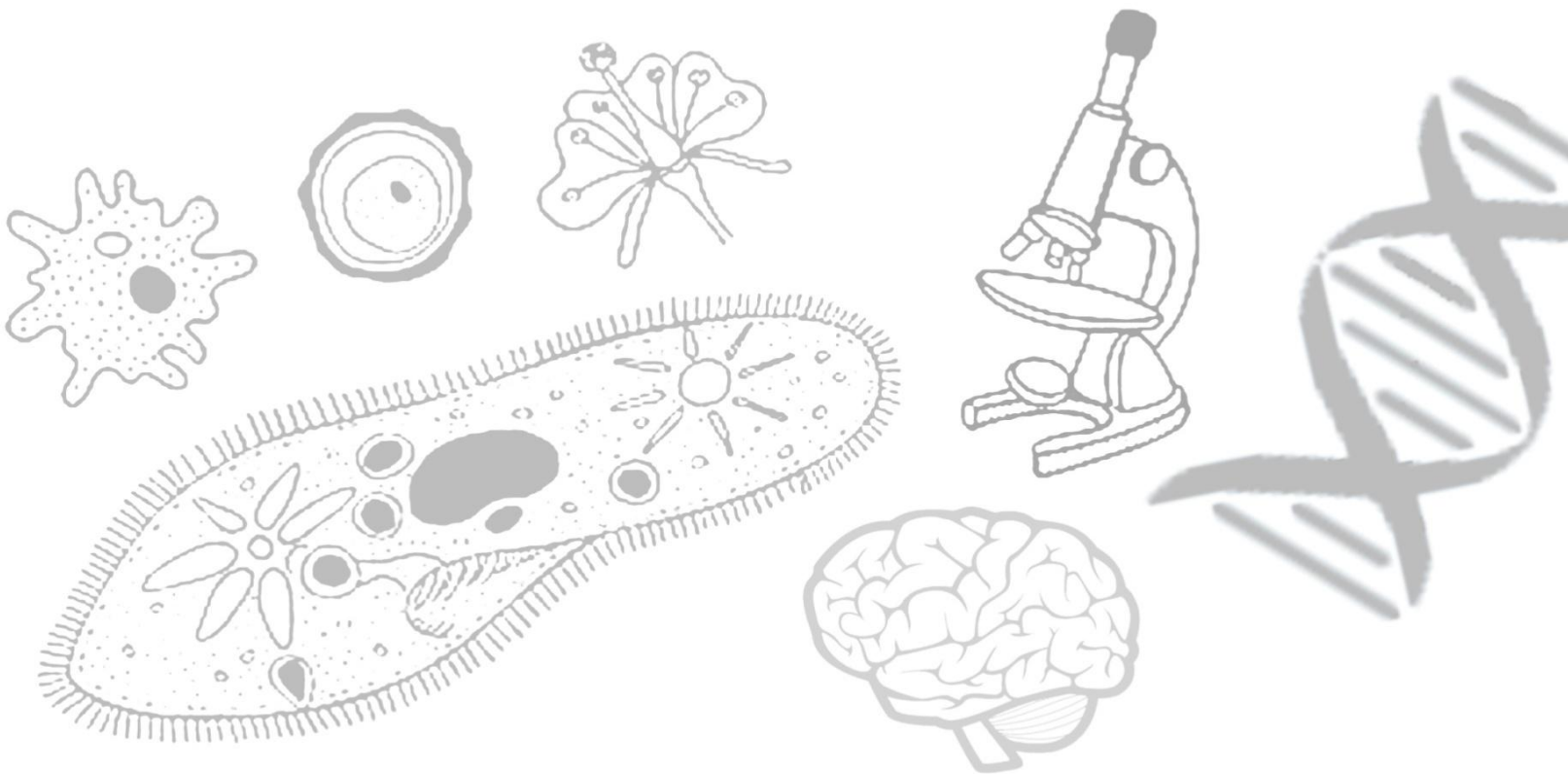


BIOLOGY



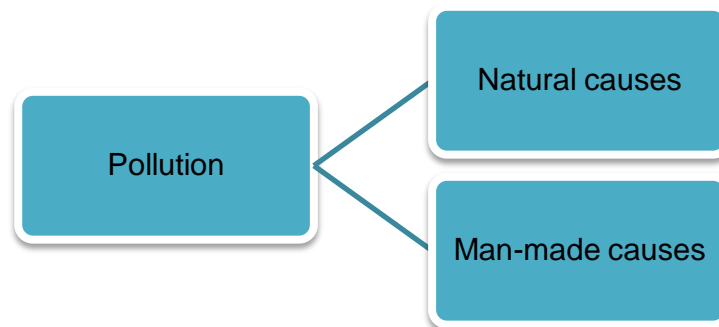
Air and Water Pollution and their Control

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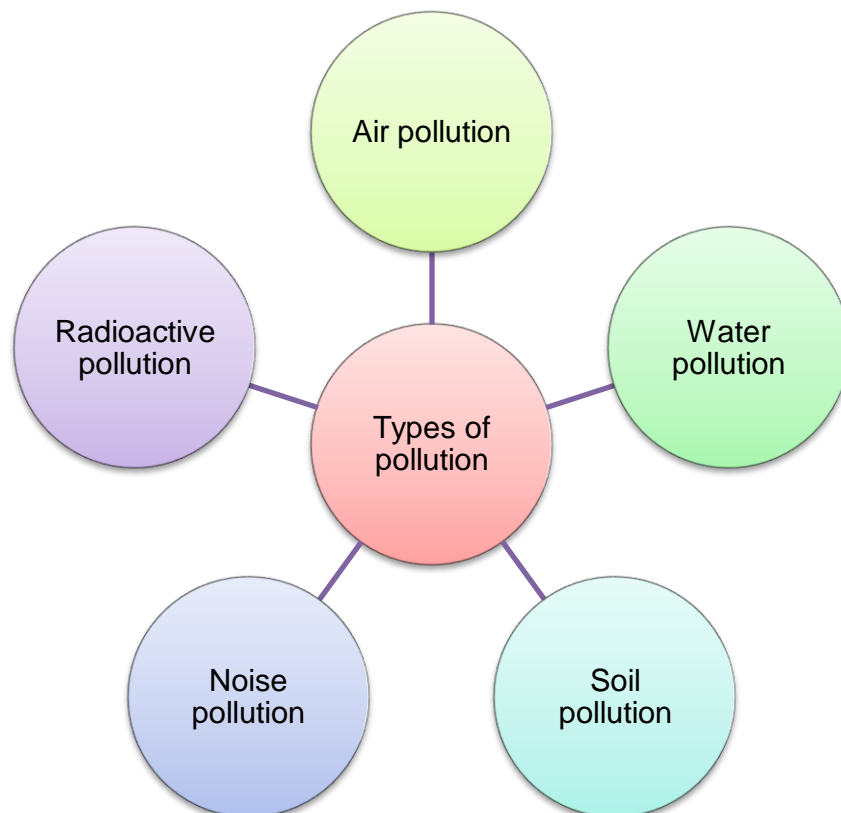
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Pollution

- Pollution is any undesirable change in the physical, chemical or biological characteristics of air, water or land which has the potential to adversely affect human life, life of desirable species, natural resources, industrial processes and cultural assets.



- Natural pollution is caused by natural sources such as the release of carbon monoxide from plants and animals, dust storms, volcanic eruptions and soil erosion.
- Man-made or anthropogenic pollution is caused by human activities such as sewage, burning of fossil fuels, mining, release of effluents, pesticides and fertilisers.
- Pollutants are substances released into the environment in large quantities because of natural or human activity and which have an adverse effect on plants, animals, man and the environment.



Environmental Laws for Controlling Pollution

Environment (Protection) Act, 1986

- It aims to protect and improve the quality of air, water and soil.

Insecticide Act, 1968

- It regulates the manufacture, import, sale, transport, distribution and use of insecticides.

Water (Prevention and Control of Pollution) Act, 1974

- It specifies the quality of water for various purposes, ways and means to control water pollution and prevention of undesirable effects on living beings.

Air (Prevention and Control of Pollution) Act, 1981

- It preserves the quality of air, controls air pollution and prevents detrimental effects of air pollutants on living beings.

Air Pollution

What is Air Pollution?

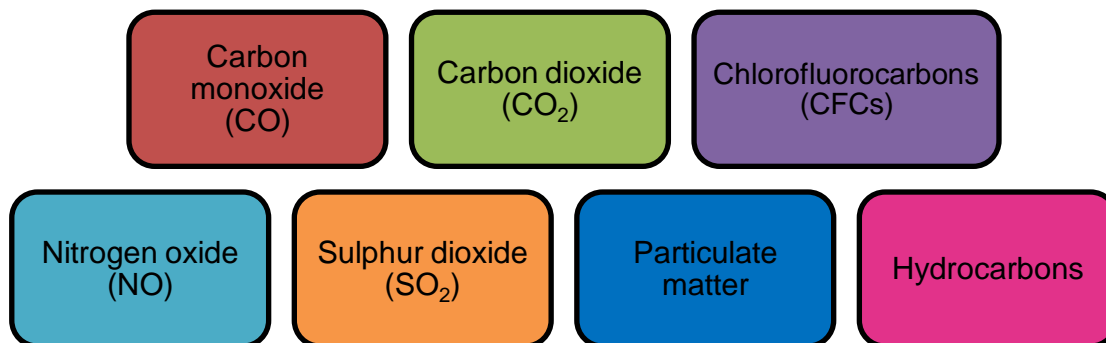
- The contamination of air with harmful gases such as carbon monoxide, sulphur dioxide and nitrogen oxide is called air pollution.



Causes of Air Pollution

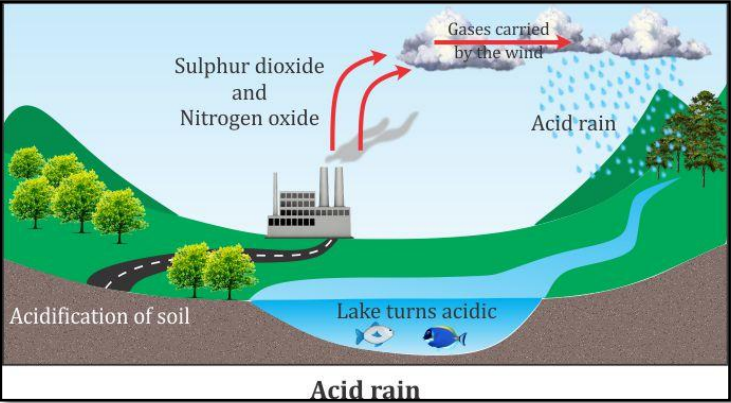

- Ash from volcanic eruptions
- Dust from storms and forest fires
- Exhaust given out by automobiles
- Gases released by industries and factories
- Mining activities, accidental emissions of radioactive elements, pesticides and insecticides
- Burning of garbage and fossil fuels
- Deforestation

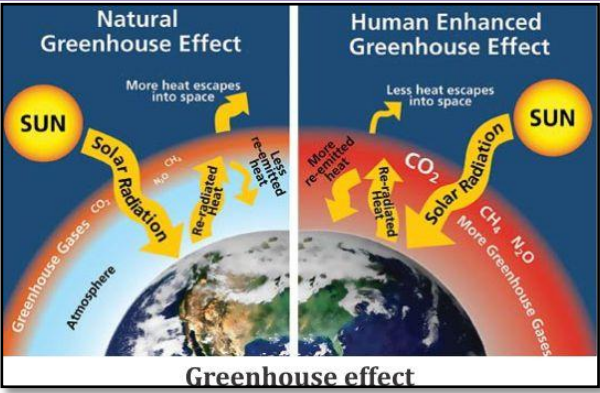
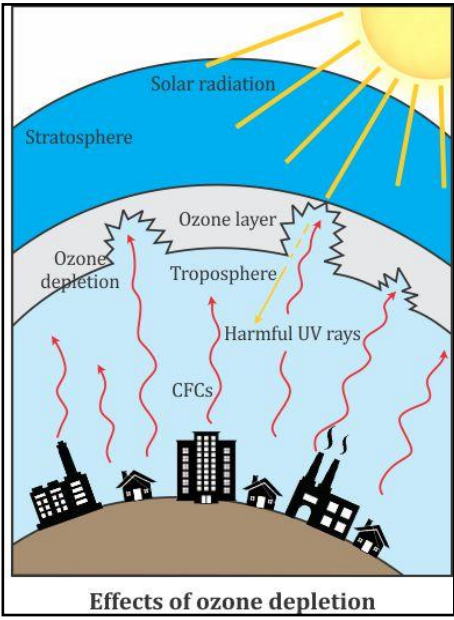
Major Air Pollutants



Effects of Air Pollution

- The effects of air pollution depend on the concentration of pollutants, the duration of exposure and the organism.

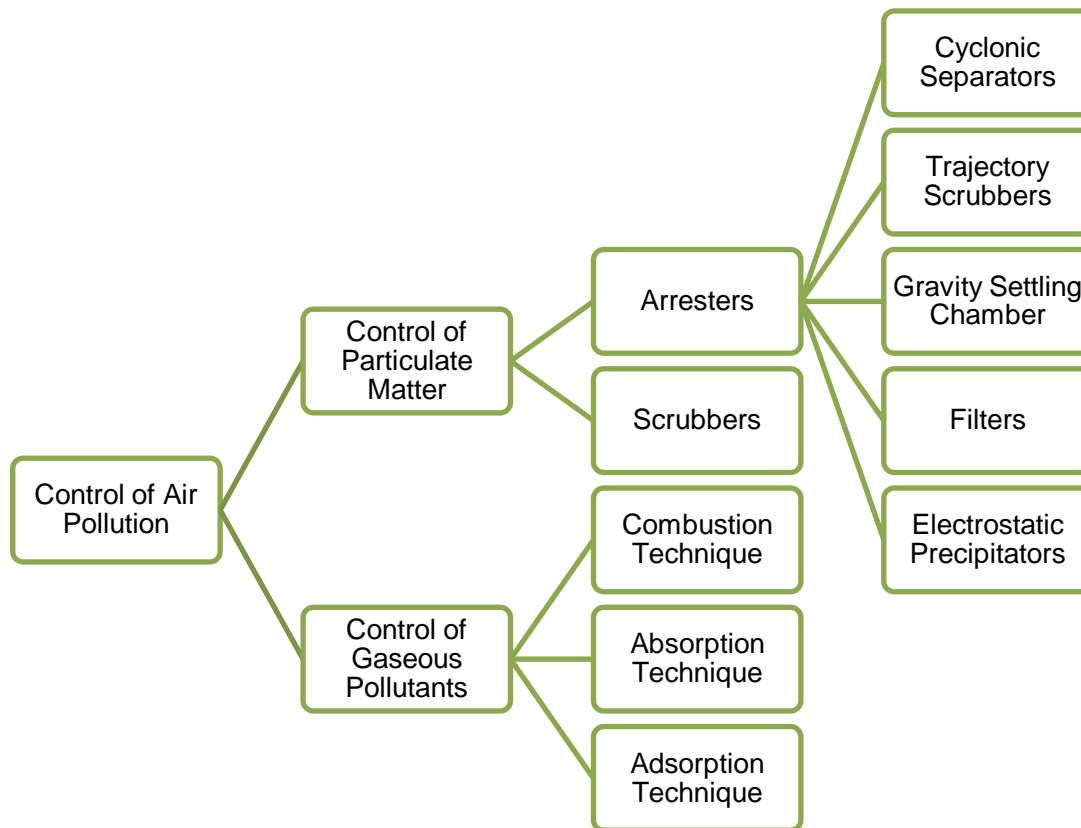
Acid rain	<p>Sulphur dioxide and nitrogen dioxide combine with the moisture present in clouds and form sulphuric acid and nitric acid, respectively. These acids fall to the Earth along with rain as acid rain.</p>  <p>The diagram illustrates the process of acid rain. A factory on the left releases plumes of 'Sulphur dioxide and Nitrogen oxide' into the air. Red arrows show these gases being carried by the wind to the right, where they combine with moisture in clouds. This process is labeled 'Gases carried by the wind'. The resulting 'Acid rain' falls from the clouds onto a landscape. The effects shown include 'Acidification of soil' and a 'Lake turns acidic', with fish in the lake. The entire diagram is captioned 'Acid rain' at the bottom.</p>
Smog	<p>Smog is formed when heat and sunlight react with particles suspended in the air.</p>  <p>A photograph showing a multi-lane highway with heavy traffic. The air is thick with a greyish haze, significantly reducing visibility. This is labeled 'Smog' at the bottom.</p>
Greenhouse effect and global warming	<p>Gases such as carbon dioxide, methane, nitric oxide and nitrous oxide in the atmosphere act as greenhouse gases. Their increased concentration in the atmosphere prevents the escape of heat which warms the air.</p>

	 <p style="text-align: center;">Greenhouse effect</p>
<p>Ozone depletion</p>	<p>Compounds such as chlorofluorocarbons (CFCs) have damaged the ozone layer. Ozone depletion often leads to sunburns, skin cancers and mutations.</p>  <p style="text-align: center;">Effects of ozone depletion</p>
<p>Health problems</p>	<p>Eye irritation; respiratory disorders; bronchitis and asthma; headaches; dizziness; nausea; decreased oxygen-carrying capacity of blood; anaemia; liver, kidney and brain damage; abnormal fertility and pregnancy; silicosis; byssinosis; asbestosis and black lungs.</p>

DID YOU KNOW ?

Approximately 12,000 people died in the London smog episode in 1952.

Measures to Control Air Pollution



Control of Particulate Matter

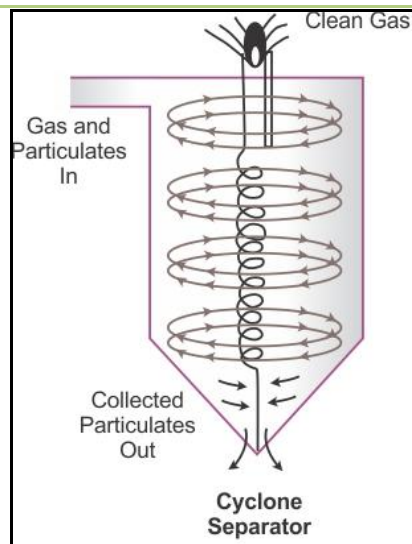
It is carried out by two types of devices—arresters and scrubbers.

Arresters

They are devices to separate particulate pollutants. They are of the following types:

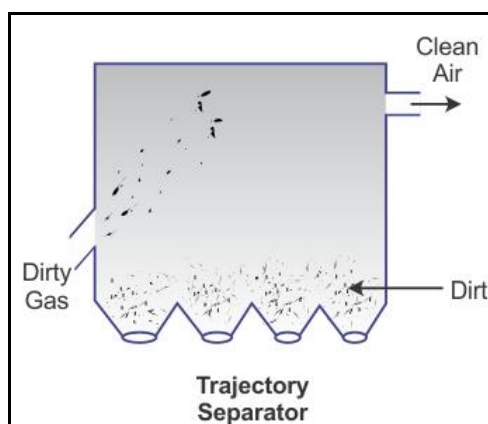
Cyclonic separators

- The particulate-rich air is passed into a chamber where it is rotated.
- Centrifugal force causes the settling of particulate matter, while clean air is allowed to pass out.



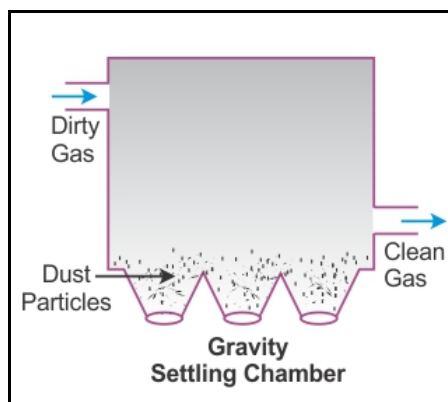
Trajectory scrubbers

- Dirty air is thrown into a collecting chamber in the form of an oblique jet.
- Heavier particles settle.



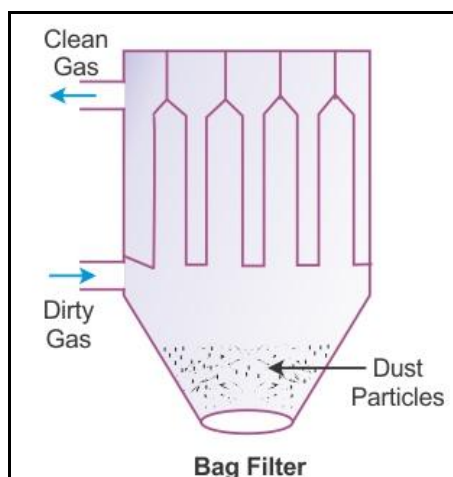
Gravity settling chamber

- Dirty air is passed through a large chamber.
- Particulate matter settles, while clean air passes out.



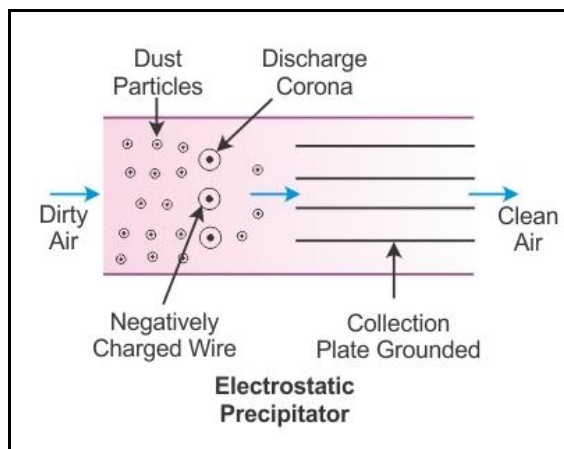
Filters

- They are large porous bags made of polyester, polypropylene, polyamide or *Teflon* through which dry emissions are passed under pressure to filter out particulate matter.



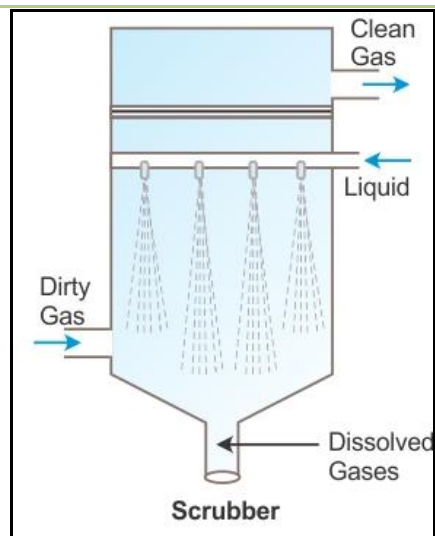
Electrostatic precipitators

- They are extremely efficient devices which remove about 99% of particulate matter present in the industrial and thermal power exhausts.
- They have charged plates connected to the ground.
- The electrode wires are provided with high-voltage electric current which produce a corona that releases electrons.
- These electrons attach to the dust particles giving them a negative charge.
- The collecting particles are grounded and attract the charged dust particles.
- The velocity of air between the plates must be low enough to allow the dust to fall.



Scrubbers

Scrubbers are of two types—dry and wet scrubbers. They can be used to separate particulate matter by passing through dry or wet packing material.

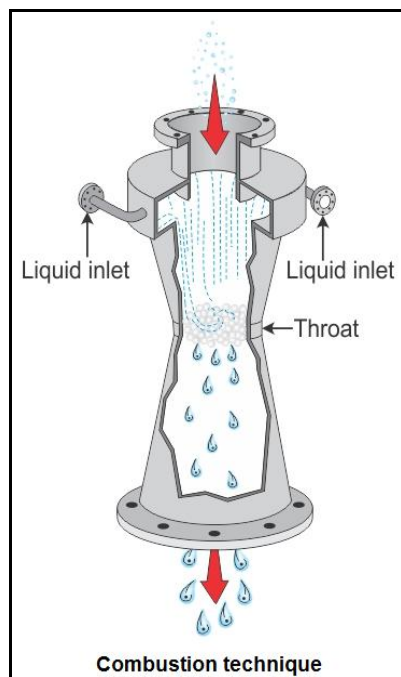


Control of Gaseous Pollutants

Gaseous pollutants can be removed from emissions by the following methods:

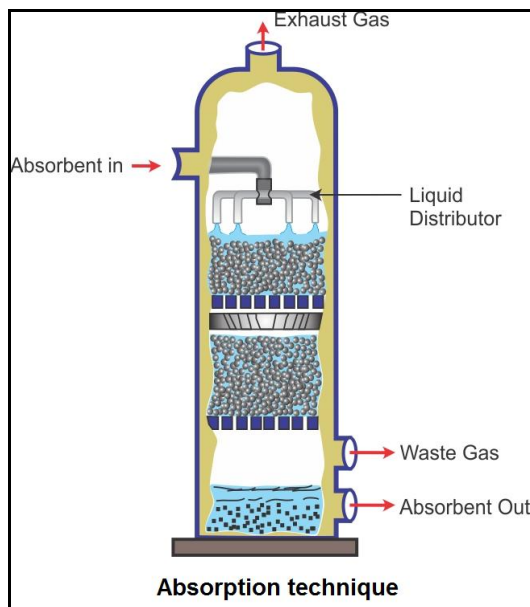
Combustion technique

- It is used to separate oxidisable pollutants.
- It is used in petrochemical, fertiliser, paint and varnish industries.



Absorption technique

- The gaseous pollutants are absorbed in the packing material.
- A fine spray of water dissolves ammonia, sulphur dioxide and nitrogen oxides.
- Calcium hydroxide is used to absorb SO_2 .



Adsorption technique

- Very fine solid particles are used to remove toxic gases, vapours and inflammable compounds.

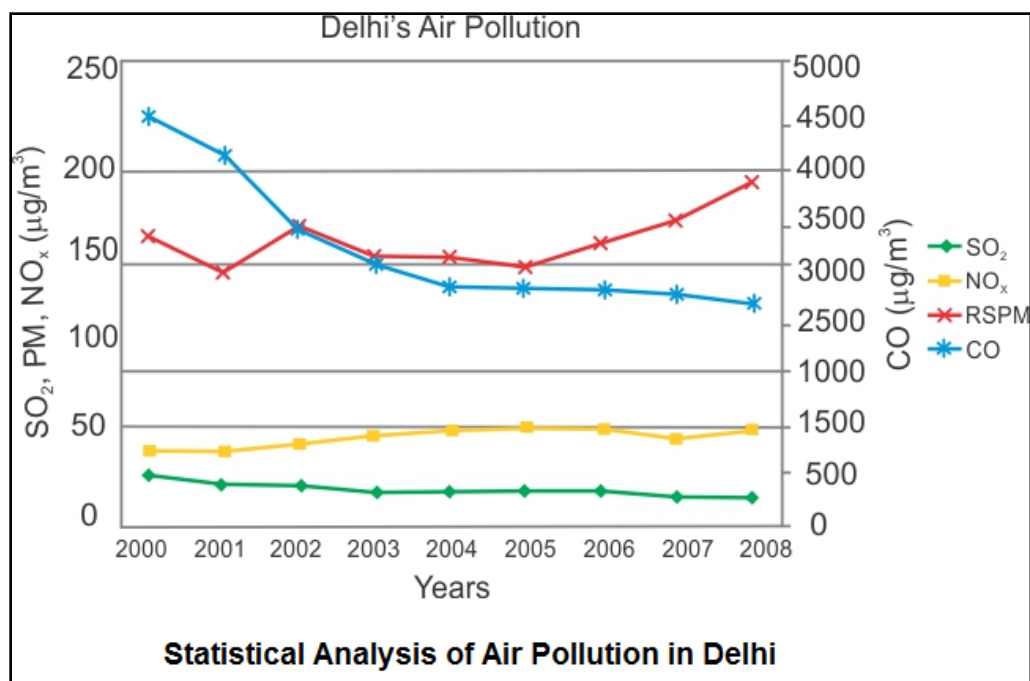
DID YOU
KNOW



Delhi has the maximum number of vehicles in India. In 1990, the total number of cars in Delhi was more than that in West Bengal and Gujarat combined. Delhi is one of the most polluted cities in the world.

Controlling Vehicular Air Pollutants: A Case Study of Delhi

- Because of the enormous number of automobiles in Delhi, the problem of air pollution was so serious that most of the Delhiites began to complain of burning eyes and respiratory discomfort.
- The Supreme Court directed the Government to take appropriate measures to reduce the pollution caused by automobiles. These included
 - i. Fuel switch over from diesel/petrol to CNG for public transport
 - ii. Phasing out of old vehicles
 - iii. Compulsory use of unleaded petrol and reduced sulphur content of diesel
 - iv. Compulsory regular check up of pollution emission of vehicles and enforcement of Euro II norms
 - v. Fitting of vehicles with catalytic converters
- The air quality of Delhi has improved with a substantial fall in the levels of SO_2 , CO, NO_x between 1997 and 2005.



- Because of the unavailability of CNG everywhere, the Government of India has formulated a new fuel policy to reduce vehicular pollution.
- According to Euro II norms, the sulphur content of diesel should not be more than 350 ppm, while that of petrol should not be more than 150 ppm. These norms have been applicable throughout the country from 1 April 2005.

- Euro III norms have been applicable in the 11 cities of Delhi, Agra, Kanpur, Ahmedabad, Surat, Mumbai, Pune, Hyderabad, Bengaluru, Chennai and Kolkata from 1 April 2005.
- Euro IV norms have been applicable to 13 cities of Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Lucknow, Sholapur, Jamshedpur and Agra from 1 April 2010.

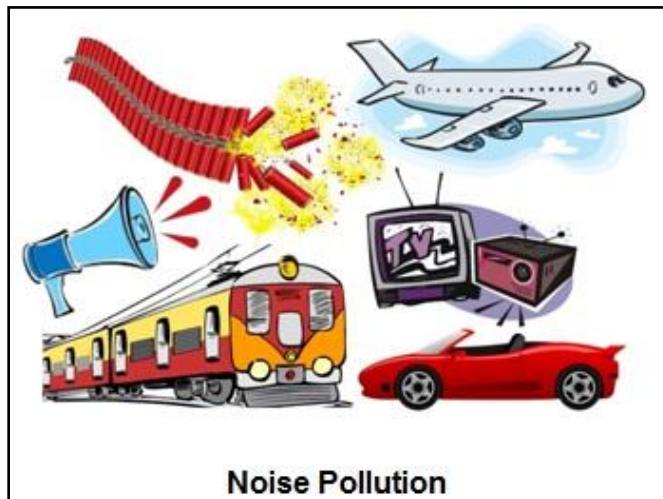
Why is CNG a better fuel than petrol or diesel?

- It is cheaper.
- It burns more efficiently.
- It does not cause much pollution.
- It cannot be siphoned off by thieves.
- It cannot be adulterated like petrol and diesel.

Noise Pollution

What is Noise Pollution?

- According to the amendments of the Air (Prevention and Control of Pollution) Act in 1987, noise has been regarded as an air pollutant.
- Any disturbing sound of very high intensity leads to noise pollution.
- Noise has an intensity of 80 dB and above. Noise becomes intolerable after 100 dB.



DID YOU
KNOW



The unit of sound level is decibel, dB, named after the great scientist Graham Bell.

Sources of Noise Pollution

- Industrial machines
- Workshops
- Trains and automobiles
- Jet aircraft
- Loud conversations
- Radio and television sets
- Loudspeakers
- Firecrackers
- Mobile phones

Effects of Noise Pollution

- Prolonged exposure to high-decibel noise damages the ear drums and can bring about permanent hearing impairment.
- Noise pollution can lead to high blood pressure (hypertension), constant headache and lack of concentration.
- It interrupts the thought process, resulting in low efficiency at work.
- It disturbs sleep which causes irritability and nervous disorders.

Measures to Control Noise Pollution

- Blowing of horns should be prohibited.
- Use of loudspeakers should be banned.
- Airports should be located away from residential areas.
- People should restrain themselves from lighting firecrackers.
- Decibel metres should be installed at different places to monitor the level of noise pollution.
- Noise pollution control laws should be strictly implemented.
- Sound diversion devices should be used to deflect the sound.
- Green muffler or green belt vegetation should be grown and maintained to serve as noise absorbers.
- Traffic police personnel and factory workers exposed to noise pollution should be provided with ear plugs or ear muffs.

Water Pollution


What is Water Pollution?

- The contamination of water sources such as rivers, lakes, oceans and groundwater with unwanted and harmful substances which makes the water unfit for use by humans and other living beings is called water pollution.



Water pollution

Sources of Water Pollution

SOURCE	DESCRIPTION
Household detergents	<ul style="list-style-type: none"> Water with detergents used to wash utensils or clothes flows into drains. 
Domestic sewage	<ul style="list-style-type: none"> Domestic sewage consists of wastes from animal sheds, slaughter houses, food processing industries, human excreta, food residues and detergents. There are four types of impurities and dissolved solids in domestic sewage: Pathogens, suspended impurities, colloidal particles and dissolved solids. In cities and industrial areas, sewage is released in lakes and rivers. Organisms present in water compete with aquatic animals for the use of oxygen.

**Industrial effluents**

- Wastewater from industries such as paper manufacturing, metal extraction and processing, and petroleum refining contain several poisonous organic compounds and toxic heavy metals such as mercury, copper, lead, zinc, cobalt, chromium and cadmium.
- Fish processing units located near the sea coast release many toxic substances into the sea.
- Industrial effluents are not only toxic to humans but also to the other life forms.
- It is important to treat industrial wastewater through various processes specified by the pollution control board.

**Domestic waste**

- Metal cans, garbage, glass bottles and plastic bags are often dumped into water bodies.



Oil spills

- It is the accidental discharge of petroleum in oceans or estuaries.
- The source of oil spills is overturned oil tankers, offshore oil mining and oil refineries.
- Oil spills kill a lot of marine life.

**Fertilisers, pesticides, herbicides**

- Nitrates, phosphates and other chemicals used in pest control and weed control are washed into rivers, lakes and ultimately the oceans.
- They cause immediate death of aquatic fauna on a massive scale.
- Excess fertilisers which are added to crop fields are passed down into the water bodies through surface run off during rains.
- Presence of excess of nutrients results in dense growth of aquatic flora and fauna. This phenomenon is called eutrophication.

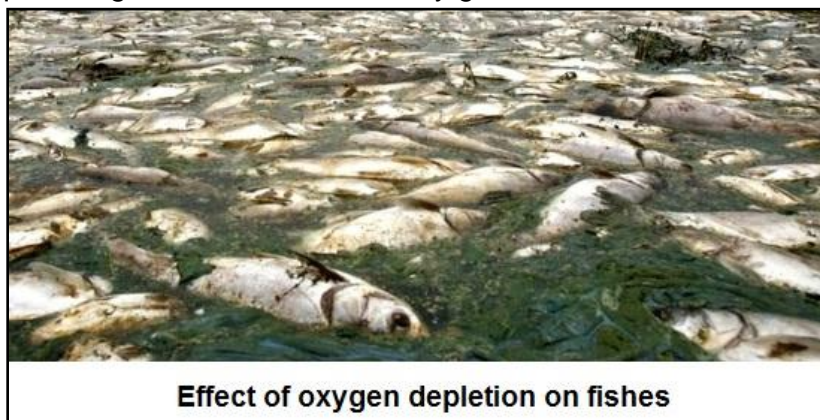


Effects of Water Pollution

- Water pollution has undesirable consequences on human life and other life forms.

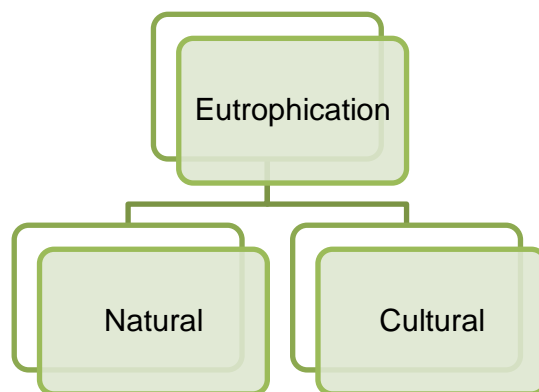
Biodegradation

- Domestic sewage is rich in biodegradable organic matter.
- Decomposition of organic matter by microbes requires the presence of oxygen.
- The degree of impurity of water because of organic matter is measured in terms of biochemical oxygen demand (BOD).
- BOD is the oxygen in milligrams required to decompose the organic matter present in one litre of water at 20°C.
- Chemical oxygen demand (COD) is the amount of oxygen required to oxidise all the reducing substances present in water. It includes BOD and reduced chemicals produced during putrefaction and other oxygen-demanding chemicals.
- Oxygen used during BOD and COD reduce the amount of the dissolved oxygen (DO) content.
- DO below 8.0 mg/L indicates pollution, and DO below 4 mg/L indicates heavy pollution.
- In such cases, the dissolved oxygen is completely used up and there is no oxygen left for respiration of fish and other aquatic organisms. Therefore, they get killed.



Eutrophication

- Eutrophication is the excessive growth of algae, plants and animals in water bodies because of nutrient enrichment particularly with nitrogen and phosphorus.



Natural Eutrophication

- Natural eutrophication is nutrient enrichment of a water body because of natural ageing.
- Run off and streams drain into young water bodies and add nutrients, especially nitrogen and phosphorus. This enhances the growth of aquatic organisms.
- Organic debris and silt accumulate at the bottom, closer to the periphery.
- Water becomes warmer, and the water body becomes shallow.
- Marsh plants grow in shallow waters. Floating plants appear.
- Silt and decaying matter accumulate and ultimately fill up the water body.



Eutrophication

Cultural Eutrophication

- Cultural or accelerated eutrophication is nutrient enrichment of water bodies because of human activities such as passage of sewage, industrial effluents and run off from fertilised fields rich in nitrates and phosphates.
- The planktonic algae increase and impart a characteristic colouration to water. It is called algal bloom.
- There is brown colouration, foul smell and bad taste because of the formation of secondary pollutants.
- Hydrogen sulphide reacts with various metallic ions to form sulphides. They produce scum and sludge along with organic matter.
- Algal blooms and floating plants cut off light from submerged plants because of which they die.
- There is a drastic decrease in oxygen replenishment inside water which causes organic loading of water.
- Decreased oxygen content also kills aquatic animals, further adding to organic loading.

DID YOU
KNOW



Water hyacinth (*Eichhornia crassipes*) also called 'Terror of Bengal' is a plant which chokes ponds, lakes and rivers. This results in an imbalance of ecosystem dynamics of water bodies.

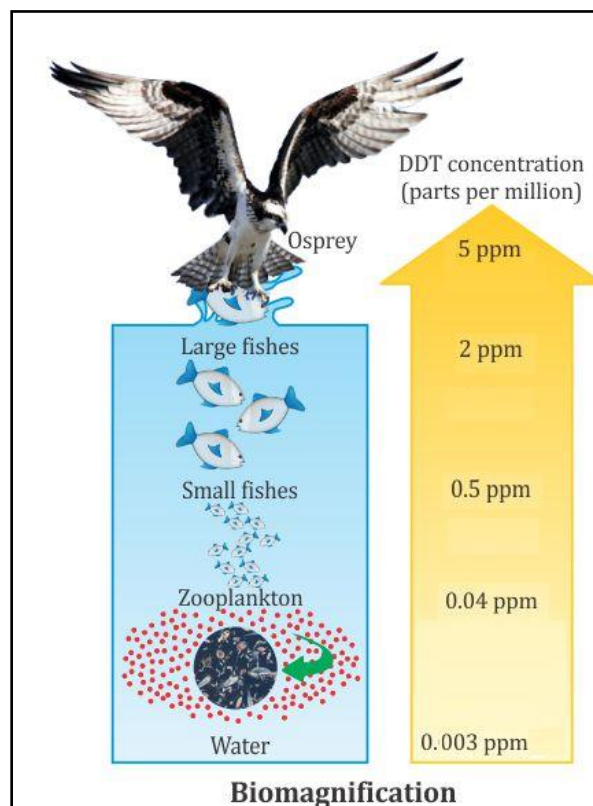
Thermal Pollution

- Thermal pollution occurs when heated water enters a river or a stream.
- Thermal power plants, nuclear power plants and oil refineries use water for cooling their machinery.
- This water may be 8–10°C warmer than the water of a source to which it is released.
- It affects aquatic life.



Biomagnification

- The process by which harmful and toxic substances enter the food chain and get concentrated in the bodies of living organisms at each successive level in the food chain is called biomagnification.
- Consider the example of biomagnification of dichlorodiphenyltrichloroethane (DDT) along a food chain.
- When DDT leaches from the agricultural field, it enters a nearby water body. The concentration of DDT in the water body is low (0.003 ppm).
- The pesticide enters the food chain and gets accumulated in zooplankton (0.04 ppm), and thereby its concentration goes on increasing at different trophic levels of the food chain, from the small fish (0.5 ppm) to the large fish (2 ppm) and finally to the fish-eating birds (5 ppm).
- Concentration of DDT increases along the food chain, reaching the highest level in the top carnivore bird.
- Increased concentration of DDT in birds disturbs calcium metabolism. Egg shells become thin, resulting in premature breaking. Consequently, there is a decline in the bird population.



Measures to Control Water Pollution

Sewage, industrial waste and domestic waste should be treated to make them harmless before they are released into water bodies.

Use of chemical pesticides must be minimised.

Use of biofertilisers should be encouraged.

Washing utensils, clothes and bathing cattle in water bodies must be avoided.

Garbage and other domestic waste should not be thrown into water bodies.

Leakage in drainage pipes must be repaired.

Awareness about the severity of water pollution must be created among students and adults.

Laws should be formulated to control water pollution. Penalties should be enforced for those who break the law.

Integrated Wastewater Treatment: A Case Study

- An integrated wastewater treatment process was developed in the town of Arcata situated on the Northern Coast of California with the help of biologists from Humboldt State University.
- The method was a combination of artificial and natural processes.
- The treatment process consisted of two stages:
 - i. Conventional method of filtering, sedimentation and chlorine treatment for the removal of large organic remains, grit and microbes. The treated water contained huge amounts of heavy metals and other dangerous pollutants.
 - ii. Innovative approach which consisted of developing a series of six connected marshes in 60 hectares of marshland seeded with bacteria, algae, fungi and plants.
- The biota absorbs, assimilates and neutralises the pollutants. The naturally purified water is then allowed to flow out.
- The marshes not only function in water treatment but also have been converted into a sanctuary where several fish, other aquatic animals and birds have found residence.
- A citizen group called Friends of the Arcata Marsh (FOAM) looks after the project.

***Ecosan* toilets**

Dry composting toilets called *Ecosan* toilets can be used for the disposal of human excreta in an ecological way. No water is required in this toilet. Human excreta is converted into a resource as it forms a natural fertiliser. *Ecosan* toilets are functional in many parts of Kerala and Sri Lanka.

