Environmental Pollution

- Environmental Pollution
- Causes, effects and control measures of Air Pollution.

Environmental Pollution

- Pollution can be defined in many ways. As per Odum, 'pollution is an undesirable change in the physical, chemical or biological characteristics of air, land and water that is likely to harmfully affect human life and other species including raw material resources'.

- Pollution has been defined by Edward as, 'the release of substances or energy into the environment by man in quantities that damage either his health or the natural resources'.

- McLaughlin defined pollution as 'the introduction by man, of waste matter or surplus energy into the environment, which directly or indirectly causes damage to man and his environment'.

- In short pollution is the contamination of habitat by undesirable substances.

Pollutants

- Harmful substances which are released into the atmosphere that affect the functioning of living organisms/ ecosystem are called pollutants. These substances include gases, particulate matter, radioactive substances etc.

- Gaseous pollutants include oxides of sulphur (SO_2, SO_3), oxides of nitrogen (NO and NO_2), carbon monoxide (CO), H_2S, volatile organic compounds (mostly hydrocarbons from automobile exhaust) etc.

- Particulate pollutants include smoke, dust, soot, fumes, aerosols, liquid droplets, pollen grains etc

Pollutants

- Other pollutants include heavy metals, pesticides, weedicides, fungicides, fertilisers, radioactive substances, sewage, etc.

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

Biodegradable & non-biodegradable Pollutants

- Pollutants can be classified into two main groups, viz., biodegradable pollutants and non-biodegradable pollutants.

- Pollutants that can be decomposed naturally are called biodegradable pollutants. Some examples are sewage, refuse, heat, noise, etc.

Non-Biodegradable Pollutants

- Pollutants that cannot be decomposed by natural processes are called non-biodegradable pollutants.

- Once these pollutants contaminate the atmosphere, it becomes very difficult to remove these.

- Few examples are DDT, polythene bags, soft drink cans, plastic bottles, etc.

Types of Pollution

- Air Pollution
- Water Pollution
- Soil Pollution
- Marine Pollution
- Noise Pollution
- Thermal Pollution
- Nuclear Pollution

Air Pollution

- Air pollution can be defined as the presence of one or more impurities like dust, mist, smoke and colour in the atmosphere that are harmful to human beings, plants and animals.

- Air Pollution indicates the contamination of the atmosphere that causes harm to living organisms and the environment.

The composition of Air

- Nitrogen   78%
- Oxygen   21%
- Argon   0.9%
- Carbon dioxide   0.04%
- Water vapour   Variable
- Other Gases   Trace amount

Sources of Air pollution

Natural sources

- Natural sources of pollution are those that are caused due to some natural event.

- Volcanic eruptions, forest fires, biological decay, pollen grains, marshes, sea salt sprays, photochemical oxidation of organic compounds, pollen grains of flowers, spores, meteorites etc.

- Radioactive substances present in the earth are the sources of radioactivity in the atmosphere.

Sources of Air pollution

Artificial or Man Made sources

- Artificial sources are those which are created by man. Ex: Thermal power plants, emissions from vehicles, industrial units, burning of fossil fuels, agricultural activities etc.

- Thermal power plants are the major sources for generating electricity in India. These plants emit two main pollutants viz. sulphur dioxide and fly ash.

- 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, oxides of nitrogen, unburnt hydrocarbons and suspended particulate matter.

Classification of Air Pollutants

Air pollutants can be divided into two categories

- Primary pollutants

- Secondary pollutants

- Primary pollutants are those that are directly emitted in the atmosphere in the harmful form

- Ex: CO, NO, SO_2, benzophyrene (from cigarette smoke), NH_3(ammonia), lead bromide (from automobile exhaust), and soot etc.

Classification of Air Pollutants

- Secondary pollutants are those that are formed by reaction of primary pollutants with other component of the atmosphere; especially such reactions may take place in the presence of sunlight.

- Examples are: O_3, PAN (peroxyacetyl nitrate), H_2SO_4 , HNO_3, aldehydes, etc.

Sources of indoor air pollutants

Indoor air pollutants are primary air pollutants. The most important indoor air pollutant is Radon gas.

Radon gas formed by decomposition of radioactive elements present in building materials like bricks, concrete, etc. that are derived from soil containing radium.

Radon is also found in natural gas and ground water and is emitted while being used.

Burning fuel in the kitchen and cigarette smoke release pollutants like CO, SO_2, HCHO (Formaldehyde) and BAP (Benzo-(α) pyrene).

Causes of Air Pollution

- Excessive use of pesticides, dust from agricultural practices, burning of crop residues in fields, etc. are responsible for air pollution due to agricultural activities.

- Dust storms, wind, volcanoes, automobiles, etc., add dust to the air causing pollution.

- Combustion of fossil fuels like coal, petroleum, cement dusts, poisonous gases, etc., all cause air pollution.

Causes of Air Pollution

- Gases released due to the burning of petrol and diesel in automobiles cause air pollution.

- The testing of atomic weapons cause air pollution due to the release of radiations like alpha particles, beta particles and gamma rays in the air.

- Solvents used in perfumes and refrigerants like chlorofluorocarbons cause air pollution by depleting the ozone in stratosphere.

Causes of Air Pollution

Fine solid particles or liquid droplets suspended in the air are known as aerosols. They block the stomata of plants inhibiting gaseous exchange between plants and the atmosphere.

Aerosols in the atmosphere are also supposed to bring climatic changes in the planet.

Common Air Pollutants

Carbon monoxide: It is a highly poisonous gas which is colourless and odourless. It is formed by incomplete combustion of wood or fossil fuels.

Main source of carbon monoxide is incomplete burning of fossil fuels (more than three fourth comes from motor vehicle exhaust)

Carbon monoxide gas inhibits the ability of red blood cells to carry oxygen to body cells and tissues. This leads to headache and anaemia. At higher levels it can cause coma, and even death.

Common Air Pollutants

- **Nitrogen Dioxide**: It is a reddish-brown irritating gas that causes photochemical smog.

- In the atmosphere, it gets converted into nitric acid (HNO_3). It is caused by burning fossil fuels in industries and power plants.

- Health effects include lung irritation and damage. Environmental effects include acid rain leading to damage of trees, lakes, soil and ancient monuments.

Common Air Pollutants

- **Sulphur Dioxide:** It is a colourless gas that is formed by combustion of sulphur containing fossil fuels especially coal and diesel oil. In the atmosphere it is converted into Sulphuric acid which is a major component of acid rain.

- Health effects involve breathing problems for healthy people.

- Environmental effects involve smog formation and acid deposition on trees, lakes, soils and monuments leading to their deterioration and adverse effect on aquatic life.

Common Air Pollutants

- Suspended Particulate Matter (SPM): Includes a variety of particles and droplets (aerosols) that can be suspended in atmosphere for short to long periods.

- SPM are formed due to: burning coal in power plants, burning fossil fuels in vehicles, agricultural activities, construction, etc.

- Health effects include nose and throat irritation, lung damage, bronchitis, asthama, reproductive problems and cancer.

- Environmental Effects include reduced visibility and deposition. Deposition may lead to damaged tree leaves etc.

Common Air Pollutants

- Ozone is a highly reactive gas with a typical odour.

- It is present in the stratosphere where it protects us from the harmful ultra-violet radiations coming from the Sun.

- Tropospheric ozone is a pollutant.

- Tropospheric ozone is formed by reaction between Volatile Organic Compounds (VOCs) and Nitrogen Oxides.

Common Air Pollutants

- Lead is a highly toxic metal. Its compounds are mainly emitted into the atmosphere as particulate matter through automobile exhaust.

- Other sources are paint, metal refineries, lead manufacture, storage batteries, leaded petrol, etc.

- Health effects: Lead accumulates in the body and brain leading to nervous system damage and mental retardation in children. Lead containing chemicals are known to cause cancer in animals.

Common Air Pollutants

- Chromium: It is a toxic metal emitted into the atmosphere as particulate matter.

- Human sources: Paint, Smelters, Chromium manufacture, Chromium plating.

- Health Effects: Perforation of nasal septum etc.

Effects of Air Pollution

Death: The presence of highly poisonous gages like phosgene or methyl isocyanate may cause death. The Bhopal gas tragedy is a good example.

Chlorosis : Presence of SO_2 and fluorides in the air causes reduction of chlorophyll in leaves. This condition is known as chlorosis.

Effects of Air Pollution

Necrosis: The breaking down of cells due to the presence of SO_2, NO_2, ozone etc. is known as necrosis.

Greenhouse effect: Concentration of gases like CO_2, CH_4, NO_2 and CFCs in the atmosphere increases the temperature of the earth slowly and gradually. These gases absorb infrared radiations, but do not allow these radiations to reflect and return back to the earth. This is known as the greenhouse effect. Increasing temperature of the atmosphere of the earth as a result of this effect is known as global warming.

Effects of Air Pollution

Destruction of crops: Smog which refers to a combination of smoke and fog, causes heavy damage to crops such as leafy vegetables, cereals, cotton, fruits, and forest trees,

Respiratory disorders: Many poisonous or irritating gases present in polluted air irritate the nasal and respiratory tracts.

Effects of Air Pollution

Depletion of the ozone umbrella – Freon and chlorofluorocarbons that are being used in aerosol packages and foam plastics, destroy O_3 molecules in the ozone umbrella and pierce holes in it. UV radiations enter the earth through the pierced holes and cause skin cancer and other diseases.

Acid rains: In industrial areas a large amount of NO_2 (nitrous oxide), NO (nitric oxide) and SO2(sulphur dioxide) is discharged in the air. These gases get absorbed by the rain water from the atmosphere and are poured back down on the earth in the form of acid rain. Acid rain not only destroys vegetation but is injurious to aquatic animals in water bodies such as lakes, ponds, etc.

Control Measures

- The atmosphere has several built-in self cleaning processes such as dispersion, gravitational settling, flocculation, absorption, rain-washout, etc to cleanse the atmosphere. However, control of contaminants at their source level is a desirable and effective method through preventive or control technologies.

Control Measures: Source control

- Using unleaded petrol

- Using fuels with low sulphur and ash content

- Encouraging people to use public transport, walk or use a cycle as opposed to private vehicles

- Ensure that houses, schools, restaurants and playgrounds are not located on busy streets

- Plant trees along busy streets as they remove particulates, carbon dioxide and absorb noise

- Industries and waste disposal sites should be situated outsdide the city preferably on the downwind of the city.

- Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons

Control measures in industrial centers

- Emission rates should be restricted to permissible levels by each and every industry
- Incorporation of air pollution control equipment in design of plant layout must be made mandatory
- Continuous monitoring of the atmosphere for pollutants should be carried out to know the emission levels.

Control measures in industrial centers

- The emission of exhaust from automobiles can be reduced by using devices such as a positive crankcase ventilation valve or a catalytic converter.

- Electrostatic precipitators can be used to minimize smoke and dust from industries.

- Gaseous pollutants arising from industries can be removed by using the method of differential solubility of gases in water.

- Removal of pollutants from the emitted exhaust can be done using a fine spray of water. A device called scrubber is used for this purpose.

- Certain gases can be removed by filtration or absorption through activated carbon.

Control measures in industrial centers

- Application of chemical pesticides should be replaced by using alternative bio-pesticides, which are environment friendly.

- Radioactive waste should be buried safely under the earth. Growth in population should be regulated.

- Emphasis should be laid on environment-friendly engines in automobiles.

- At the government level, pollution can be controlled by formulating different laws and legislations.

Equipment used to control air pollution

- Removal of SPM by gravitation

- Removal of SPM by centrifugation

- Removal of SPM by filtration

- Removal of SPM by scrubbing

- Removal of SPM by Electrostatic precipitator

# Electrostatic precipitator

Wet electrostatic precipitator
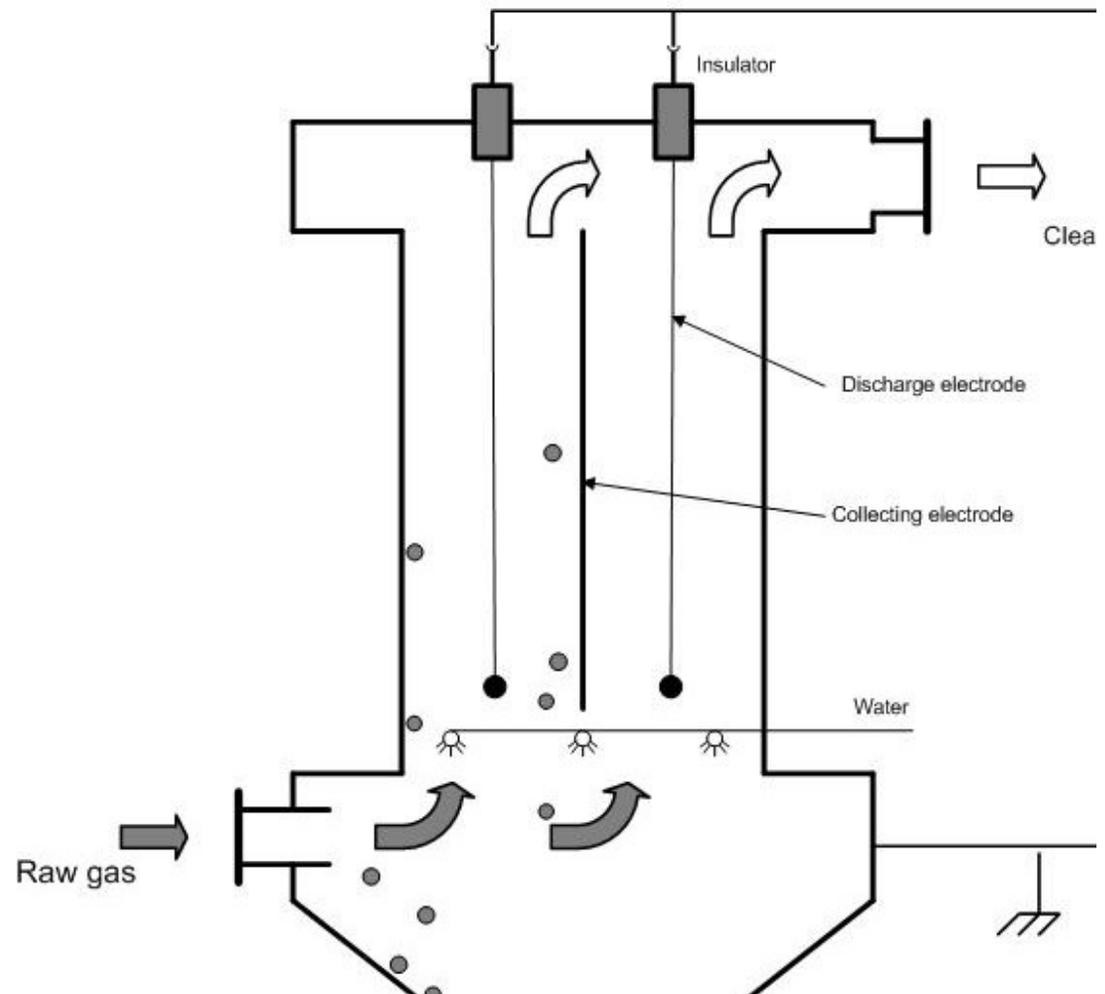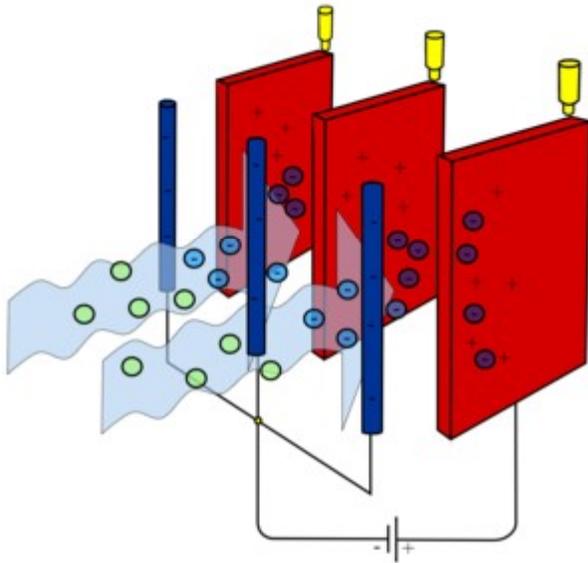
Electrostatic precipitator

Cyclone Separator

Power pack

Clean-air outlet

Dirty-air inlet

Helical baffle

Inner cylinder

Welded or flang

Cabinet base
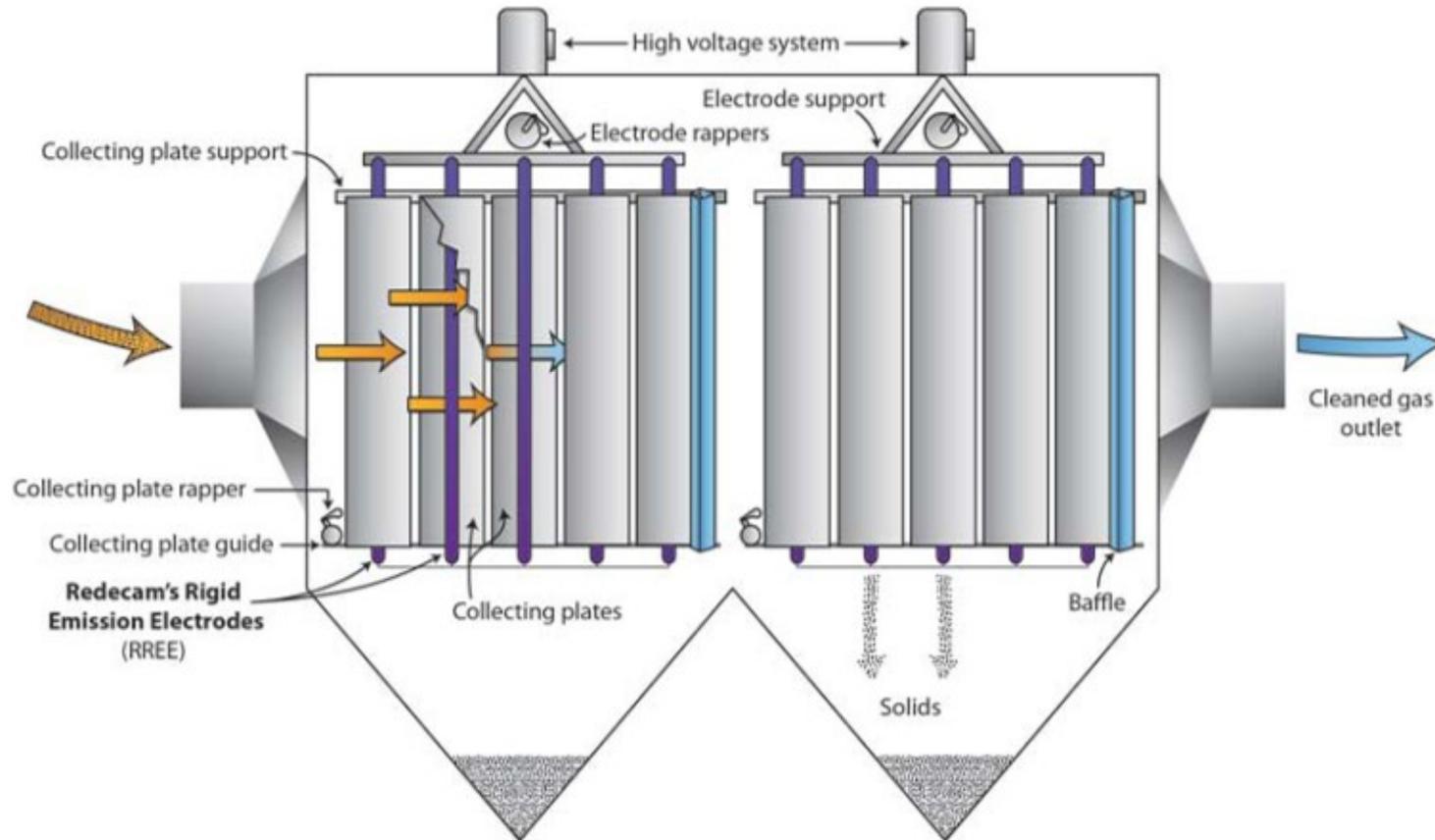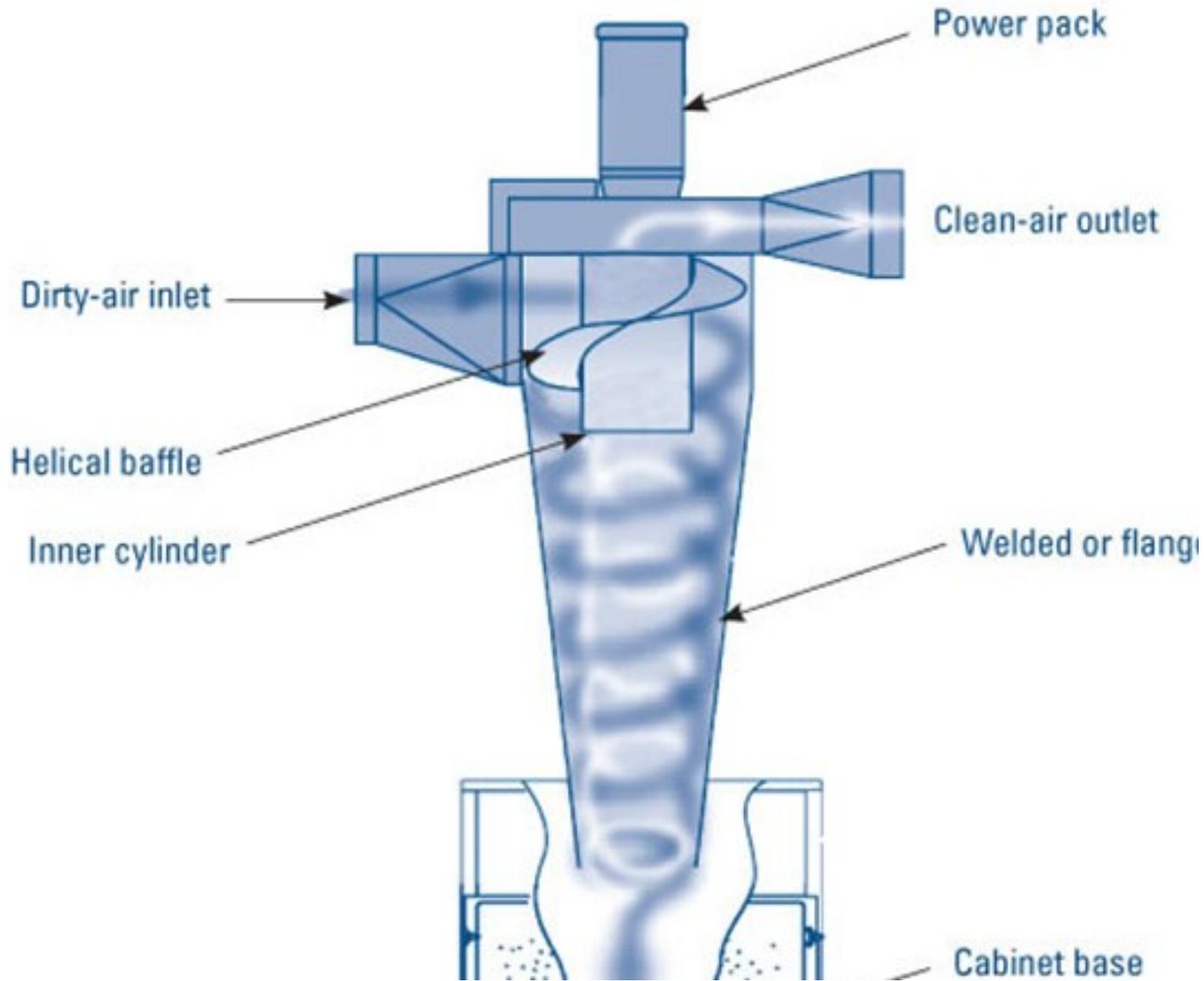
Cyclone Separator

- Centrifugation is a process that involves the use of centrifugal force for sedimentation of a heterogeneous mixture with a centrifuge. It involves removal of particulates from air, gas or a liquid stream without use of filters with a vortex separation. When removing particulates from a gaseous stream, a gas cyclone is used while a hydrocyclone is used to remove particulates from a liquid stream. This method can also be used to separate fine droplets of liquid from a gaseous stream.

Cyclone Separator

- Their efficiency is between 50-99%. Cyclone separators work best on flue gases that contain large amount of big particulate matter.
- **Advantages:**
- Cyclones are less expensive to install or maintain as they do not contain any moving parts
- It is easy to dispose particulate matter as it is collected in the dry state
- Space requirement is very less
- **Disadvantages:**
- They are not efficient in collecting particulate matter smaller than 10 microns
- They cannnot handle sticky material

Bag Filter

• In a fabric filter system, a stream of the polluted gas is made to pass through a fabric that filters out the particulate pollutant and allows the clear gas to pass through. The particulate matter is left in the form of a thin dust mat on the insides of the bag. This dust mat acts as a filtering medium for further removal of particulates increasing the efficiency of the filter bag to sieve more sub mi-cron particles (0.5 µm).

Bag Filter

- Advantages:
- Bag filter is a high quality performance instrument to effectively control particulate emissions and its efficiency is as high as 99%
- Collection efficiency is not affected by sulphur content in fuel
- It is not sensitive to particle size distribution
- It does not require high voltage
- It can be used to collect flammable dust
- Special fiber or filter aids can be used to sub-micron level smoke and fumes
- DISADVANTAGES:
- Fabric life is reduced due to presence of highly acidic or alkaline atmospheres, especially at high temperatures
- Maximum operating temperature is 500 F
- Collection of hygroscopic materials or condensation of moisture can lead to fabric plugging, loss of cleaning efficiency and large pressure losses.
- Certain dusts may require special fabric treatments to ai

Bag Filter


Compressed air

Clean air is taken away by Fan

Dusty air enters from various points through ducts

Rotary air lock
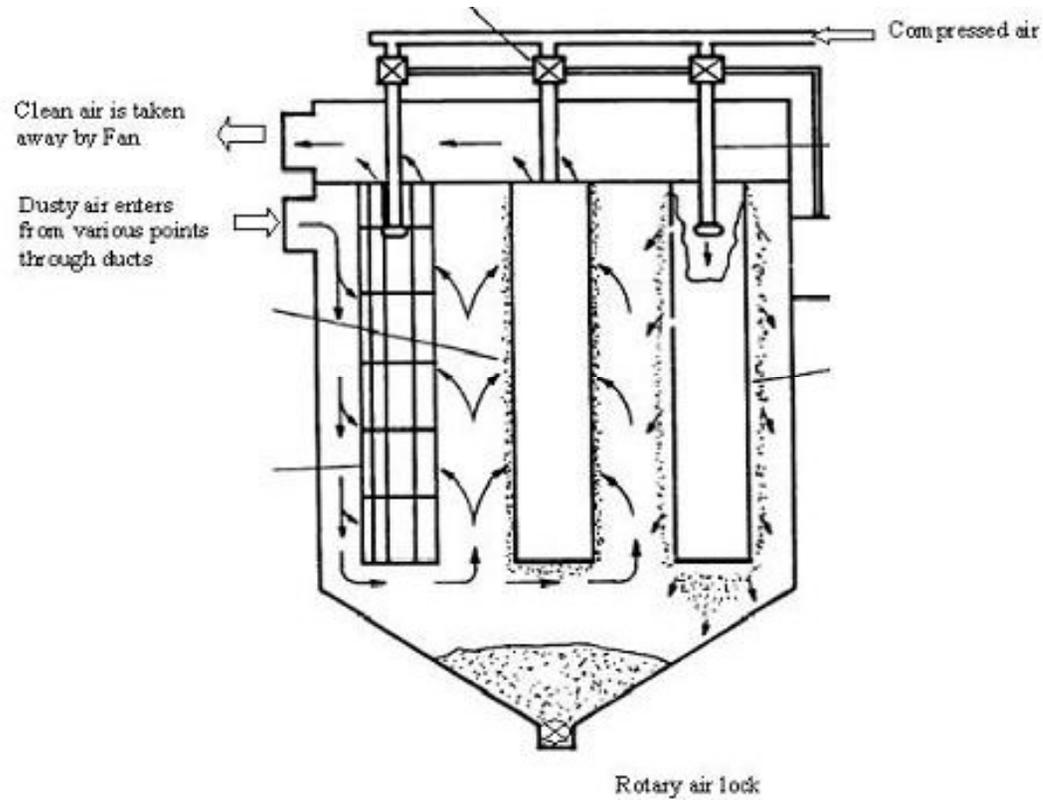
Wet Scrubber/ Spray Tower
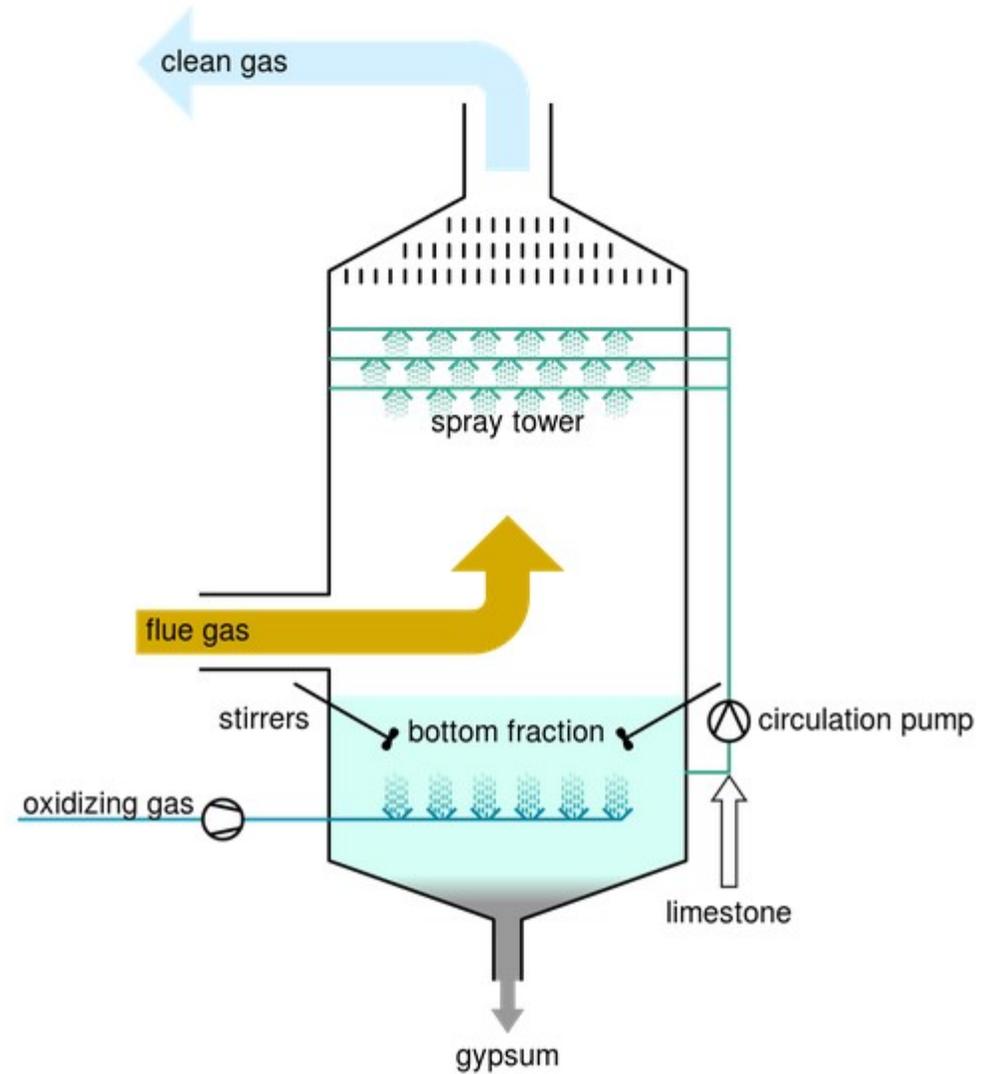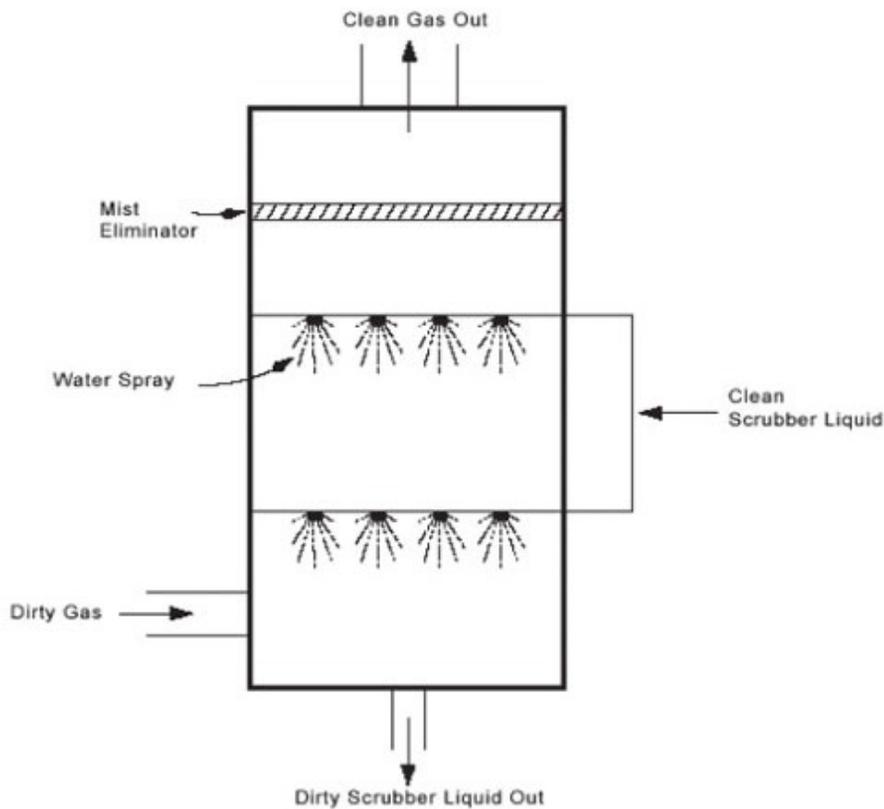
Dry Scrubber

DRY SCRUBBER

Scrubbed Exhaust Gas

Dry Granulate Absorbent In

Satura Granul Out