Environmental Pollution

Definition, types, causes, effects and control measures of

(a) Air pollution,

(b) Water pollution,

(c) Soil pollution

(d) Marine pollution

(e) Noise pollution

(f) Thermal pollution

(g) Nuclear hazards.

Pollution case studies.

Air pollution

Definition: It is defined as the presence of chemicals in the atmosphere in quantities and duration that are harmful to human health and the environment

Sources of air pollution

- Natural Source - volcanic eruptions, forest fires, biological decay,
- Man – made Source (Anthropogenic) – Thermal power plants, agricultural activities, fossile fuel combustion, vehicular emission

Types of pollutant:

A. on the basis of origin

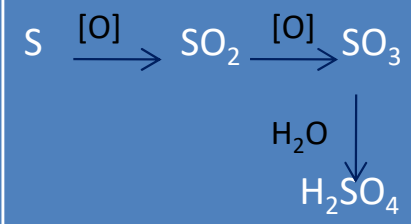
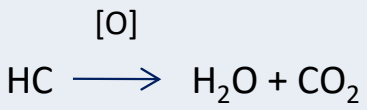
- *Primary pollutant* – these are those emitted directly in the atmosphere in harmful form like CO, NO.
- *Secondary pollutant* – these may react with one another or with the basic components of air to form new pollutants. Exa: photochemical Smog, ozone layer depletion

B. On the basis of physical state

- *Gaseous Pollutant*: in gaseous state exa: CO, CO_2, SO_2, NO_x
- *Particulate pollutant*: in finely divided solid or in liquid state. Exa: smog, dust, smoke, Pb, Hg asbestos

Common Air Pollutants

Pollutants	Nature	Sources	Effects	Controls
Carbon Monoxides	Colourless, odourless, poisonous gas $2C + O_2 \rightarrow 2CO$	i. Incomplete combustion of fuel ii. Automobile exhaust iii. Industrial emission	i. Form carboxyhaemoglobin ii. Decrease Concentration of O2 iii. Causes headaches, anemia, coma iv. Global warming	i. Modification of engine deigns ii. Fuel modification iii. Treatment of exhaust gases
Oxides of Nitrogen (NO_X) (NO, N_2O, NO_2, N_2O_3 and N_2O_5)	NO_2 + Moisture → HNO_3	•Combustion of fossil fuels •Industrial emission	i. NO_2 which reacts with water to produce HNO_3 which causes acid rain ii. Photochemical smog iii. lung irritation and bronchitis	i. Modification of engine deigns ii. Scrubbing of flue gases iii. Selective catalytic reduction iv. Treatment of exhaust gases

Oxides of Sulphur (SO_x) (SO_2, SO_3)	colourless gas with pungent smell  	•Volcanic eruption •Petroleum refining plant, copper smelting plants •Burning of fossil fuel,	i. Reduce visibility, Acid rain ii. Acid deposition on trees, soils & aquatic life iii. Breathing problems iv. Conversion to sulphate that causes damage to building, carbonate based materials	i. Use of low sulphur content fuel ii. Chemical scrubbing of exhaust gases by lime stone or by citric acid
Particulate matters (Aerosol, Dust, Mist, Smoke, Fly Ash and heavy metals)	Dispersed matter having i. Size: 0.002 to 500m Ii Density: $10^2 cm^3$ to $10^5 cm^3$	Natural : Volcanic eruption, wind, dust Man made source: burning of wood, coal, oil and	Carcinogenic in nature Affect iungs, brain, blood, kidney Respiratory diseases Corrosion Damage to soil, building, monuments Smoke, smog, heat radiation	Gravity settling chamber Cyclone separator Filters scrubbers
Hydrocarbons (HC)	Low molecular weight. Gases or volatile liquid at RT  	1. Natural: organic Matter, tree 2. Man made: motor fuel, Automobile exhaust, organic solvents	•Carcinogenic in nature •Photochemical smog	i. Incineration ii. Adsorption in carbon bed iii. Absorption iv. Condensation of hydrocarbon vapour by connecting to induction system

Photochemical Smog

Definition: Smog (*Smoke* + *fog*) is the condensation of carbon particle of smoke in fog

Types of Smog

Classical Smog (London Smog)	Photochemical smog(Los Angels Smog)
It is formed due to the condensation of carbon particle of smoke in fog	It is formed due to the photochemical reaction in air containing NO_2 and hydrocarbon
Components: carbon shoot, CO, S compound	O_3, NOx, CO, hydrocarbon
Occurrence : December- January	August- September
Time of occurrence: Early Morning	Mid-day
Chemical condition: Reductive	Oxidative
Temperature: -1 -4°C	24- 32°C
Relative Humidity: 85%	<70%
Visibility: <30 m	< 0.8-1.6 Km

Conditions required:

✓*Presence of nitrogen dioxide*
✓*Sunlight*
✓*Hydrocarbon*
✓*Temperature above 18 ° C*

Hydrocarbon + NOx + sunlight ⟶ *Photochemical Smog*

Major chemical pollutants in photochemical Smog

✓Nitrogen Oxide
✓Volatile Organic Compound (VOC)
✓Ozone (O_3)
✓Peroxyacetyl nitrate (PAN)

Chemistry of photochemical smog

$$N_2 + O_2 \rightleftharpoons 2NO$$

$$2NO + O_2 \rightleftharpoons 2NO_2$$

$$NO_2 + h\nu \xrightarrow{\text{Sunlight}} NO + O$$

$$O + O_2 \longrightarrow O_3$$

$$NO + O_3 \longrightarrow NO_2 + O_2$$

$$NO_2 + \text{UV radiation} \xrightarrow{\text{Photolysis}} NO + (O) \quad \text{...(i)}$$

$$O + O_2 \rightleftharpoons O_3 \quad \text{...(ii)}$$

Ozone so formed oxidise NO to $NO_2 + O_2$

$$NO + O_3 \longrightarrow NO_2 + O_2 \quad \text{...(iii)}$$

$$(O) + \text{Hydrocarbon} \rightarrow RCO^{\bullet} \xrightarrow{O_2} RCO_3^{\bullet}$$

$$RCO_3^{\bullet} + \text{Hydrocarbons} \rightarrow CH_2 = O,$$

ketones, etc.

$$RCO_3^{\bullet} + O_2 \longrightarrow RCO_2^{\bullet} + O_3$$

$$RCO_3^{\bullet} + NO \longrightarrow RCO_2^{\bullet} + NO_2$$

$$RCO_3^{\bullet} + NO_2 \longrightarrow RCO_3NO_2 \text{ (PAN)}$$

1½

The presence of excessive O_3, along with aldehydes ketones, PAN constitute photochemical smog.

ACID RAIN

Definition: Normal rain is slightly acidic due to CO_2 gas. The pH of the rain water is further acidic due to SO_2 & NO_2 gases. The rain water having acidic pH (<5.7) is called acid rain (acid deposition)

Formation of Acid rain:Thermal power plants, industries,& vehicles release nitrous oxide & sulphur dioxide into atmosphere. When these gases react with water vapour they form acids

i. $SO_2 + O_2 \rightarrow SO_3 + H_2O \rightarrow H_2SO_4$

ii. $NO + O_3 \rightarrow NO_2 + O_2$
$NO_2 + O_3 \rightarrow NO_3 + O_2$
$NO_2 + NO_3 \rightarrow N_2O_5$
$N_2O_5 + H_2O \rightarrow 2HNO_3$

Control measures

- Reduction of SO_2 & NO_2 emission
- Using pollution control equipments
- Replacement of coal by natural gas
- Use of Coal with lower sulphur content

Effects of acid rain

1. Acidification of water body:
✓ Death of Fish population.
✓ Increased level of toxic elements.
2. Damage to vegetation
✓ Reduces rate of photosynthesis, growth of crops
✓ Nitrogen, & phosphorous stay up in dead wastages
3. Effect on human beings:
✓ Destroy life – nervous, respiratory and digestive system
✓ Causes premature death from heart and lung disorders like asthma & bronchitis
✓ Release toxic metals (Heavy metals)
4. Damage to building and sculptiral monuments

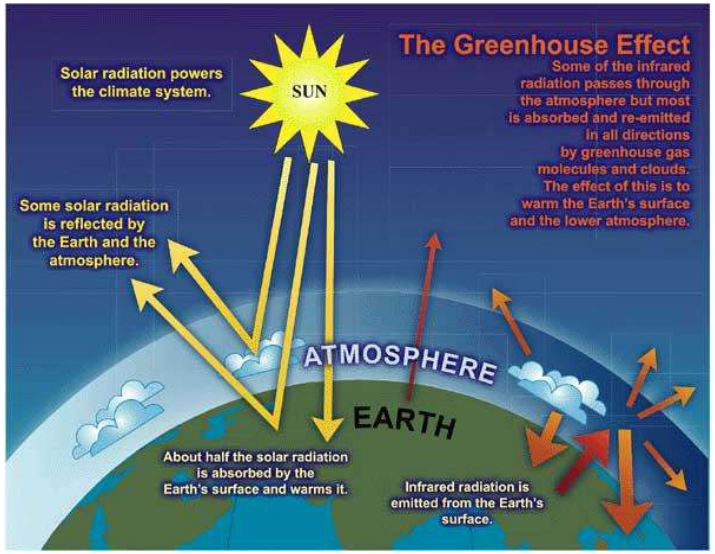
Exa:Taj Mahal in Agra suffer due to H_2SO_4 acid fumes released from Mathura refinery

$CaCO3 + H_2SO_4 \rightarrow CaSO4 + H_2O + CO_2$

GREEN HOUSE EFFECT AND GLOBAL WARMING

Definition: The rise in the temperature of earth surface due to the blanketing effect of certain gases such as man made CO2 CH4, N2O, CFCs presence in the atmosphere is green house effect. Human activities increase the green house effect & raise the atmospheric temperature & this is called global warming.

Process



Effect on global warming

1.Rise in Sea level: glacial melting & thermal expansion of ocean → raise the sea level

2.Agriculture and forestry: Climatic pattern shifts → reduced rainfall → dried soils → decrease in crop yield → drought

3.Water resources : Rainfall pattern change, → Drought & Floods

Rise in temperature → increases water demand

4.Human health: → Change in climate → frequent floods & droughts → Increase in waterborne diseases, infectious diseases

Preventive Measures of Global Warming:

✓Reducing CO_2 emission by reducing use of fossil fuels

✓Utilizing renewable resources like wind, solar, hydro power etc.

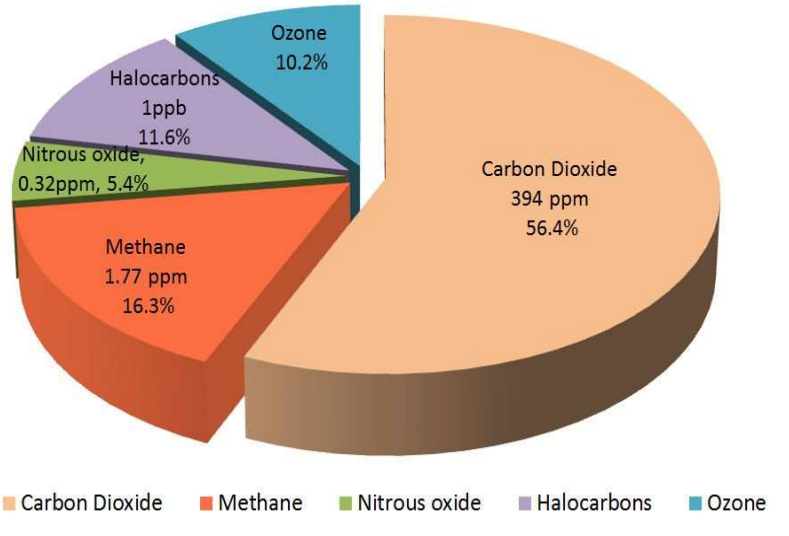
✓Reforestation and conservation of forest

✓Adopt sustainable agriculture.

✓Use natural gas instead of coal

✓Remove CO_2 by photosynthetic algae

✓Reduction and replacement of CFC



OZONE LAYER AND ITS DEPLETION

Ozone gas O_3 is formed in the stratosphere by photo - chemical reaction.

It protects us from the Ultraviolet radiation of the sun

Recent evidence shown that ozone layer is becoming thinner & holes have developed

Ozone depleting chemicals

- Chloro Fluro carbon (CFC): Used in refrigerators, propellent, spray cans, blowing agent, foam agent
- Hydro chloro fluoro carbon (HCFC): Used in refrigerants, blowing agents
- Bromo fluoroCarbon (BFC): Used in fire extinguisher

Formation of Ozone:

$O_2 + h\nu \rightarrow O\bullet + O\bullet$ [Ozone is formed by photochemical reaction]

$O\bullet + O_2 + M \rightarrow O_3 + M$ [atomic oxygen reacts with molecular oxygen to form ozone, M = third body like N_2 or O_2]

$O_3 + h\nu \rightarrow O_2 + O\bullet$

Mechanism of Ozone layer depletion:

A. Chloroflouro carbon (CFC):

i. Freon- 11: $CFCl_3 + h\nu \rightarrow Cl + CFCl_2$

ii. Freon- 12: $CF_2Cl_2 + h\nu \rightarrow Cl + CF_2Cl$

$CF_2Cl + O_2 \rightarrow CF_2O + ClO$

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + O \rightarrow Cl + O_2$

B. Nitric oxide:

$NO + O_3 \rightarrow NO_2 + O_2$

$NO_2 + O \rightarrow NO + O_2$

$O_3 + h\nu \rightarrow O_2 + O$

iii. Hydroxy radicals:

$O_3 + OH\bullet \rightarrow O_2 + OOH\bullet$

$OOH\bullet + O \rightarrow O_2 + OH\bullet$

Effects

- *On human health* – Skin cancer, Non melanine skin cancer, slow blindness called keratitis,cataracts, Allergies, reduces human resistivity, infectious diseases etc.
- *On plant & aquatic systems*- impair growth of plants and animals
- *On materials*- Degradation of paints, plastics, & other polymeric material result in economic loss.
- *On climate* – being green house gas, it causes global warming

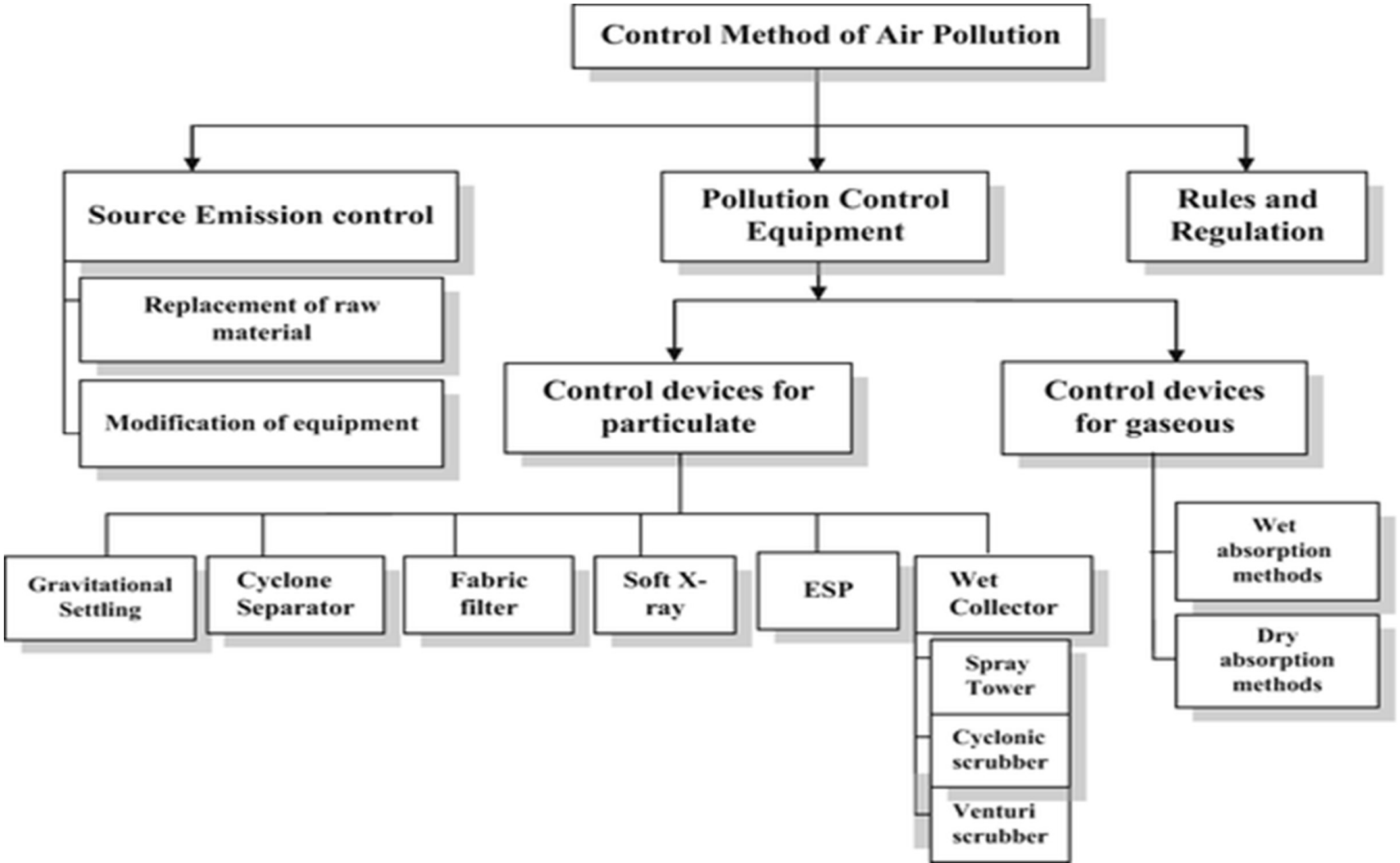
Control measures

✓Replacing CFCs by less damaging materials such as hydrochloroflouro carbon (HCFC)

✓Use of methyl bromide – crop fumigant should be controlled

✓Manufacturing & using of ozone depleting chemicals should be stopped.

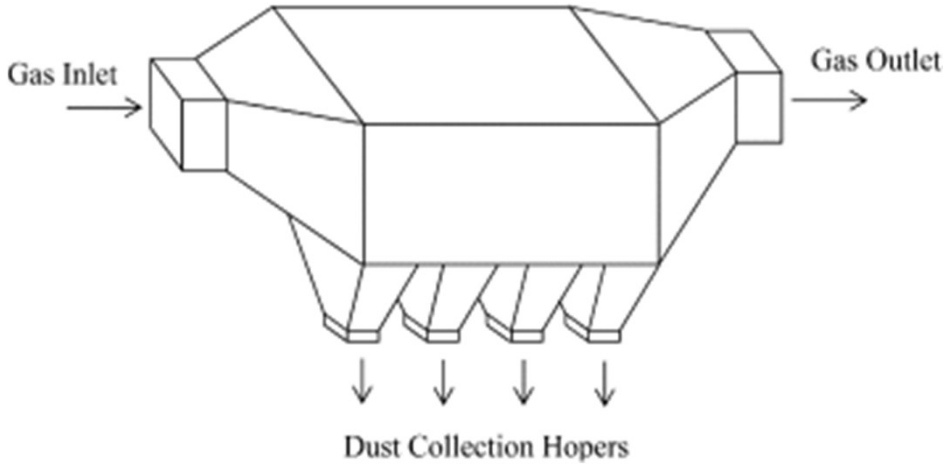
Control of Air pollution



Pollution Control Devices

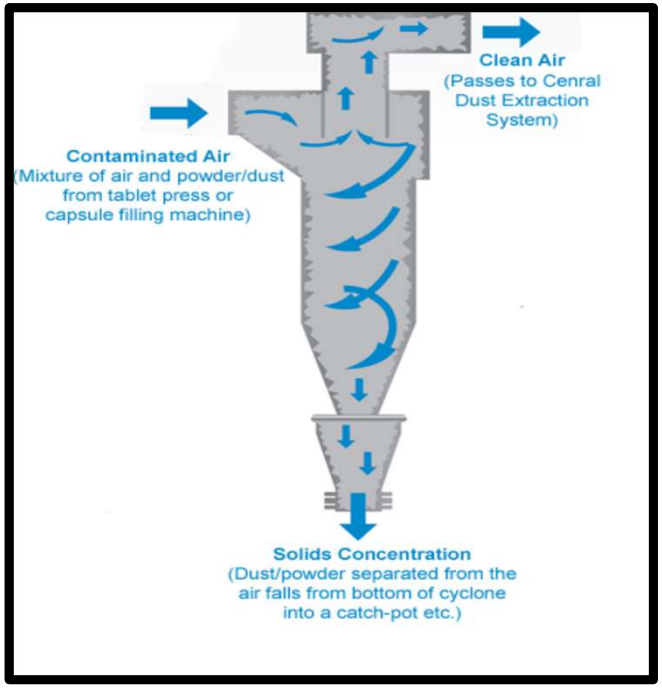
Gravity Settling Chambers

- Used to remove particle size >50µm
- Velocity of polluted air/ flue gas reduced in large chamber
- Particle settled under gravitational force
- Particle settled by its own weight by lowering the velocity of incoming air

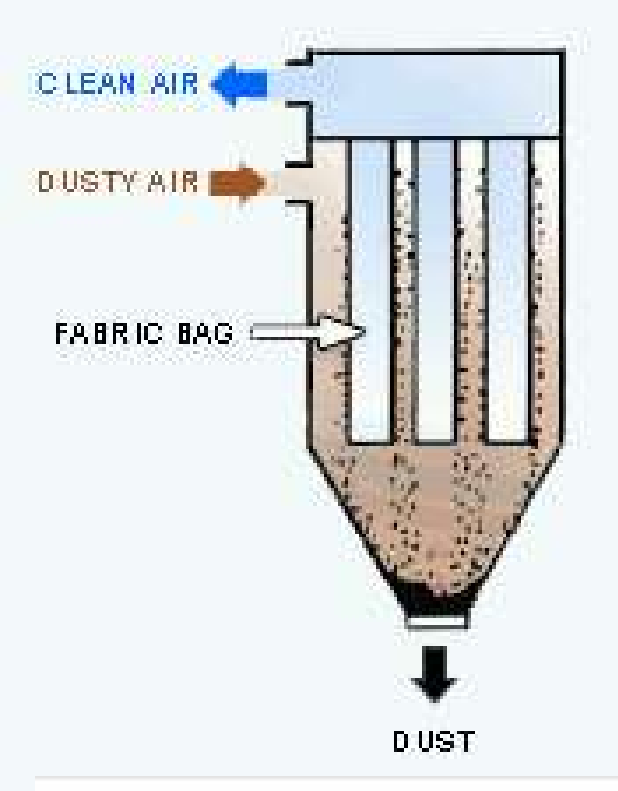


Cyclone Separator

- Gas containing particulate is allowed to flow into a tight circular spiral fitted chamber
- Particle move towards the wall of chamber due to centrifugal force
- Particle settled down due to force of gravity
- Used in power plant and industries dealing with rock products

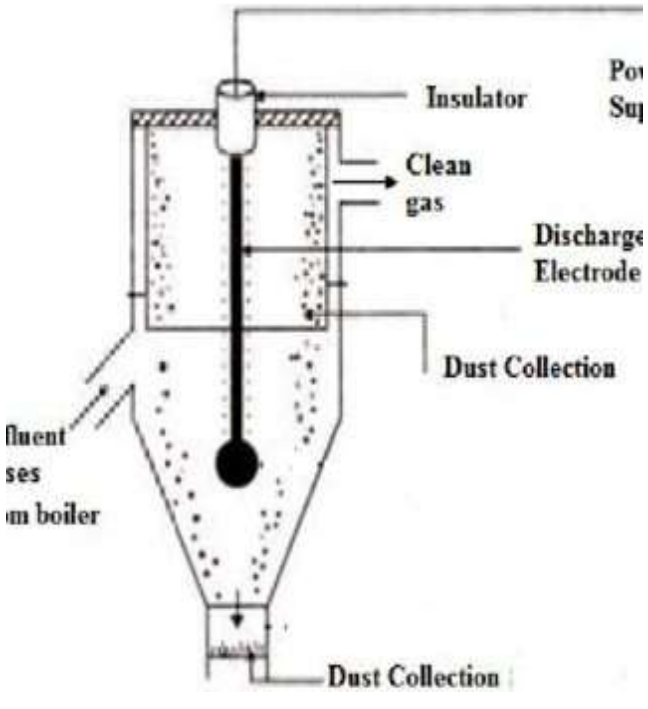


Bag House Filter



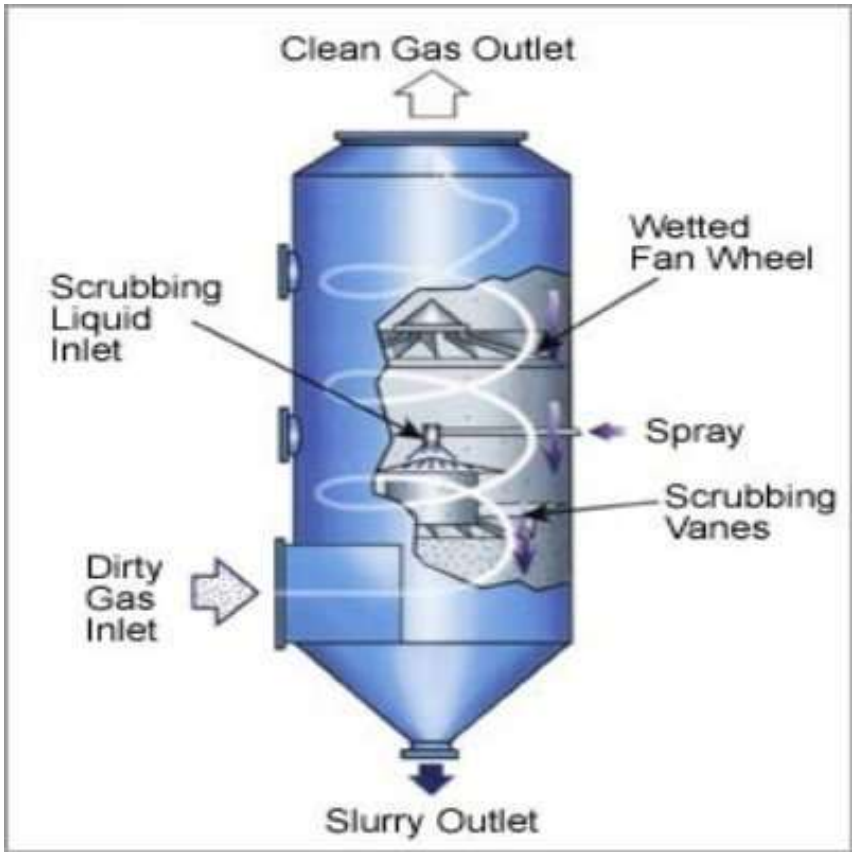
- Used for removal of very small particle
- Exhaust gas forced to pass through very fine mesh fabric
- Fabrics are generally made up of cotton, wool, nylon, dacron
- Particles filtered out throgh different layer of fabric bags
- Used in power plant and industries dealing with rock products

Electrostatic Precipitator



- Most efficient device for controlling particulate emissions
- Exhaust gas charged electrically and separated from the gas stream under the influence of electric field
- Used in power plant and industries like steel, chemical, pulp and paper
- Efficiency of ESP is 97.6% and it is capable of cleaning 150000lt of gas/min at 600°C

Wet Scrubbers



- Natural cleaning mechanism
- Exhaust gas passed through a fine spring/ spray of water
- Effective size of particle increased due to water particulate agglomerates
- Then separated from gas stream

Controlling of Gasesous Pollutant

- Combustion: converted organic pollutant into water vapour, CO_2
- Absorption/ Adsorption: passing effluents through scrubbers or absorbers/ suitable solvents
    - Wet scrubbing: main solvents are NaOH, Na_2SO_3, NH_4HCO_3, $Ca(OH)_2$
    - Dry scrubbing: Activated Charcoal

Carbon dioxide sequestration

- Also known as “carbon capture”
- A geoengineering technique for the long-term storage of carbon dioxide (or other forms of carbon) for the mitigation of global warming
- Long-term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of carbon dioxide (the principal greenhouse gas) concentration in the atmosphere will be reduced

- More than 33 billion tons of carbon emissions (annual worldwide)
- Ways that carbon can be stored (sequestered):
  - In plants and soil “terrestrial sequestration” (“carbon sinks”)
  - Underground “geological sequestration”
  - Deep in ocean “ocean sequestration”
  - As a solid material (still in development)

Terrestrial Carbon Sequestration/ Bio sequestration

The process through which CO2 from the atmosphere is absorbed naturally through photosynthesis & stored as carbon in biomass & soils.

Ways to reduce greenhouse gases:

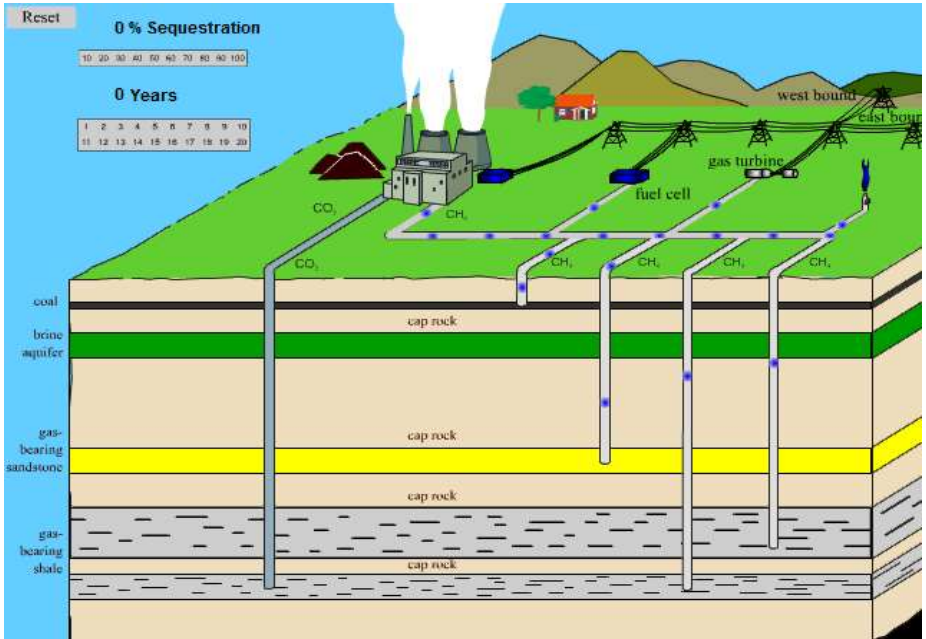
- avoiding emissions by maintaining existing carbon storage in trees and soils
- increasing carbon storage by tree planting or conversion from conventional to conservation tillage practices on agricultural lands
- Biosequestration involves platation of biodiesel crops such as jatropha curcas, algae species

Geological Sequestration

Storing of CO2 underground in rock formations able to retain large amounts of CO2 over a long time period

Declining oil field, saline aquifierand unminable coal seams used as storage site

Held in small pore spaces (have held oil and nat. gas for millions of years)



Ocean Sequestration

"Carbon is naturally stored in the ocean via two pumps, solubility and biological, and there are analogous man-made methods, direct injection and ocean fertilization, respectively. Eventually equilibrium between the ocean and the atmosphere will be reached with or without human intervention and 80% of the carbon will remain in the ocean. The same equilibrium will be reached whether the carbon is injected into the atmosphere or the ocean. The rational behind ocean sequestration is simply to speed up the natural process."

- **Carbon sequestration by direct injection into the deep ocean involves the capture, separation, transport, and injection of CO2 from land or tankers**
- **1/3 of CO2 emitted a year already enters the ocean**
- **Ocean has 50 times more carbon than the atmosphere**

Effects of Air Pollution

Air Pollution affects???

- Human health
- Animals
- Plants
- Materials
- Environment

Effect on Human health

- Main problems are related to Respiratory Track - Asthma, hay fever, and other allergic diseases.
- Irritation of the eye, nose and throat. In severe cases there may be headaches, nausea, and loss of coordination.
- Prolonged exposure can cause damage to the nervous system, digestive problems, and in some cases cause Lung cancer.
- It lowers our resistance to colds and pneumonia.
- CO has affinity towards Hb which cause disturbance in transportation of Oxygen, impairing our concentration, slow our reflexes, and make us confused and sleepy.
- SO_2 in the air leads to diseases of the lung and other lung disorders such as wheezing and shortness of breath.
- Chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys.
- Effects of Arsenic, Asbestos, Mercury , Benzene etc.

Effect on Plants

- Pollutants enter through stomata
- Destroy chlorophyll and Affect photosynthesis
- Cuticle(Wax Layer on Leaves) is lost
- Necrosis – Damage to Leaf Structure
- Chlorosis - Loss/ reduction of Chlorophyll
- Abscission - Dropping of leaf
- Epinasty – Downward curling of Leaf
- DEATH

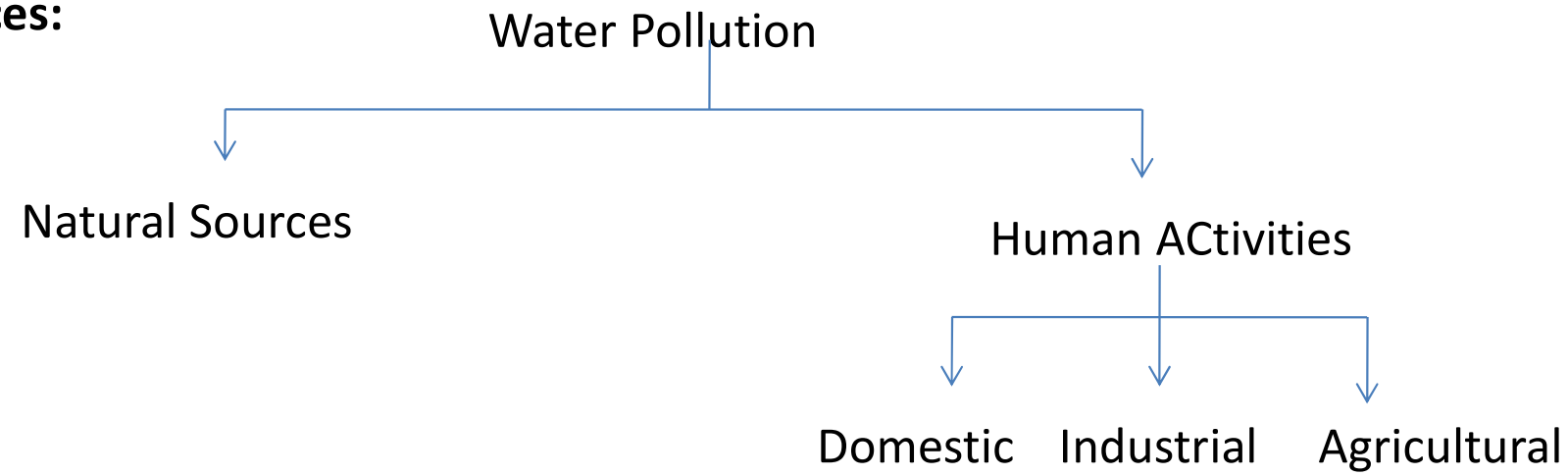
Effect on Animals and materials

- Corrosion of metal surfaces, fading
- SO_2 & water form H_2S – corrosion as well as disfigurement of statues made up of limestone or Marble
- Air pollutants mix with rain water and increase acidity (Acid Rain) of water body and kill fish.
- Ozone causes crackling of rubber

Water Pollution

Definition: water pollution is defined as the deterioration of physical, chemical and biological properties of water that causes harmful effect on human and aquatic lifes

Sources:



Characteristics of Waste Water

➢*Dissolve Oxygen*: It is the amount of oxygen dissolved in a given quantity of water at a particular pressure & temperature. It is determined by oxidation of KI i.e by iodometric titration.

- Biological oxygen demand (BOD): = It is the amount of oxygen required by micro-organism to oxidize the organic waste aerobically present in the water
- Chemical oxygen demand (COD): = It is the amount of oxygen required for chemical oxidation of organic matter using oxidizing agent like $K_2Cr_2O_7$ & $KMnO_4$

➢*Dissolve CO_2 :*

Source: atmosphere, decay of organic matters

Methods of determination: Acid-base titration using phenolpthalein as indicator

➢*Free Chlorine:*

Source: chlorine or hypochlorite used as disinfectant

Methods of determination: Iodometric titration (Redox titration)

➢*Dissolve chlorides:*

Source: industrial effluents, irrigation drainage, marine sedimentary deposite

Methods of determination: Argentometric titration

➢*Total dissolve solids:*

Source: minerals, organic substances

Methods of determination: TDS meter, gravimetrical calculation

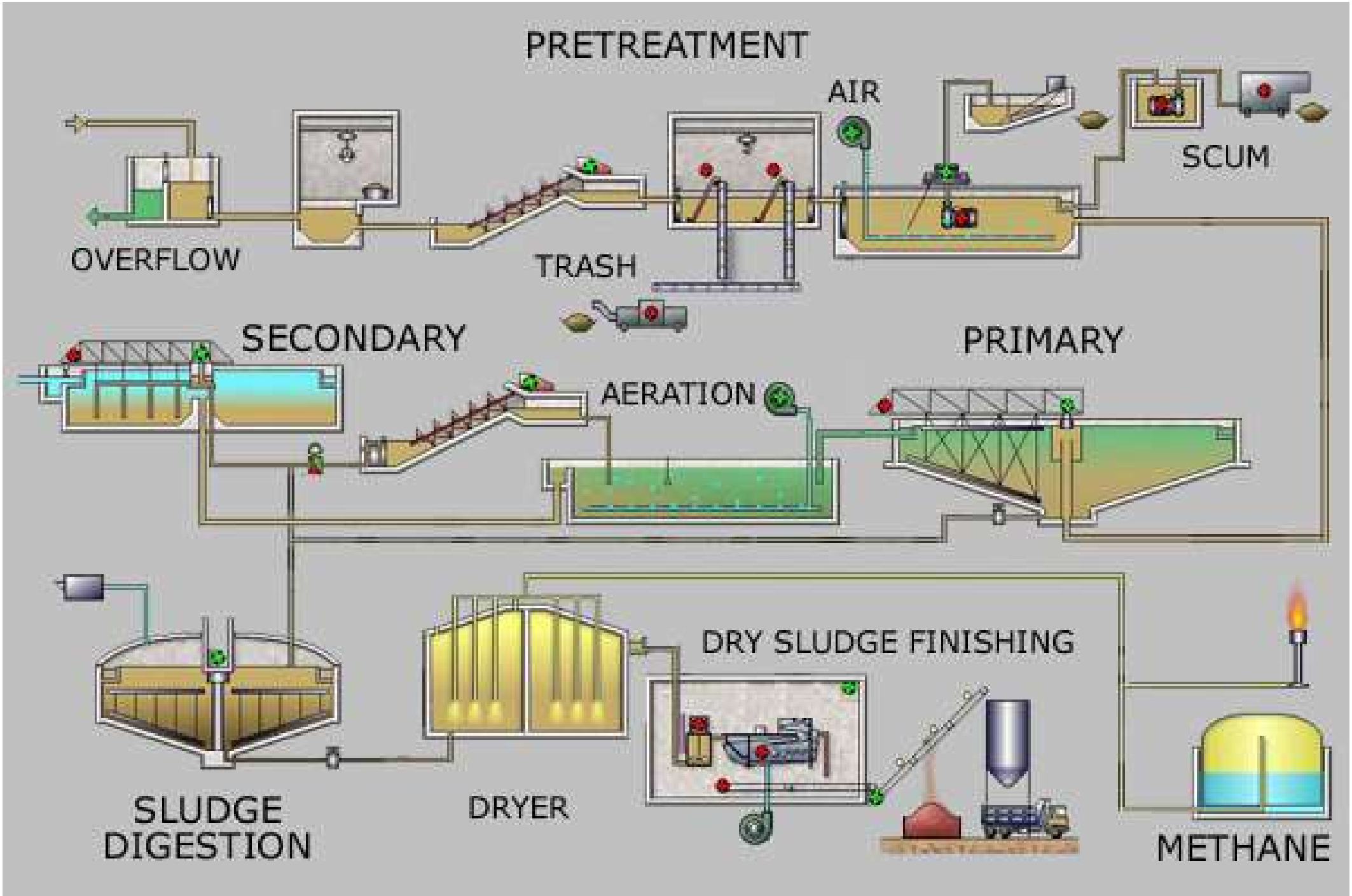
Classification of water pollutants

Type of pollutant	Agents	Major sources	Effect
Oxygen demanding waste	Micro-organism (algae) ,oxygen demanding waste	Effluents from food processing industry, Municipal waste water, industrial waste,	Reduction in dissolve oxygen (DO) level (minimum DO level should 5ppm)
Pathogens	Bacteria (E coli), fungi, protozoa or virus	Sewage, industrial waste (exa: tanning and wheat packaging)	Water borne disease: cholera, dysentry, typhoid, hepatitis Water contact disease:Schistosomiasis
Synthetic Organic compounds	Pesticides, organic chemicals, detergents	Agricultural land runoff, domestic and industrial effluents discharge	Pesticides: very persistent in earth, carcinogenic, toxic to human being and animals Detergents: lowers the surface tension of water, causes foaming, reduce rate of oxygen absorption which causes asphyxia in aquatic animals

Plant nutrients	Nitrogen, phosphorous, sulphur, calcium, potassium	Municipal waste water, industrial waste, fertilized land runoff	Eutrophication, nitrate ions causes blue baby syndrome
Inorganic chemicals and minerals	Inorganic salts, mineral acids, metals and its compound, heavy metals, trace elements, organo-metallic compounds	Municipal waste water, industrial waste, mines runoff	Increase acidity of natural water, hardness of water, scale and sludge, health hazards to human and aquatic life
Sediments	Soil, sand, mineral particle	Soil erosion, soil deposition	Siltation, hindrance in photosynthesis, increase turbidity, decrease in oxygen liberation
Radioactive substances	Uranium, thorium, radium, bismuth	Mining of radioactive elements, nuclear power plant discharge, leakage , use of radio isotopes in medicine, industry	Genetic disasters, cancer, leukemia

Thermal discharge	Heat	Coolant water discharge in cooling towers of power plants such as coal, hydro, nuclear, chemical waste from industry	Decrease dissolve oxygen, increase in temperature affect aquatic life, increase toxicity of chemical pollutant
Oil	Petrochemicals oils, petrol, diesel, crude oil	Industrial effluent, oil refineries, automobile waste oil, petrochemicals plants	Prevent diffusion of oxygen, affect photosynthesis, reduced dissolve oxygen
Volatile organic compounds	Hydrocarbons such as vinyl chloride, CCl4, dichloro ethane	Paint industry, chemicals manufacturing industry, solvents	Toxic, carcinogenic

Waste water Treatment processes



Waste water treatment processes

Primary Treatment
(Physical Process)

✓ Removal of suspended and floating materials

Secondary Treatment
(Biological Process)

✓Removal of Organic matters

Tertiary Treatment
(physical, chemical and biological Process)

✓Removal of the impurities, suspended solid, bacteria, nutrients

Primary Treatments

- Removal of organic and inorganic solids .
- Removed approximately 25 to 50% of the incoming biochemical oxygen demand (BOD_5), 50 to 70% of the total suspended solids (SS), and 65% of the oil and grease .
- Removal of some organic nitrogen, organic phosphorus, and heavy metals associated with solids

Pre-Primary Treatment

Sedimentation Treatment

Pre-primary treatment: removal of large floating objects

Collection of waste water to a tank → Screening chamber: consist of screen of steel bars, wire screen. Remove large floating objects. Exa: paper, wood, plastic bottles → Grit Chamber: settling of sand, grits, other heavy materials → Sedimentation tank

Communicator: grinding of coarse material to small pieces

Sedimentation: Removal of finely divide solids by reducing the velocity and allowing them to settle down

Sedimentation tank / clarifiers:

Round or rectangular basins, typically 3 to 5 m deep, with hydraulic retention time between 2 and 3 hours.

➢Remove 50-90% solid matters with 40% organic matters

Sedimentation aid: to help in settling down the finely divided particles

mechanical flocculation: sedimentation tank fitted with rotating paddle (Speed= 0.43m/s) which helps in coalesce of finer particles to large particle

Chemical coagulation: addition of coagulants sometimes with coagulant aids

Exa: alum, ferric chloride, activated silica polyelectrolyte, high mol wt polymer

Equalization: mixing of effluents collected from different sources to produce homogeneous equalized effluents

Neutralization:

neutralization of waste water by addition of acid or alkali

Acid waste neutralized by lime stone

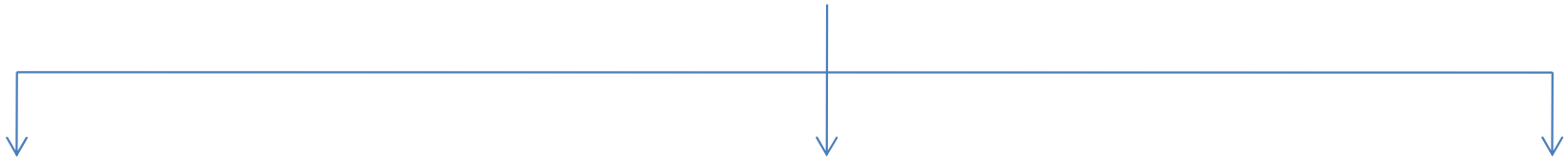
Alkaline waste neutralized by H_2SO_4 or CO_2

Sludge Disposal digesters

Secondary Treatment

➢ Removal of organic matter the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes

➢Remove ~85% of BOD and solids



Trickling Filter(Aerobic filtration)

Activated Sludge method

Oxidation Ponds (Lagoons)

Trickling Filters:

Spray of waste water by rotating arm on rock bed of 1-3m deep with enough space between coarse rocks

Rock bed is coated with a layer of biological slime or gelatinous materials containing aerobic microorganism (Bacteria, fungi, protozoa). This is collectively called ad ZOOGLEA

Diffusion of oxygen and organic matters from waste water into the slime layer

Aerobic Decomposition of organic matters by microorganism with evolution of CO_2, NO_3 etc

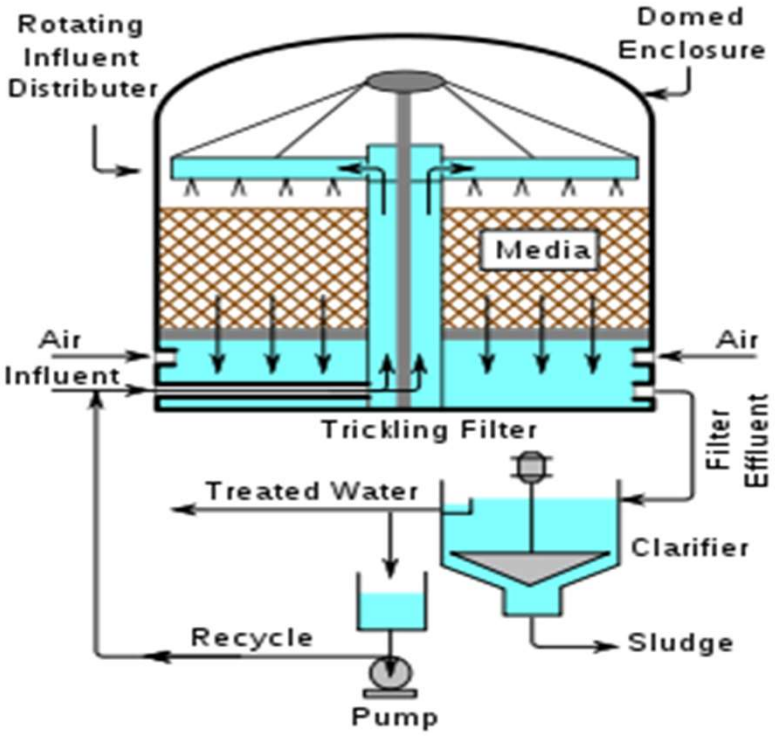
Increse in thickness of slime layer during decomposition (humus) and finally detached from the surface and carried away with effluent

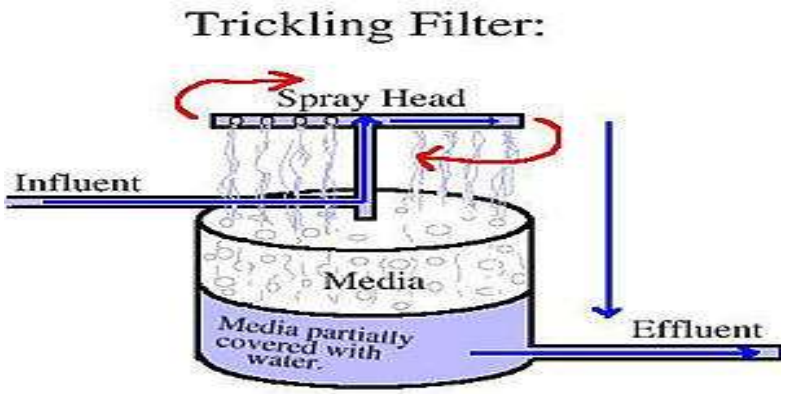
Slimy layer (Sludge)

Sludge digesters

Treated water

Sedimentation Tank





Advantages:

✓Simple to operate
✓Remove 65-85% BOD
✓Better quality effluents
✓No constant monitoring

Disadvantages:

✓Microbial film is sensitive to temperature
✓Efficiency of filter depends on composition of waste, pH, oxygen supply
✓High construction cost

Activated Sludge method

Salient features:

- Versatile biological oxidation method
- Useful for removal of dissolve solids, coarse solid and organic matters
- Use of Activated sludge which contains active micro-organism and obtained by settling the sewage in presence of excess oxygen

Process:

Waste water after primary treatment

↓

Aeration Tank containing previously prepared activated sludge (20-30%) and aerated and mixed for 4-8h. The waste water referred as mixed liquor

↓

Oxidation of organic matter present in waste water by micro-organism (0.1mm) which promotes coagulation and flocculation

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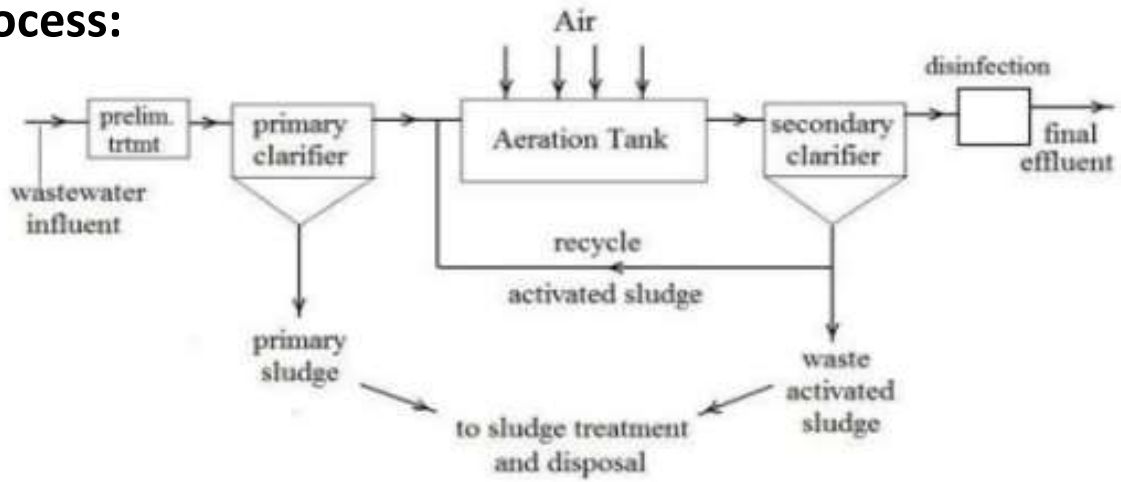
Settling of mixed liquor in settling tank where solid bacterial mass (Sludge) is separated from liquid

↓

A part of sludge reintroduces in treatment process and rest digested in sludge digester



Activated Sludge Wastewater Treatment Flow Diagram

Advantages:

- ✓Less expensive and Less area required
- ✓The effluent after treatment is free from bad smell and odour
- ✓Good quality effluent BOD reduced to <20mg/ L

Disdvantages:

- ✓Minimum 0.5 ppm of oxygen is required throughout the process
- ✓Optimum pH range is 6.5-9
- ✓Low temperature slow down the rate of metabolism while high temperature increases it
- ✓At High temperature, consumption of oxygen is fast leading to anaerobic condition
- ✓Huge amount of sludge is produced
- ✓Presence of non-biodegradable detergent makes the process difficult

Oxidation Ponds(Lagoons)

Salient features:

- oxidation ponds are large, shallow ponds designed to treat waste water through interaction of sunlight, bacteria and algae
- Algae produce O_2 during photosynthesis in presence of sunlight
- Use of this O_2 by aerobic bacteria to decompose organic matters in waste water

Process:

Waste water enter the large shallow pond (1-2m deep) at one end

↓

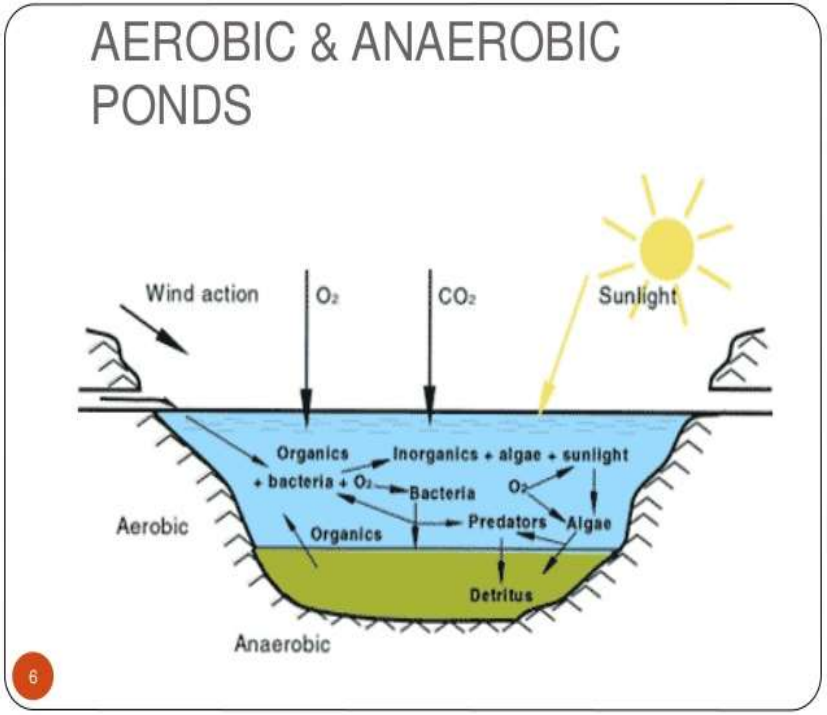
Oxidation of the organic matter by the microorganism present in the pond such as psuedmonas, flavo bacterium.

↓

At the surface of the pond the degradation is aerobic whereas at the bottom it is anaerobic. Such ponds having mixed aerobic and anaerobic conditions are called facultative ponds

↓

Treated water collected at another end of the pond



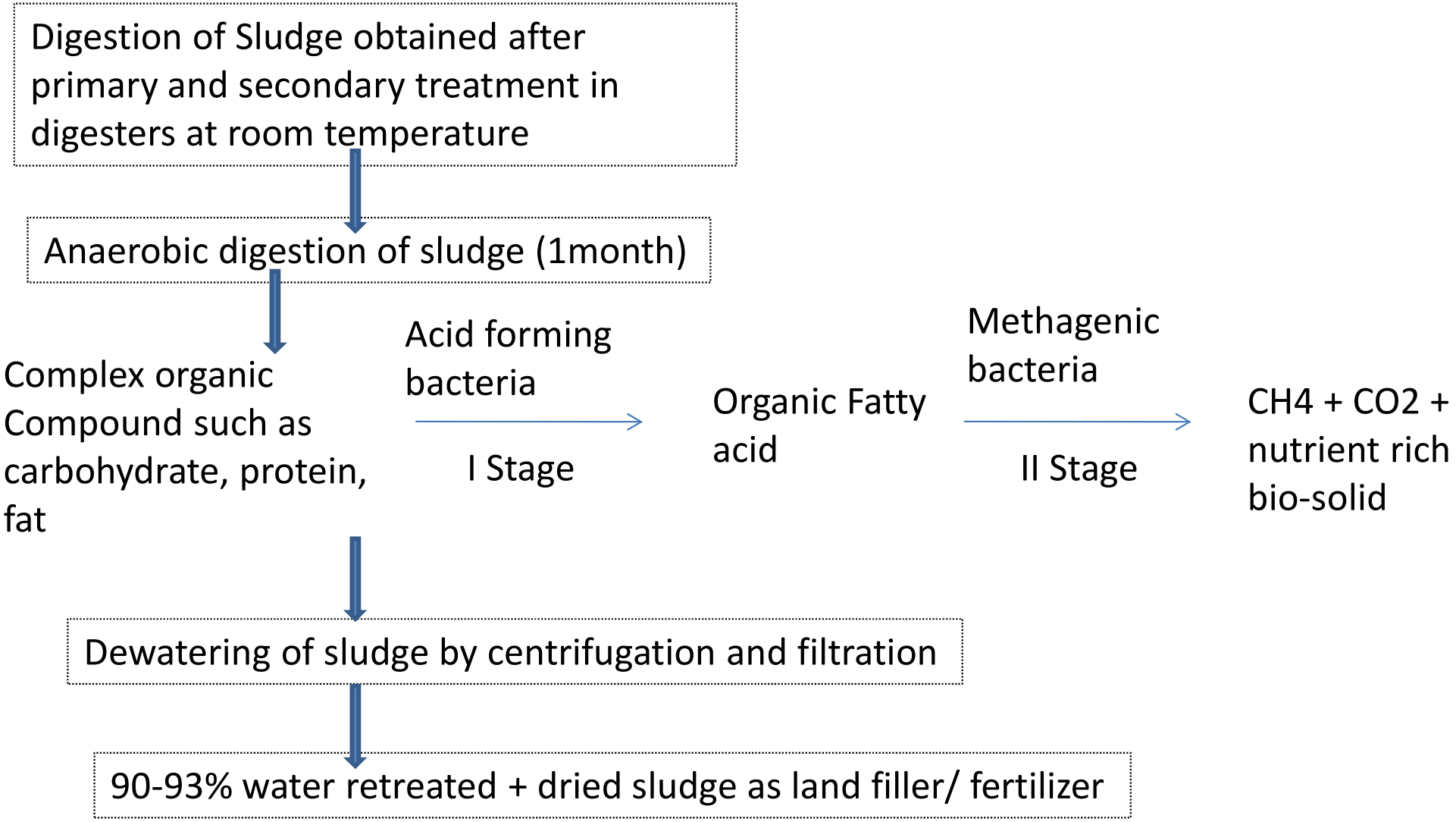
Advantages

- Simple and cheap process
- Used for all type of waste water
- Removal of heavy metals from waste water

Disdvantages

- Require large space
- Anaerobic condition may lead to bad odour

Sludge treatment and disposal

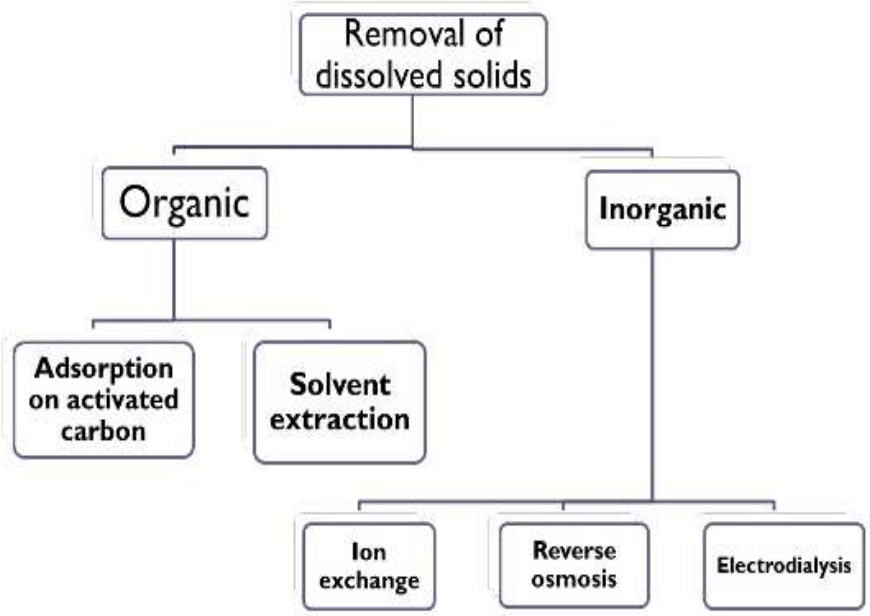


Tertiary (Advanced)Treatment of water

Tertiary treatment is the final cleaning process that improves wastewater quality before it is reused, recycled or discharged to the environment. This process remove up to 99 percent of the impurities from the wastewater. This process removes

- Suspended solid
- Bacteria
- Dissolved organic solids
- Toxic substances
- Nutrients (Nitrogen and Phosphorous)

1. **Removal of suspended solids:** (Microstaining): Treated water passed through a finely woven stainless steel fabric
2. **Removal of dissolved solids:**



3. Removal of Nutrients:

Nitrogen and phosphorus are usually found in high concentration in wastewater and this, if untreated and released into the natural water environment, can cause excessive growth, consequent death (due to nutrient and space limitation) and eventual decomposition of algae. As the dead algae due to bacterial action, the amount of oxygen becomes much less than is necessary for other aquatic life to survive.

Nitrogen Removal:

- Ammonia striping: $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$
- Nitrification : $NH_4^+ + O_2 \rightarrow NO_3^- + 2H^+ + H_2O$

Phosphorus removal

Chemical precipitation : $Al_2SO_4 + 2PO_4^{3-} \rightarrow 2AlPO_4 + 3SO_4^{2-}$

PRETREATMENT	PRIMARY TREATMENT	SECONDARY TREATMENT	TERTIARY TREATMENT
Pretreatment function is to provide protection to waste water treatment plant.	The purpose of this treatment is to remove the settled or floating particles.	The purpose of this treatment is to remove the soluble BOD_5 that escaped from the primary treatment. It also removes suspended solids.	The purpose of this treatment is to provide chemical treatment and filtration.
The processes involve in pretreatment includes: Bar rack, grit chamber, equalization basin.	Primary treatment includes all the processes involved in pretreatment and additionally primary settling tank.	Biological processes are involved which are performed by secondary settling tanks.	Tertiary waste treatment and land treatment systems are involved in this treatment.
Equalization step is less important compared to other steps. Hence, it can be eliminated at times.	This step removes about 60% of suspended solids and 35% of BOD_5. However, it cannot separate soluble pollutants.	This step removes more than 85% of BOD_5. However, nitrogen, phosphorous, and some heavy metals cannot be removed.	This step removes 99% of BOD_5, phosphorous, suspended solids and bacteria. It also removes 95% of nitrogen.