet radiation from the sun.

(c) Mesosphere: It stretches between 50 - 85 Kms from the earth surface. It contains less Ozone but more nitrogen oxide.

Gaseous pollutants include oxides of sulphur (mostly SO2, SO3 oxides of nitrogen (mostly NO and NO2 or NOx), 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.

CLASSIFICATION OF AIR POLLUTANTS:

Air pollutants can be classified depending upon the form in which they are present in the environment as:

1) Primary pollutants and 2) Secondary pollutants

1) Primary pollutants are those emitted directly into the atmosphere in the harmful form. eg. CO, NO, SO_2 etc.

2) Secondary pollutants: Some of the primary pollutants might react with one another or with the basic components of air to form new pollutants. These resultant new pollutants are called secondary pollutants.

Moisture

Eg. NO/NO_2 ----------→ (HNO_3/ NO_3) etc.

Indoor Air Pollutants: These are primary air pollutants. Important example is 'Radon Gas'

(i) Radon gas emitted from the building materials like bricks. Concrete, tiles etc. – derived from soil containing Radium

(ii) Also present in natural gas, ground water and is emitted during their usage indoors.

(iii) Burning of fuels in the kitchen, smoking, - CO, SO_2, formaldehyde,

BAP(Benzo-(a) pyrene etc.

WHO (World Health Organization) has made it known, that according to the statistics available to it, more than 1.1 billion people live live in urban areas where outdoor air is unhealthy to breathe. With the ever increasing rate of urbanization the number of such affected presently may be much larger. Some of the air pollutants are detailed below:

(1) Carbon monoxide(CO):

Description: It is a colourless, odourless gas (hence not perceived by the nose to get alerted about the lurking danger) that is poisonous to air breathing beings. It is formed during the incomplete combustion of carbon containing fuels:

$$2\,C + O_2 \rightarrow 2\,CO$$

Even in villages, people using fire wood and charcoal for their cooking purposes can cause this event. The general human sources for this dangerous pollutant are: Cigarette smoking, incomplete burning of fossil fuels. About 77% comes from motor vehicle exhaust. (Dogs get asphixated in the mine walkups due to the CO contamination

Health Effects: CO reacts with the Haemoglobin in red cells and reduces the ability of blood to bring Oxygen to body cells and tissues – causing headaches and anaemia. At high levels it causes coma, irreversible brain cell damage and death.

(2) Nitrogen Dioxide: It is a reddish brown irritating gas that gives photochemical smog. In the atmosphere it can get converted into Nitric Acid (HNO_3).

NO_2 + Moisture $\rightarrow$ HNO_3

Human Sources: Fossil fuel burning motor vehicles (49%) and Industrial Power Plants (49%)

Health effects: Lung irritation and damage

Environmental effects: Acid deposition of HNO_3 could damage trees, soils and aquatic life in lakes. HNO_3 could corrode metals and eat away stone on the buildings, statues and monuments. NO_2 could damage fabrics.

(3) Sulphur Dioxide:

It is again an irritating gas that is also colourless. It is mostly formed from the combustion of Sulphur containing Fossil fuels such as coal and Oil. (Start up of the Sulphuric Acid plant). In the atmosphere it can be convertd into Sulphurous and Sulphuric acids. These are the major components of acid deposition.

Human Sources: Coal combustion in Thermal Power Plants (88%) and other industrial processes (10%)

Health Effects: Breathing problems even for healthy people

Environmental effects: Reduces visibility, acid deposition of H_2SO_4. It can cause damage to trees, soils and aquatic life in lakes.

(4) Suspended Particulate Matter (SPM)

These include a variety of particles and droplets (aerosols) They can be suspended in atmospheric air for short to long periods. (Room deodorizers)

Human Sources: Burning of coal in power and industrial plants (40%), burning diesel and other fuels in vehicles(17%), agriculture, unpaved roads, construction work etc.

Health Effects: Nose and throat irritation, lung damage, bronchitis, asthma, reproductive problems and cancer.

Environmental Effects: Reduces visibility, causes acid deposition and H_2SO_4 droplets. These could damage trees, soils and aquatic life in lakes.

(5) Ozone:

This is a highly reactive gas which possess an unpleasant odour and is irritative. As we have seen in the introduction chapter it forms a major portion of the troposphere. It is the major component of photochemical smog.

Human Sources: Chemical reaction with volatile organic compounds (emitted mostly by cars and industries) and nitrogen oxides.

Environmental Effect: Moderates the climate.

(6) Photochemical Smog:

A photochemical reaction is any reaction activated by light. Air pollution known as photochemical smog is a mixture of more than 100 primary and secondary pollutants formed under the influence of sunlight. Its formation begins inside automobile engines and the boilers in coal-burning power and industrial plants.

Health Effects: Breathing problems, cough, eye, nose and throat irritation, heart ailments, reduces resistance to colds and pneumonia.

Environmental effects: Ozone can cause damage to plants and trees, Smog can affect visibility

(7) Lead (Pb): This is a toxic solid metal. Even its compounds, emitted into the atmosphere as particulate matter is also a pollutant.

Human sources: Paint, smelters (Metal refineries), lead manufacture, storage batteries, leaded petrol

Health effects: accumulates in the body, brain and nervous system damage and possible mental retardation (especially in children); digestive and other problems. Some lead containing chemicals caused cancer in test animals.

Environmental effects: Can harm wildlife

CAUSES / 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 Sources:

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 SO2. 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.

Indoor Air Pollution

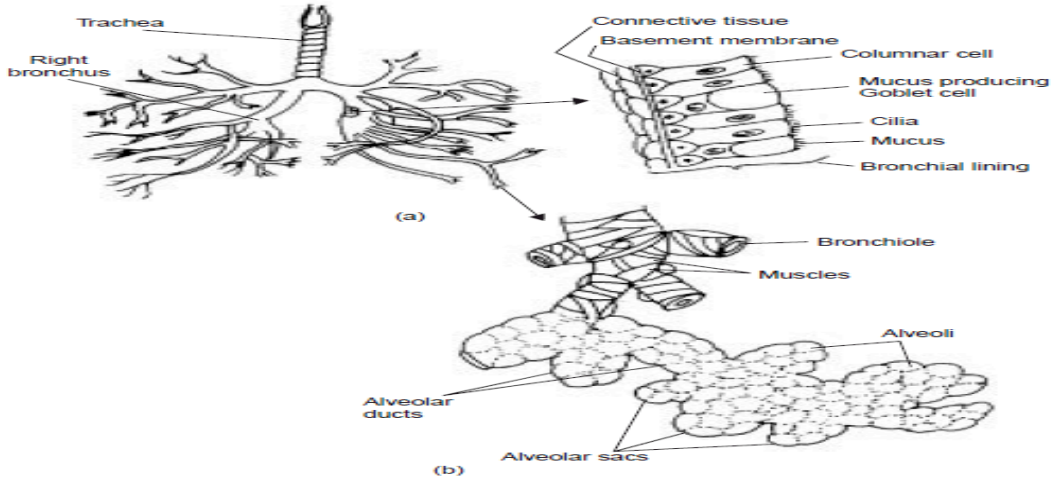
The most important indoor air pollutant is radon gas. Radon gas and its radioactive daughters are responsible for a large number of lung cancer deaths each year. Radon can be emitted from building materials like bricks, concrete, tiles etc. which are derived from soil containing radium. Radon is also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

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).



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

Oxides of nitrogen especially NO2 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.

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 SO2 and moisture can accelerate corrosion of metallic surfaces. SO2 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.

Ozone Depletion

Ozone layer or shield is present in the stratosphere. It protects the earth from short-wave ultra-violet rays (below 300 nm) by changing the same into infra-red rays. A large hole has appeared in ozone shield over Antarctica (first detected by Farman, 1982) and a smaller one over North Pole. Size of the holes varies with the seasons.

Ozone hole. During the period 1956-1970 the spring time 03 layer thickness above Anarctica varied from 280-325 Dobson unit. Thickness was sharply reduced to 225 DU in 1979 and 136 DU in 1985. Antarctic air is completely isolated from rest of world by natural circulation of wind called as polar vertex. The decline in spring time, ozone layer thickness is called ozone hole. It was first noted in 1985 over Antarctica. Thinning of ozone shield has also been reported elsewhere (e.g., 8% between 30°—50°NP).

Depletion of ozone layer allows harmful ultra-violet radiations to reach earth. It is the major cause of skin cancer, cataract, dimming of eye sight, decrease in immune system and increased susceptibility to herpes.

Thinning of ozone shield is being caused by a number of pollutants like chlorofluorocarbolls (14% of total depletion), nitrogen oxides (3.5% depletion), sulphur dioxide, halon, carbon tetrachloride, methyl chloroform, chlorine, etc. Many of these are being released by jets flying in the stratosphere and rockets being fired into space. Others are persistent in the troposphere and gradually pass into stratosphere.

(b) Ozone layer as protective layer. The ozone layer in the stratosphere is very useful to human beings because it absorbs the major part of harmful ultraviolet radiation coming from the sun. Therefore, it is called protective layer. However, it has been observed that the ozone layer is getting depleted. One of the reasons for depletion of ozone layer is action of aerosols spray propellants. These are the chemicals such as fluorocarbons and chlorofluorocarbons. These compounds react with ozone gas in the atmosphere thereby depleting it. Scientists all over the world are worried at the destruction of ozone layer. If the ozone layer in the atmosphere is significantly decreased, these harmful radiations would reach the earth and would cause many damages such as skin cncergenetic disorders in man and other living forms. Efforts are being made to find substitutes of these chemicals which do not react with ozone.

Effects of UV radiations on human:

1. In humans, the increased UV radiation increases the incidence in cancer (including nelanoma).
2. Reduces the functioning of immune system.
3. Cornea absorbs UV-B radiations, and a high dose of UV-B causes inflammation of cornea called snow blindness, cataract etc. Exposure may permanently damage cornea and cause cataract.

Measures to prevent ozone layer depletion

- Cut down the use of CFCs
- Do not use polystyrene cups that have chlorofluorocarbon molecules in them which destroy ozone layer.
- Use CFC free refrigerators.
- Use the chemicals derived from peaches and plums to clean computer chips and circuit boards instead of CFCs.

Acid rain

"Acid rain" is a broad term used to describe several ways that acids fall out of the atmosphere. A more precise term is acid deposition, which has two parts: wet and dry. Wet deposition refers to acidic rain, fog, and snow. As this acidic water flows over and through the ground, it affects a variety of plants and animals. The strength of the effects depend on many factors, including how acidic the water is, the chemistry and buffering capacity of the soils involved, and the types of fish, trees, and other living things that rely on the water.

Dry deposition refers to acidic gases and particles. About half of the acidity in the atmosphere falls back to earth through dry deposition. The wind blows these acidic particles and gases onto buildings, cars, homes, and trees. Dry deposited gases and particles can also be washed from trees and other surfaces by rainstorms. When that happens, the runoff water adds those acids to the acid rain, making the combination more acidic than the falling rain alone.

Prevailing winds blow the compounds that cause both wet and dry acid deposition across state and national borders, and sometimes over hundreds of miles. Scientists discovered, and have confirmed, that sulfur dioxide (SO2) and nitrogen oxides (NOx) are the primary causes of acid rain. In the US, About 2/3 of all SO2 and 1/4 of all NOx comes from electric power generation that relies on burning fossil fuels like coal.

Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. Sunlight increases the rate of most of these reactions. The result is a mild solution of sulfuric acid and nitric acid.

Effects of Acid Rain:

Acid rain causes acidification of lakes and streams and contributes to damage of trees at high elevations (for example, red spruce trees above 2,000 feet) and many sensitive forest soils. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. Prior to falling to the earth, SO2 and NOx gases and their particulate matter derivatives, sulfates and nitrates, contribute to visibility degradation and harm public health.

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 ofbacteria)

- Removing NOx 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 NOx 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

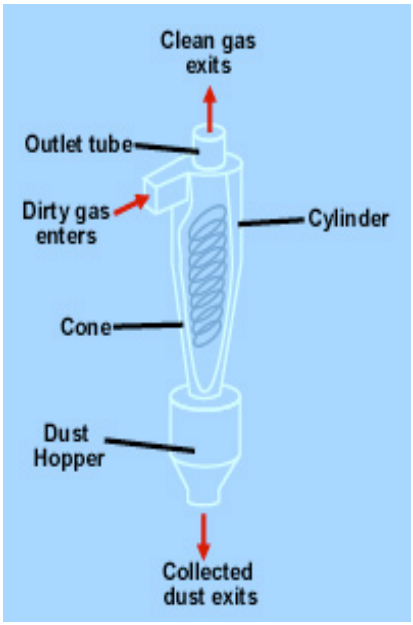
REDUCTION OF AIR POLLUTION AT SOURCE

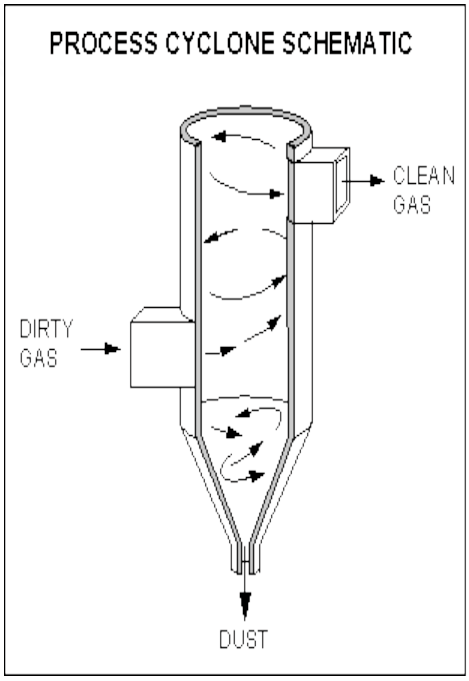
Control of particulate pollutants

Cyclones Separator

Cyclones provide a low-cost, low-maintenance method of removing larger particulates from a gas stream. The general principle of inertia separation is that the particulate-laden gas is forced to change direction. As gas changes direction, the inertia of the particles causes them to continue in the original direction and be separated from the gas stream. The walls of the cyclone narrow toward the bottom of the unit, allowing the particles to be collected in a hopper. The cleaner air leaves the cyclone through the top of the chamber, flowing upward in a spiral vortex, formed within a downward moving spiral. Cyclones are efficient in removing large particles but are not as efficient with smaller particles. For this reason, they are used with other particulate control devices.

Because the particulate control devices discussed above capture the pollutants but don't destroy them, proper disposal of the collected material is needed. Collected solid particles are most often disposed of in a landfill. Wastewater generated by scrubber must be sent to a wastewater treatment facility. When possible, collected particle matter is recycled and reused.





Electrostatic precipitator

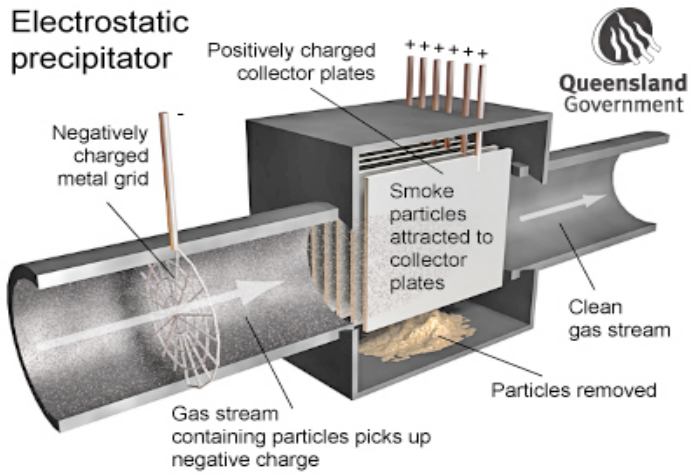
The electrostatic precipitator works by removing particles and smoke from a gas stream using an induced electrostatic charge.

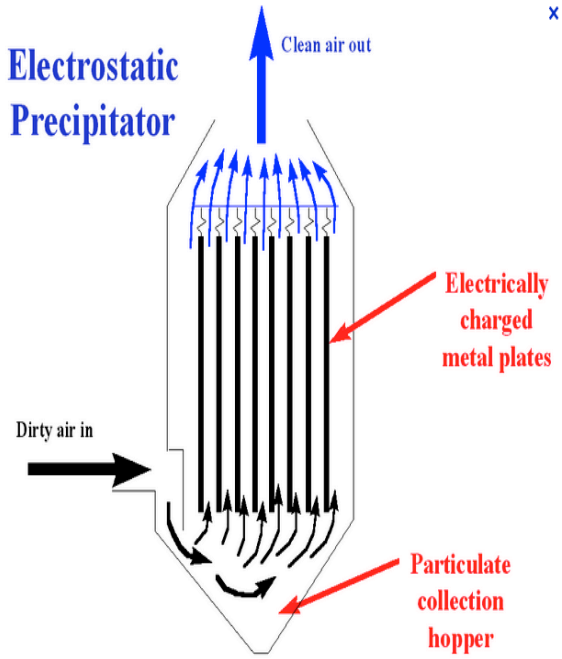
Dust particles pass by wires that have a high DC voltage applied, which ionises the surrounding gas. This is a known as a 'corona discharge' from which the particles pick up a small electrostatic charge. These particles are then attracted to an oppositely charged plate where the charge is neutralised and the particles retained.

Particles are physically removed by regular tapping (rapping) of the plates.

In some situations, the particles may be pre-conditioned by introducing a water spray to reduce the electrical resistivity of the particles allowing them to accept the charge more easily.

Electrostatic precipitators are an efficient way of removing particles and do not cause a significant pressure drop across the unit.





Wet scrubber

A wet scrubber is a device that removes gaseous and/or particle contaminants from a

gas stream. It operates by bringing the gas stream into contact with a scrubbing liquid (usually water).

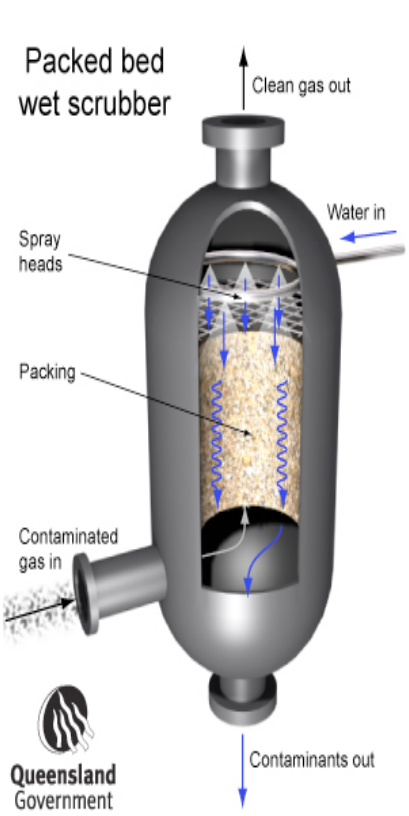
To increase the contact between the gas and scrubbing liquid and thus increase the removal efficiency some form of packing is often used. These are known as packed bed wet scrubbers.

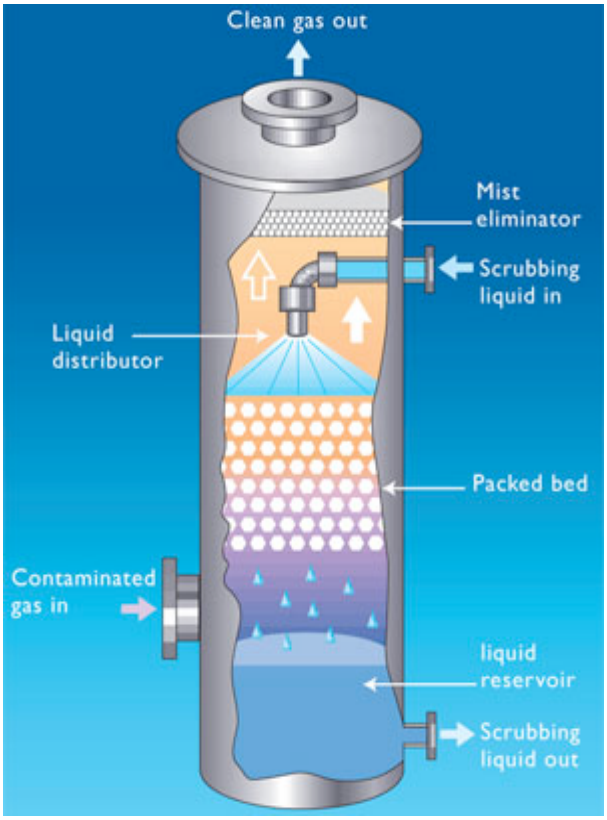
Gaseous pollutants are removed by absorption into the scrubbing liquid (absorbers) while particles are removed by physical capture of the particles in the droplets.

While packed bed scrubbers can remove both gaseous pollutants and particles they are usually engineered to be more efficient at one or the other depending on the conditions.

Gaseous pollutant removal can also be enhanced by using specific scrubbing liquids. An example would be the removal of acidic pollutants using an alkaline liquid. Some gas streams may require pre-conditioning, either to reduce high temperatures or to remove very high dust loadings that would otherwise clog the packing material.

Other designs may use an entrainment separator to remove any scrubbing liquid droplets that may be carried along in the cleaned gas stream, or to recycle the scrubbing liquid either directly or after suitable treatment.





Bag House filters

Bag filters, alternatively known as fabric filters or baghouses, use fabric filter bags to remove particles from dust-laden gas.

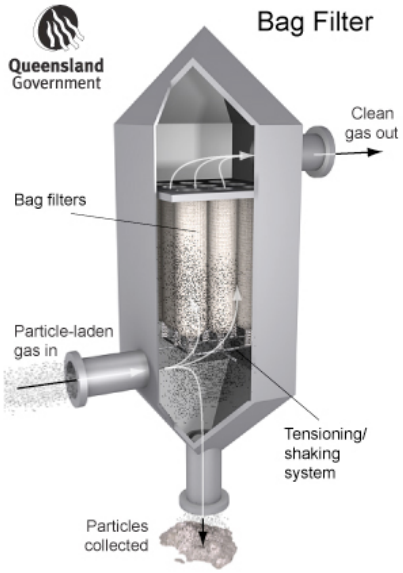
These filters can achieve high efficiencies for very fine particles due to the build up of particles on the surface of the bag.

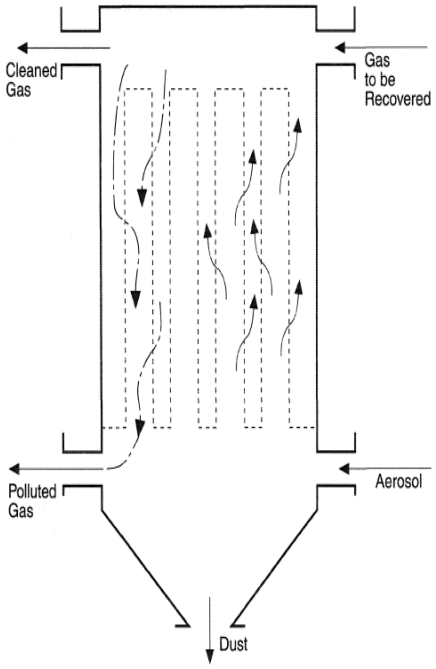
Collection can occur on either the inside or outside of the bag depending on the design.

As particles build up, the pressure drop across the bag increases, so the filters must undergo a regular cleaning schedule, usually by having the filters running in tandem—while one is operating the other is undergoing cleaning.

Cleaning schedules are normally automated and the methods employed are mechanical shaking, the use of a reversed air flow, or a pulse of compressed air.

Each method is used to dislodge the cake of dust from the fabric surface, which then falls by gravity into a collection system.





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.

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 mid high 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

noise generated by various firecrackers is beyond the permissible noise levels of 125 decibels as per the Environmental (Protection) (Second Amendment) Rules, 1999

1. 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.

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 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.

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.

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

4. Use of sound absorbing silencers: Silencers can reduce noise by absorbing sound.

5. Planting more trees having broad leaves.

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 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

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

Non Point Sources

The non-point sources are

- Surface run-off from agricultural fields,
- overflowing small drains,
- rain water sweeping roads and fields, atmospheric deposition

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) 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, Ground water pollution with arsenic, fluoride and nitrate are posing serious health hazards.

Surface water pollution

1. Sewage
2. Industrial effluents
3. Synthetic detergents
4. Agrochemicals
5. Oil
6. Waste Heat

EFFECTS OF WATER POLLUTION

Oxygen demanding wastes:

Organic matter which reaches water bodies is decomposed by micro-organisms present in water.

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.

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.

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.

Toxic Compounds:

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

CONTROL OF WATER POLLUTION

(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.

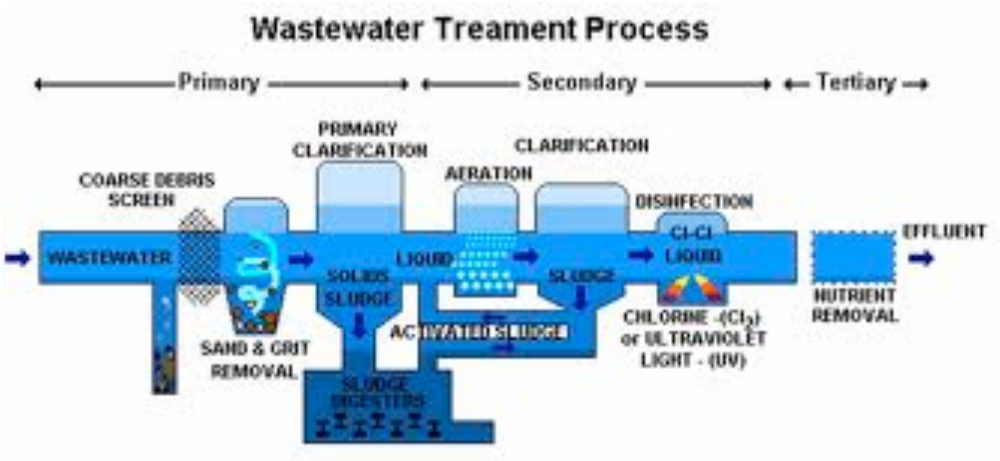
(iii) Adopting integrated pest management to reduce relying on pesticides.

(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.

WASTE WATER TREATMENT



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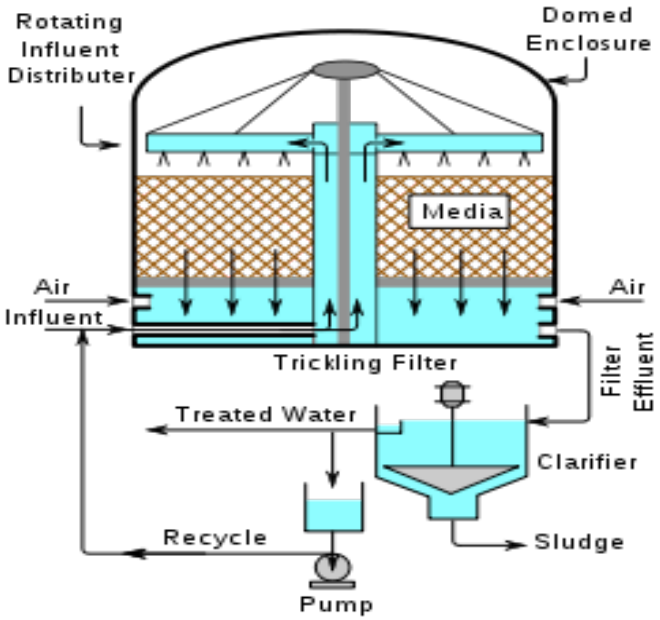
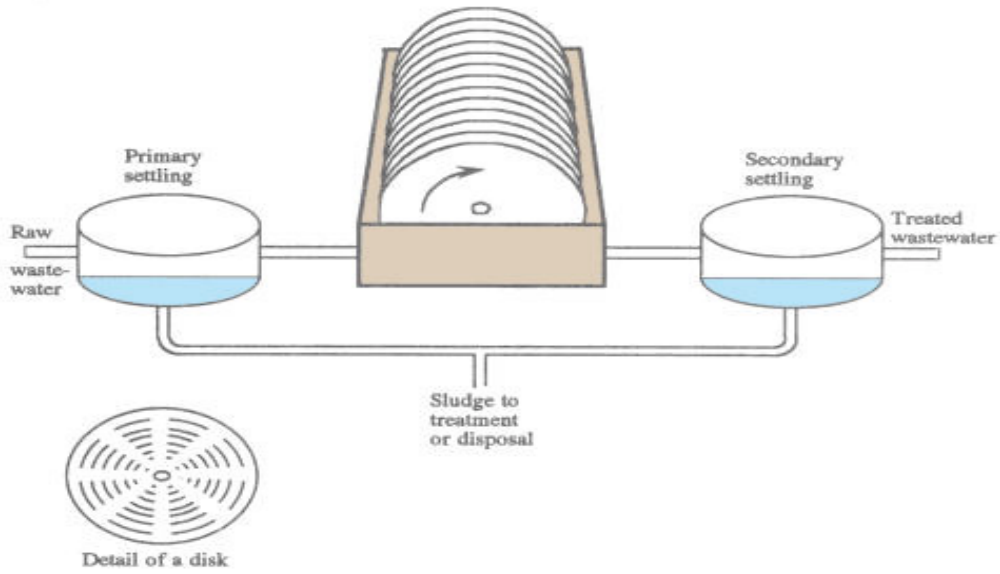


ROATING BIOLOGICAL CONTRACTORS



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. Excess of heat reaching 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.

(iii) Toxicity of pesticides, detergents and chemicals in the effluents increases with increase in temperature.

(iv) Discharge of heated water near the shores can disturb spawning and can even kill young fishes.

(v) Fish migration is affected due to formation of various thermal zones.

CONTROL OF THERMAL POLLUTION:

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

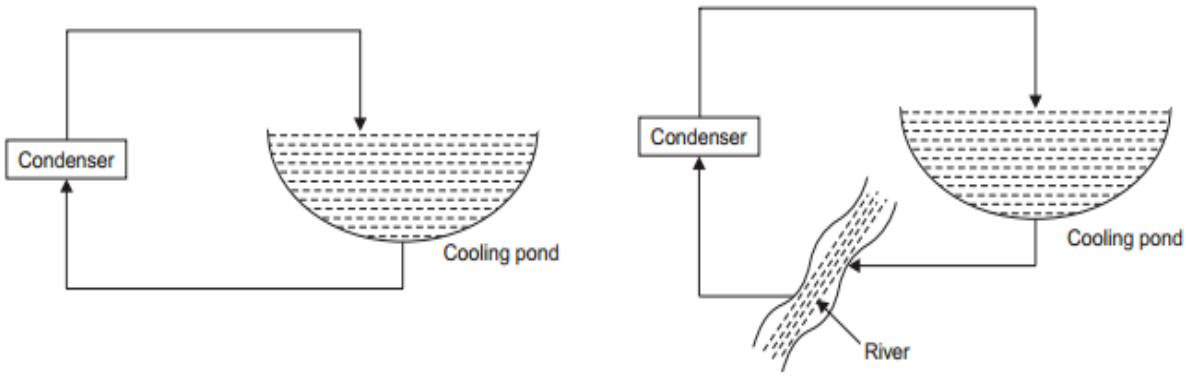
(i) Cooling ponds,

(ii) Spray Ponds,

(iii) Cooling towers

(i) Cooling Ponds:

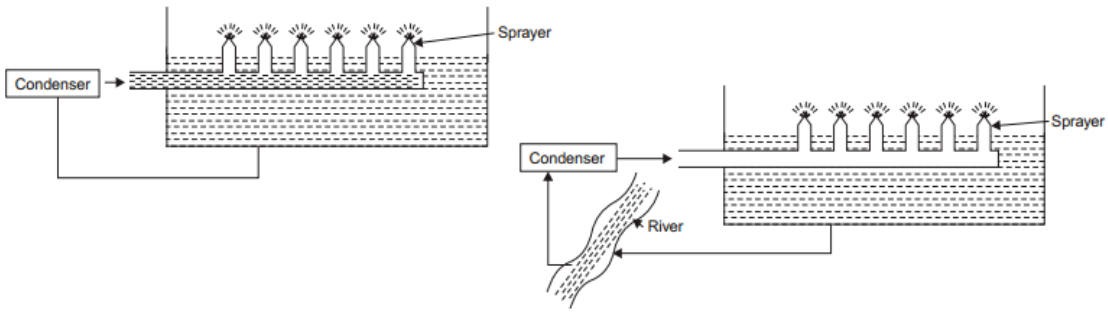
Water from condensers is stored in ponds where natural evaporation cools the water which can then be recirculated or discharged in nearby water body



Dissipation of heat by cooling ponds.

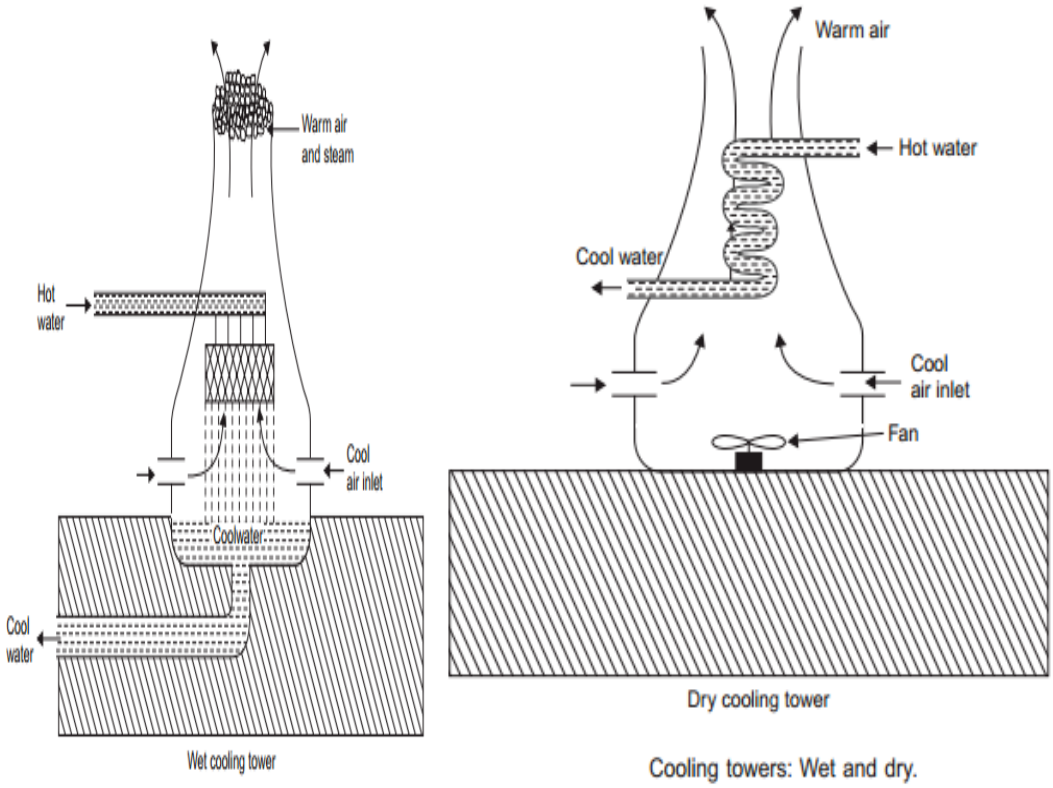
(ii) Spray Ponds:

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.



(iii) Cooling Towers:

(a) Wet cooling tower (b) Dry cooling tower



Cooling towers: Wet and dry.

MARINE POLLUTION

SOURCES / CAUSES OF 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

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.

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. 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

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.

(iv) Developmental activities on coastal areas should be minimized.
(v) Oil and grease from service stations should be processed for reuse.
(vi) Oil ballast should not be dumped into sea.
(vii) 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.
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.

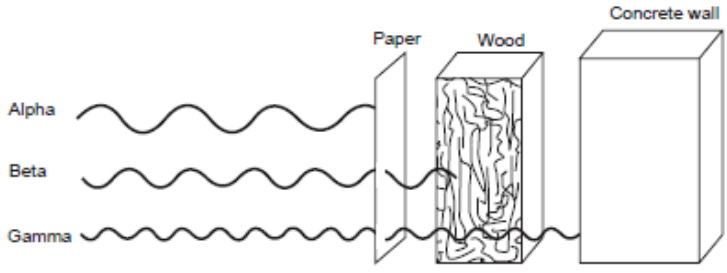
CONTROL OF SOIL POLLUTION

(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. 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.

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.



Variable penetration power of ionisation radiations emitted by radioisotopes.

Sources of Radioactivity

(i) Natural sources
(ii) Anthropogenic (man made) sources.
(i) Natural Sources: Sources of natural radioactivity include cosmic rays from outer space, radioactive radon-222, soil, rocks, air, water and food, which contain one or more radioactive substances.
(ii) Anthropogenic sources: These sources are nuclear power plants, nuclear accidents, X-rays, diagnostic kits, test laboratories etc. where radioactive substances are used.

Effects of Radiations

Ionisation radiations can affect living organisms by causing harmful
changes in the body cells and also changes at genetic level.
(i) 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.
(ii) Somatic damage includes burns, miscarriages, eye cataract and cancer of bone, thyroid, breast, lungs and skin
Control of Nuclear Pollution
(i) Siting of nuclear power plants should be carefully done after studying long term and short term effects.
(ii) Proper disposal of wastes from laboratory involving the use of radioisotopes should be done.

SOLID WASTE MANAGEMENT

Management of solid waste has, therefore, become very important in order to minimize the adverse effects of solid wastes. Solid waste (waste other than liquid or gaseous) can be classified as municipal, industrial, agricultural, medical, mining waste and sewage sludge.

Sources of Urban and Industrial Wastes

Urban waste

Urban waste consists of medical waste from hospitals; municipal solid wastes from homes, offices, markets (commercial waste) small cottage units, and horticulture waste from parks, gardens, orchards etc. Waste from homes (Domestic waste) contains a variety of discarded materials like polyethylene bags, empty metal and aluminium cans, scrap metals, glass bottles, waste paper, diapers, cloth/rags, food waste etc.

1. Waste from shops mainly consists of waste paper, packaging material, cans, bottles, polyethylene bags, peanut shells, eggshells, tea leaves etc.
2. Biomedical waste includes anatomical wastes, pathological wastes, infectious wastes etc.
3. Construction/demolition waste includes debris and rubbles, wood, concrete etc.
4. Horticulture waste and waste from slaughter houses include vegetable parts, residues and remains of slaughtered animals, respectively.

Industrial waste:
Industrial waste consists of a large number of materials including factory rubbish, packaging material, organic wastes, acids, alkalis and metals etc.
Effects of Solid Wastes
Municipal solid wastes heap up on the roads due to improper disposal system. This produces foul smell and breeds various types of insects and infectious organisms besides spoiling the aesthetics of the site.

MANAGEMENT OF SOLID WASTE:

For waste management we stress on .three R's-Reduce, reuse and recycle before destruction and safe storage of wastes.

(I) REDUCTION IN USE OF RAW MATERIALS:

Reduction in the use of raw materials will correspondingly decrease the production of waste. Reduced demand for any metallic product will decrease the mining of their metal and cause less production of waste.

(II) REUSE OF WASTE MATERIALS:

The refillable containers which are discarded after use can be reused. Villagers make casseroles and silos from waste paper and other waste materials. Making rubber rings from the discarded cycle tubes which are used by the newspaper vendors, instead of rubber bands, reduces the waste generation during manufacturing of rubber bands.

(III) RECYCLING OF MATERIALS:

Recycling is the reprocessing of discarded materials into new useful products. (i) Formation of some old type products e.g. old aluminium cans and glass bottles are melted and recast into new cans and bottles.

ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

Each individual should change his or her life style in such a way as to reduce environmental pollution
Help more in pollution prevention than pollution control.
> Use eco friendly products.
> Cut down the use of chlorofluorocarbons (CFCs) as they destroy the ozone layer.
> Use the chemicals derived from peaches and plums to clean computer chips and circuit boards instead of CFCs.
> Use CFC free refrigerators.
Reduce your dependency on fossil fuel especially coal or oil.
> Save electricity by not wasting it when not required because electricity saved is electricity generated without polluting the environment. Put on warm clothes rather than switching on a heater.
> Adopt and popularize renewable energy sources.
> Improve energy efficiency. This will reduce the amount of waste energy, i.e. more is achieved with less energy.
> Promote reuse and recycling wherever possible and reduce the production of wastes.

> Use mass transport system. For short-visits use bicycle or go on foot. Decrease the use of automobiles.
> Use pesticides only when absolutely necessary and that too in right amounts. Wherever possible integrated pest management, including alternate pest control methods (biological control), should be used.
> Use rechargeable batteries. Rechargeable batteries will reducemetal pollution.
> Use less hazardous chemicals wherever their application can be afforded. Baking soda, vinegar and borax can help in cleaning, bleaching and softening. Baking soda can replace modern deodorants.
> The solid waste generated during one manufacturing process can be used as a raw material for some other processes.
> Use low phosphate, phosphate-free or biodegradable dish washing liquid, laundry detergent and shampoo. This will reduce eutrophication of water bodies.
> Use organic manure instead of commercial inorganic fertilizers.

CASE STUDIES OF POLLUTION

DONORA AIR POLLUTION DISASTER:

Donora of Pennsylvania (in USA) is a small mill town dominated by steel mill, zinc smelter and sulphuric acid plant. A four days fog occurred from October 25-31, 1948. Due to anticyclonic weather conditions there was no air movement and temperature inversion had set in due to sea breeze conditions. Donora lies in a horse shoe shaped valley on the Monongahela river, south of Pittsburgh with steep raising hills on each side of the river.
Fog which formed due to accumulation of cold air at the bottom of the river valley persisted for 4 consecutive days. This condition, when cold layer is trapped below the warm layer, is called inversion. The top fog layer reflected the solar radiations during the day time. So the heat received by it was not sufficient to break the inversion. During night times the top layer had been loosing heat which further cooled the layer to stabilize. Wind speed in the inversion layer was also slow. The deadly pollutants emitted by the steel mill, zinc smelter and sulphuric acid plant got trapped and concentrated in the stable weather conditions of the valley and remained there for four days. About 6000 of the town.s 14,000 inhabitants fell ill and 20 of them died.

THE BHOPAL GAS TRAGEDY:

The world.s worst industrial accident occurred in Bhopal, M.P., India on the night of 2nd and morning of 3rd December, 1984. It happened at Union Carbide Company which used to manufacture Carbaryl (Carbamate) pesticide using Methyl isocyanate (MIC). Due to accidental entry of water in the tank, the reaction mixture got overheated and exploded because its cooling system had failed. Other safety devices also did not work or were not in the working condition. Forty tons of MIC leaked into the atmosphere which might have contained 40 kg of phosgene as an impurity. MIC gas at lower concentrations affects lungs and eyes and causes irritation in the skin. Higher amounts remove oxygen from the lungs and can cause death. In the winter night of December there were fog like clouds over south and east of the plant. The gas spread over 40 Km2 area. About 5100 persons were killed (2600 due to direct exposure to MIC and other 2500 due to aftereffects of exposure) according to Indian officials. About 2,50,000 persons got exposed to MIC. An estimated 65,000 people suffered from severe eye, respiratory, neuromuscular, gastrointestinal and gynecological disorders. About 1000 persons became blind. Without counting the damage of human lives, it

cost about $ 570 million in clean up and damage settlement. This tragedy could have been averted had the company spend about $ 1 million on safety improvement.

THE LOVE CANAL TRAGEDY

The Love canal tragedy occurred in a suburb of Niagara Falls, New York. The love canal was built by William Love which was later dug up and was used to dump sealed steel drums of chemical wastes by Hooker Chemicals and Plastics Corporation between 1942-1953. In 1953, the dump site was covered with clay and topsoil by the company and was sold to the city Board of Education which built an elementary school on that site. Houses were also built near the school. In 1976, the residents started complaining of foul smell. Children playing in the canal area received chemical burns.In 1977, the corroded steel containers started leaking the chemicals into storm sewers, basement of homes and the school playground. About 26 toxic organic compounds were identified. The dump site was covered with clay and the leaking wastes were pumped to new treatment plant. The affected families were relocated.

CHERNOBYL NUCLEAR DISASTER

Chernobyl nuclear accident is the worst nuclear disaster in the history of human civilization which occurred at Chernobyl, Ukraine in the erstwhile USSR (now CIS). On 26 April, 1986 the accident occurred at the reactor of the Chernobyl power plant designed to produce 1000 MW electrical energy. The reactor had been working continuously for 2 years. It was shut down on April 25, 1986 for intermediate repairs. This period coincided with the period when people including the top executives were busy in the preparations for national holiday, The May Day. Due to faulty operations of shutting down the plant, an explosion occurred The explosion was so severe that the 1000 tonne steel concrete lid of the reactor 4 blew off. Fire started at the reactor due to combustion of graphite rods. The reactor temperature soared to more than 2000°C. Fuel and radioactive debris spewed out in a volcanic cloud of molten mass of the core and gases. The debris and gases drifted over most of the northern hemisphere. Poland, Denmark, Sweden and Norway were affected.