- POLLUTION: introduction of contaminants into the environment that cause harm or discomfort to humans or other living organisms or “that damages the environment which can come in the form of chemical substances or energy such as noise,heat or light.”

- ENVIRONMENTAL POLLUTION:
- “The contamination of physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected.”

TYPES OF ENVIRONMENTAL POLLUTION

- 1) Air pollution
- 2) Water pollution
- 3) Noise pollution
- 4) Thermal pollution
- 5) Soil / land pollution
- 6) Radioactive pollution

AIR POLLUTION

- Air Pollution is an atmospheric condition in which certain substances like gases , particulate matter , radioactive substances etc are present in concentrations which can cause undesirable effects on human environment.
- SOURCES: dust of drugs produced during milling and seiving.

Classification of Air Pollutants

- Primary Pollutants: CO, CO_2, NO_2, SO_2, volatile organic compounds(hydrocarbons), and suspended, particulate matter.
- Secondary Pollutants: sulfuric acid, nitric acid, carbonic acid.

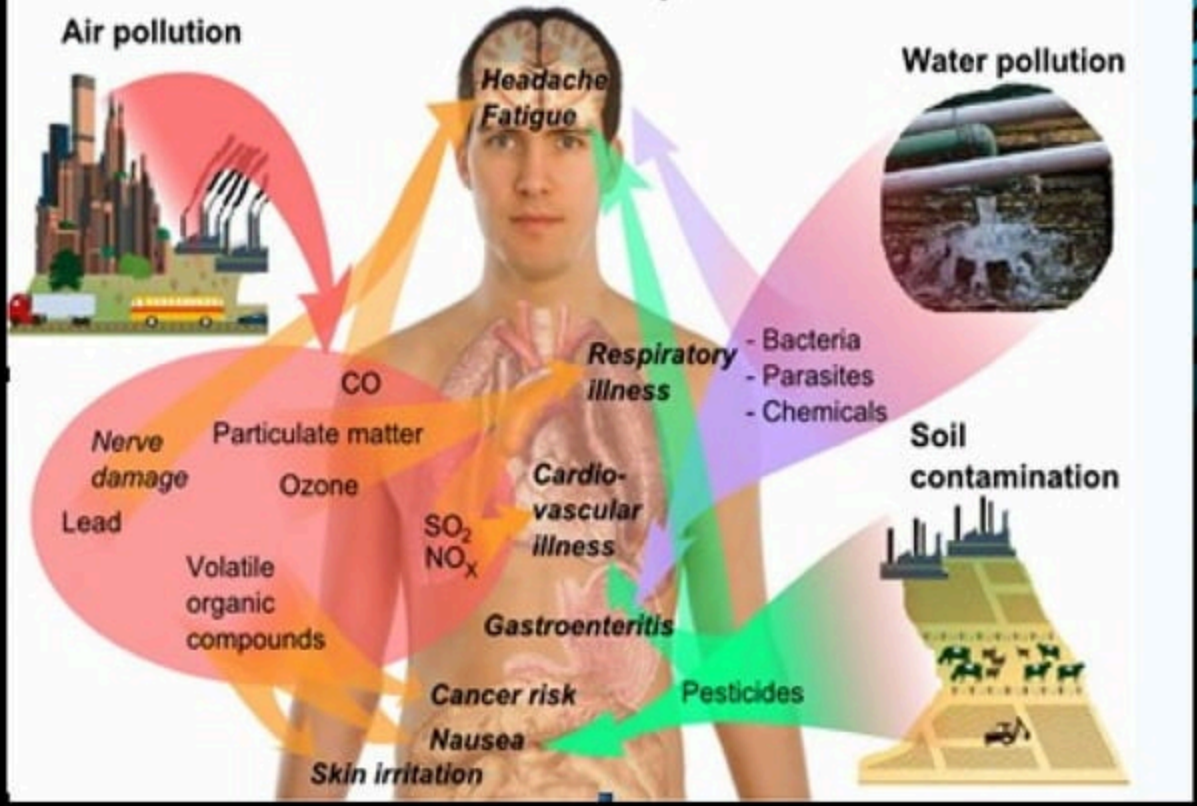
NATURE OF AIR POLLUTION

- The pollutants present in the air should be identified and categorised so that appropriate measures can be adopted to combat pollution.
- Solid matter: light,fine and coarse particles,hydrocarbons,aromatics.
- Liquid substances: smoke, soot, fly-ash, dust, mist, fumes, organic acids, inorganic acids
- Gases: sulfur dioxide,nitrogen oxide, carbon dioxide.

ADVERSE EFFECTS OF AIR POLLUTION

1) Health problems: optic irritation(PAN), bronchitis, lung carcinoma, change in blood chemistry,skin cancer, etc in human beings.
2) Livestock damage: injury n death due to arsenic metals and fluorides.
3) Agriculture damage: leaf damage, stunting of growth, decreased size and less yield of fruit and destruction of flowers
4) Material damage: damage of structural metals, surface coatings, fabrics,weathering of stone in buildings and monuments
5) Effect on climate: increase in carbondioxide enhances the temperature of the earth melting polar ice caps and glaciers.

Health effects of pollution



AIR POLLUTION CONTROL

- Air pollution can be controlled by two fundamental ways.

1) Preventive technique:

- It includes use of devices for removal of pollutants from exhaust gases e.g. Scrubbers, dry and wet collectors, filters, electrostatic precipitators etc.
- Building of higher stake facility for discharging of pollution into air.

2) Effluents control:

- Substitution of raw-materials causing more pollution with that of less pollution causing materials.
- Use of non-conventional fuels like; Gobar gas, Biogas, CNG and LPG must be prepared and encouraged

AIR POLLUTION CONTROL

TYPE OF POLLUTANT	NATURE OF DEVICE /MECHANISM	EXAMPLES OF DEVICES
Particulate matter(coarse or fine)	Low-energy units(gravitational effect, centrifugal action)	Settling chambers, cyclone separators and spray chambers
Intermediate sized particles	Low energy units	Impingement separators and wet scrubbers
Sub-micron particles	High energy units	Bag filters,electrostatic precipitators and venturi scrubbers
Gaseous pollutants	Absorption,adsorption, condensation,incineration	Filters,adsorbers and absorbers

AIR POLLUTION CONTROL DEVICES

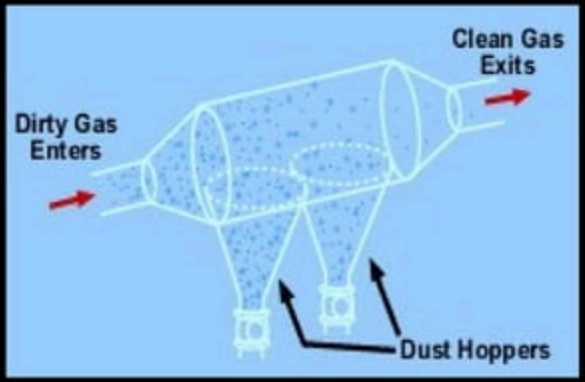
- Dust collectors: it consists of a blower, dust filter, filter cleaning system & dust removal system.

Different types of dust collectors :

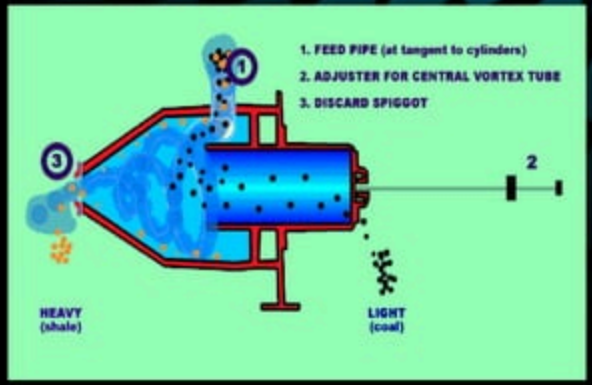
1. Mechanical collectors -Gravity settling chamber, cyclone separator
2. Electrostatic precipitators
3. Filters- HEPA Filters, unwoven fabric air filters.
4. scrubbers – wet scrubbers, dry scrubbers, venturi scrubbers
5. Absorbers- special type of wet scrubbers.
6. Adsorbers- activated carbon, activated alumina, silica gel

MECHANICAL SEPARATORS

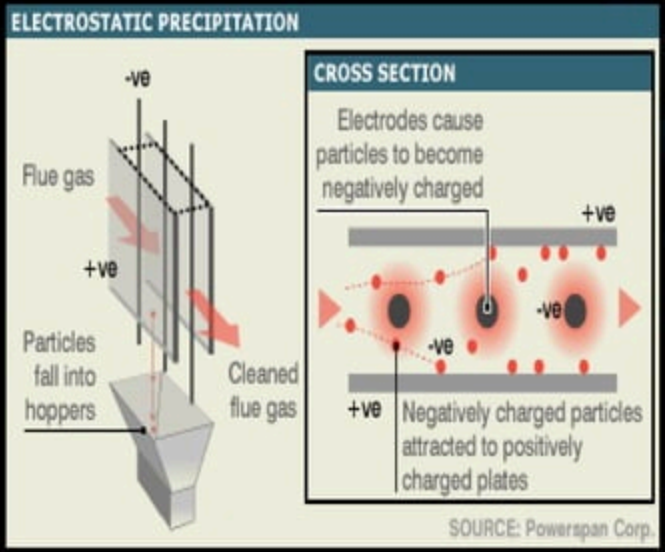
Gravity settling chamber



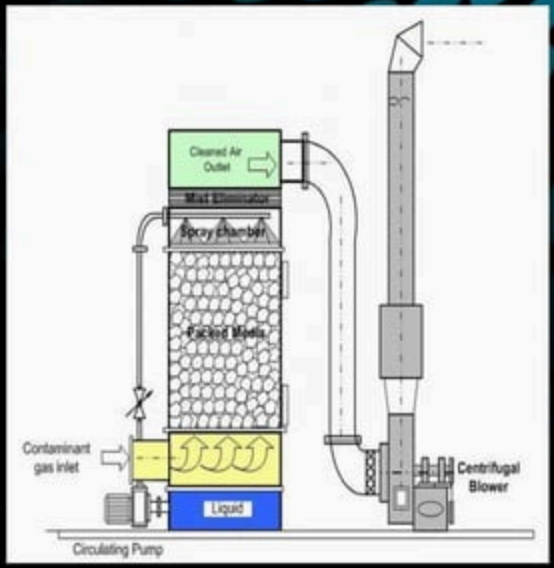
cyclone separator



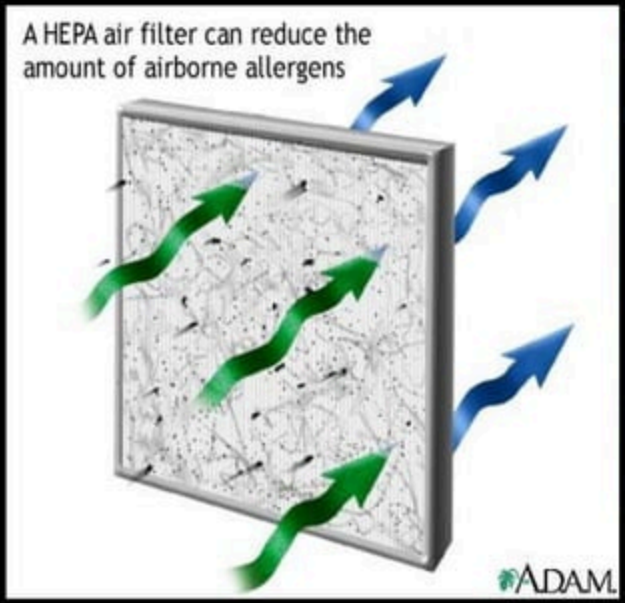
Electrostatic precipitators



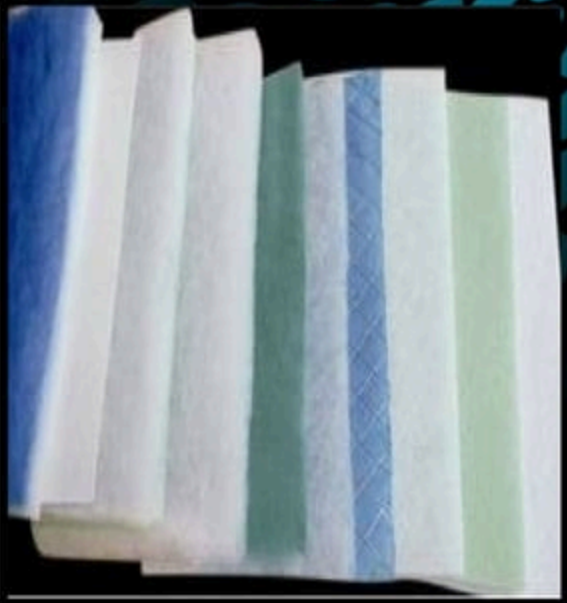
Wet scrubbers



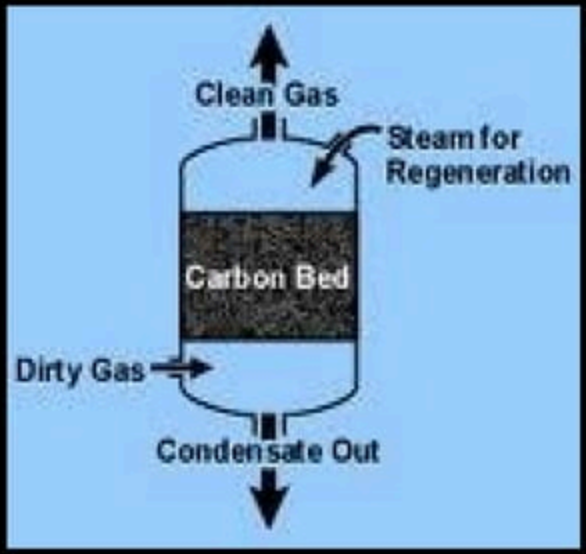
HEPA FILTERS



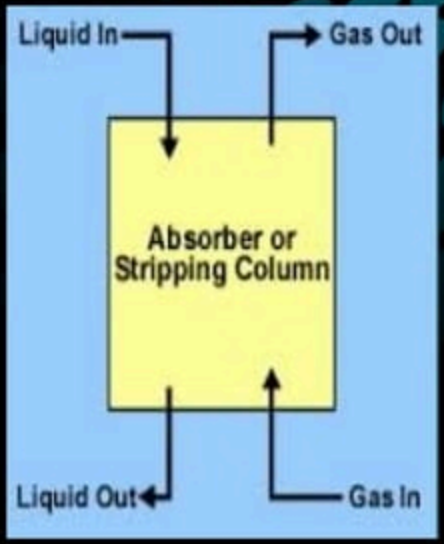
Non-woven fabric air filter



Adsorbers



Absorbers

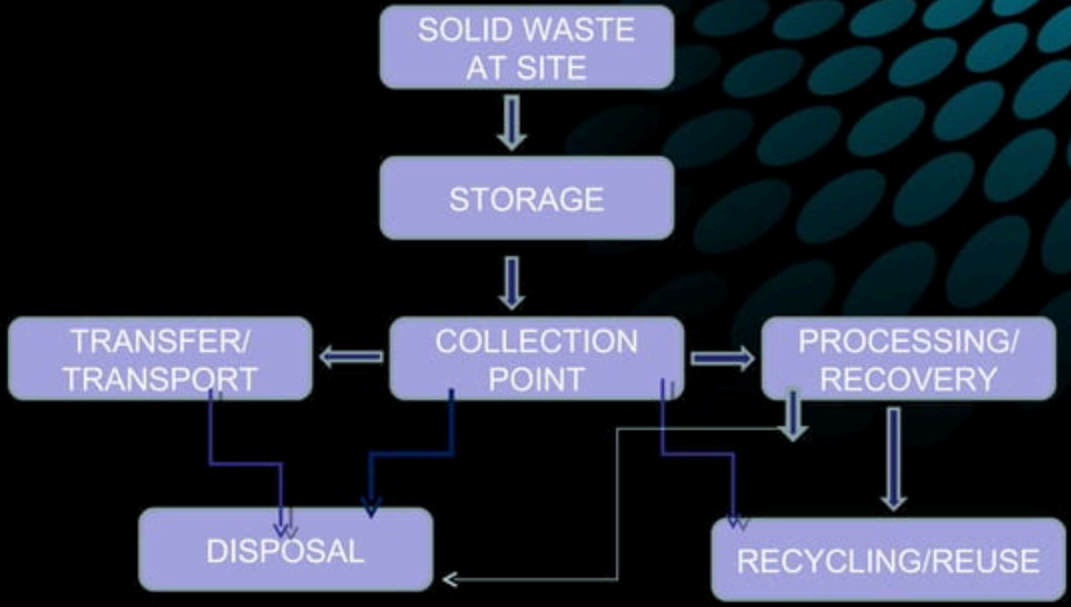


LAND POLLUTION/SOLID WASTE

- Solid waste refers to all solid discardant materials that are improperly discarded like used chemical containers, packages etc.

- Industrialization are major causes of land pollution.
- Adverse effects of land pollution:
- 1)have impact on human health.
- 2)affect agriculture.

SOLID WASTE MANAGEMENT SYSTEM



SOLID WASTE HANDLING METHODS

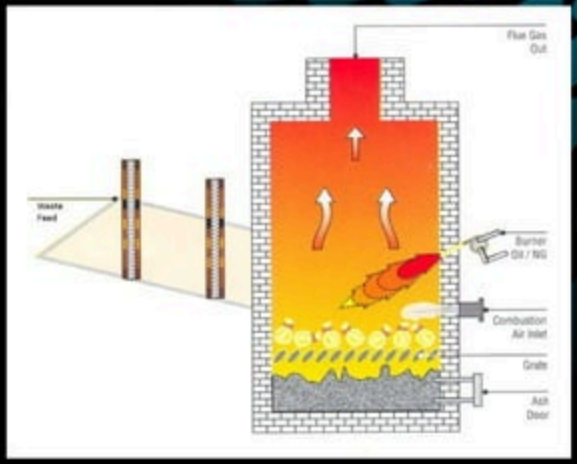
The physical nature of the solid waste mainly determines it's handling methods.

Using these methods solid wastes are transported to the desired destination.

NATURE OF MATERIAL	HANDLING METHODS
Solids	Front end loaders, buckets, fibre-pack drums, packages, cartons
Semisolids, wet, sticky materials	Front-end loaders, buckets
Viscous liquids	Special pumps
liquids	General purpose pumps

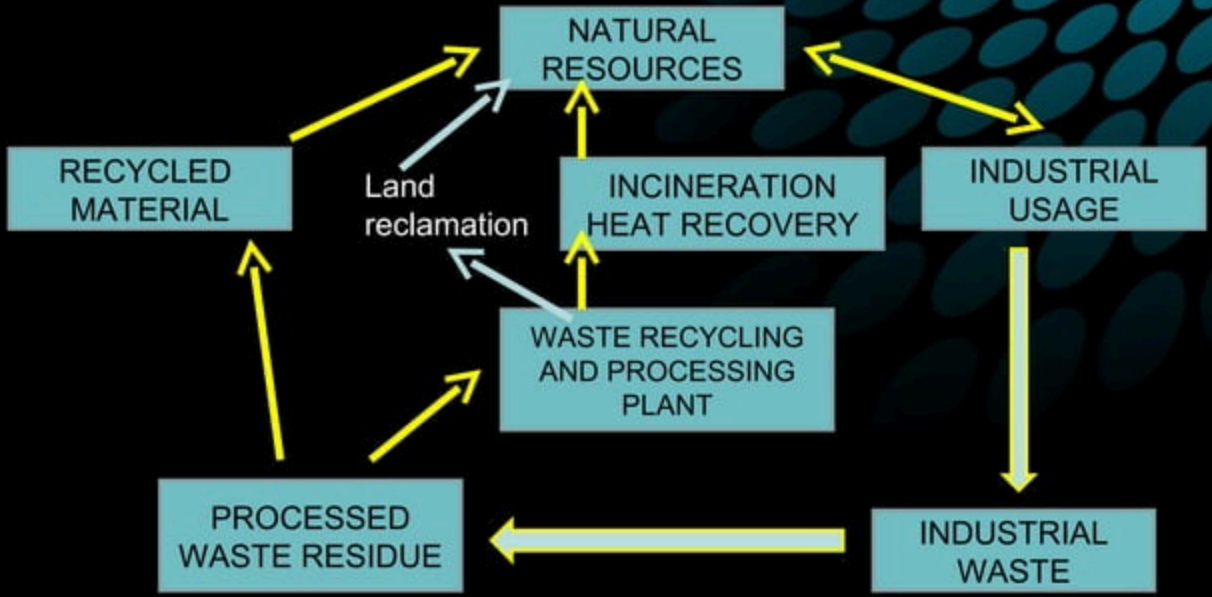
buckets

INCINERATOR



SOLID WASTE DISPOSAL METHODS:
1)Land reclamation/land filling
2)Deep well injection
3)Incinerators

SOLID WASTE SALVAGE AND RECOVERY



NOISE POLLUTION

NOISE: It may be defined as unwanted sound in the wrong place at the wrong time.

- SOURCES OF NOISE POLLUTION:
- Various equipment used in pharmaceutical manufacturing unit.(ex: ball mill, seiving machines, roller compactors, tablet punching machines etc)

Effects of Noise:

1) Interfere with man's health :Rise in BP, CVS problem, elevated stress levels, stimulate violent behaviour.
2) Hearing damage : Depends on intensity and duration of sound level.
3) Physiological and psychological changes : Affects the functioning of various systems of the body.

standards recommended by Central Pollution Control Board committee

AREA CODE	CATEGORY OF AREA	NOISE LEVEL IN DECIBLE DAY	NIGHT
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence zone	50	40

SOURCES OF NOISE POLLUTION AND CONTROL MEASURES

EQUIPMENT	SOUND LEVEL IN dBA at 3 feet	POSSIBLE NOISE CONTROL MEASURES
Air coolers	87-94	Aerodynamic fan blades,decrease in rpm,decrease pressure drop
Coolers	90-120	Install mufflers on intake and exhaust,enclose machine with casing,vibration isolation
Electric motors	90-110	Acoustically lined fan covers,enclosures and motor mutes
Heaters and furnaces	95-110	Acoustic plenums, intake mufflers, lined and damped ducts
Valves	<80-108	Avoid sonic velocities,limit pressure drop and mass flow, replace with low noise valves
Pipes	9-105	Inline silencers, vibration isolation and lagging

Melamine foam or fibre glass core

Sound barrier for hammer mill

Equiptment enclosures

SONEX ACOUSTICS lining a pump room

THERMAL POLLUTION

- Defined as presence of waste heat in the water which can cause undesirable changes in the natural environment.

- Sources of thermal pollution :
- Certain process like evaporation, convection, radiation , and use of equipment such as dryers, evaporators etc may sometimes lead to thermal pollution.

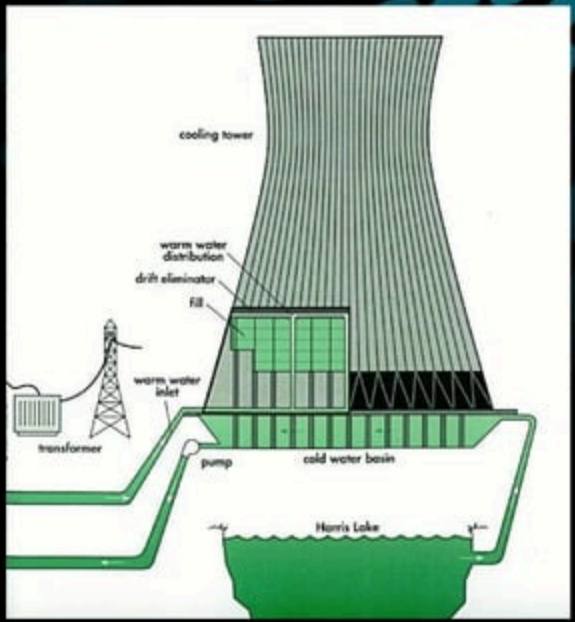
- Effects of thermal pollution :

- Thermal pollution inturn decreases the oxygen content in the atmosphere and whereby leads to ill effects of human beings

CONTROL OF THERMAL POLLUTION

- Cooling ponds: Water from condensers is stored in ponds where natural evaporation cools the water which can then be discharged in nearby water vapour.
- Spray ponds: Here the water is sprayed through nozzles where fine droplets are formed.
- Cooling towers:
- A) Wet cooling tower: Cool air entering from sides takes away the heat and cools the water. Large amount of water is lost through evaporation.
- B) Dry cooling tower: There is no water loss in this method but installation and operation cost of dry cooling tower is many times higher than wet cooling tower

COOLING TOWERS



RADIOACTIVE POLLUTION

- Sources of radioactivity:

i. Natural: Cosmic rays from outer space, radioactive radon-222.

ii. Anthropogenic: Nuclear power plants, nuclear accidents, X-rays, diagnostic kits, test laboratories etc.,

- Effects of Radiations

i. Genetic damage is caused by radiations, which affects genes and chromosomes.

ii. Somatic damage includes burns, miscarriages, eye cataract and cancer of bone, thyroid, breast, lungs and skin

- Control of Nuclear Pollution
- Siting of nuclear power plants should be carefully done.
- Proper disposal of wastes from laboratory should be done
- Uranium and Thorium mining and refineries must be carefully maintained.
- In-door pollution should be minimized.

WATER POLLUTION

- Water pollution is defined as something that adversely impairs the beneficial use of water.

Classification of water pollutants:

1. Chemical pollutants:

- a)Organic pollutants: detergents, fats & grease, insecticides & herbicides which contents huge range of organohalides & other chemicals, petroleum hydrocarbons, lubricants (motor oil), volatile organic compounds
- B)Inorganic pollutants: soluble salts change the P^H of the water, acidity(SO_2), fertilizers containing nutrients (nitrates & phosphates), heavy metals & toxic chemicals.

- Physical pollutants:
  - Colour: undesirable in drinking water
  - Turbidity: due to colloidal or finely divided suspended water which is caused by the formation of hydrous oxides of ferrous & Mn
  - Temperature:
  - Foam:
- Biological pollutants: Micro organisms
- Radioactive pollutants: presence of radioactive materials

Measurement of water pollution & tests

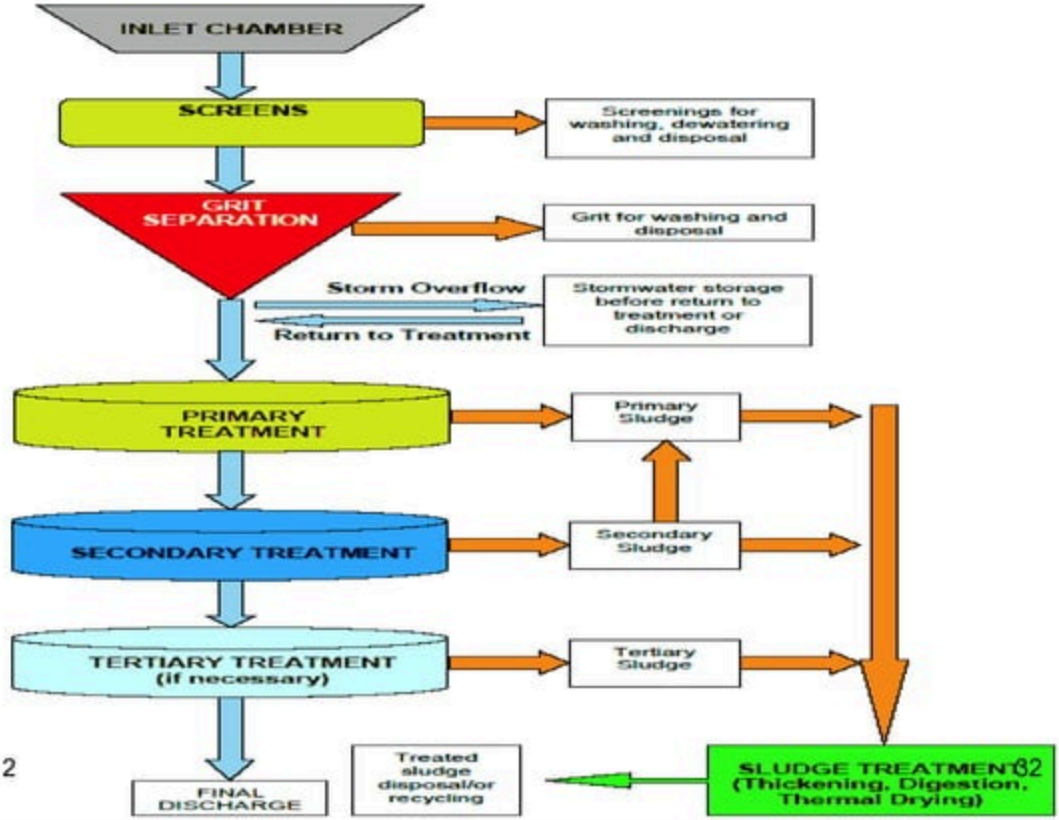
- In order to measure the quality of water the following general tests are done

- **Physical testing**: Colour, Turbidity, odor (volatile materials, dissolved gases, phenolic compounds), temperature.
- **Chemical testing**: water samples may be examined in the principles of analytical chemistry it includes ph, BOD ,COD, nutrients (nitrates & phosphorus), metals, including Cu, Zn, Cd, Pb & Hg.
- **Biological testing**: it involves the use of plant, animal or microbial indicators to monitor the health of an aquatic eco system.

Water Pollution Abatement And Effluent Treatment

- The handling of a liquid water effluent is more complex than handling a waste gas effluent
- The water effluent may contain dissolved gases /solids or it may slurry in either concentrated or diluted form. because of this complexity ,priority is given for recovering a part or all of the waste products, which may be reused
- The treatment of the wastewater is may be physical, chemical or biological in nature
- **Physical treatment**: sedimentation, gravity settling, adsorption process is employed using activated carbon for the removal of refractive organic substances, toxic substances & colour
- **Chemical treatment**: coagulation, flocculation, emulsion breaking, precipitation & neutralization.
- **Biological treatment**: bacteria are found in water, many organic materials will be oxidized to form CO_2, H_2O, sulphate. This treatment consumes oxygen that dissolved in water, cause depletion of oxygen

WASTE WATER TREATMENT



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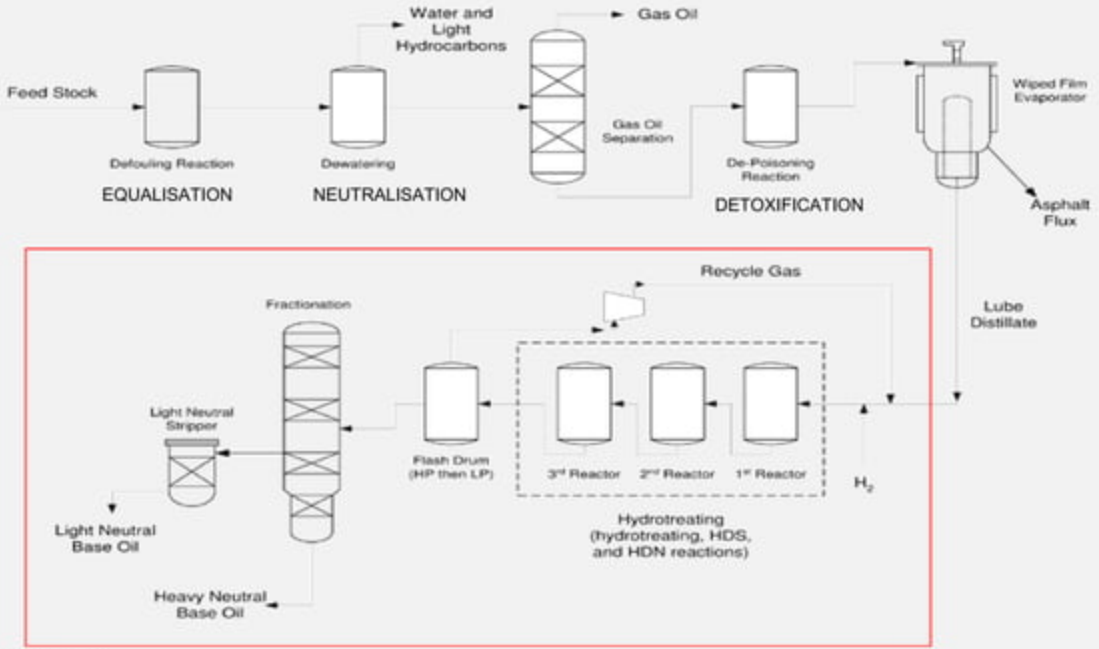
PRETREATMENT



Pre treatment:

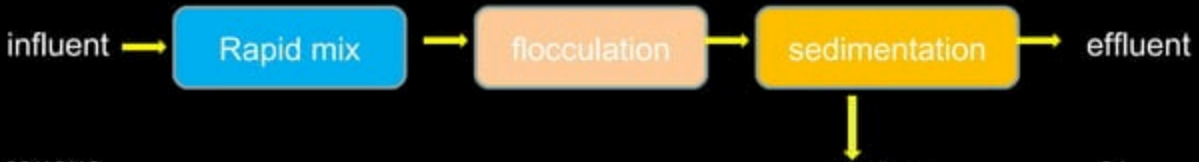
- Equalization
- Neutralization
- Grease and oil removal
- Removal of toxic substances

- Purpose: to remove all large objects that are deposited in the sewage system. This type of waste is removed because it can damage the sensitive equipment in the sewage treatment plant.

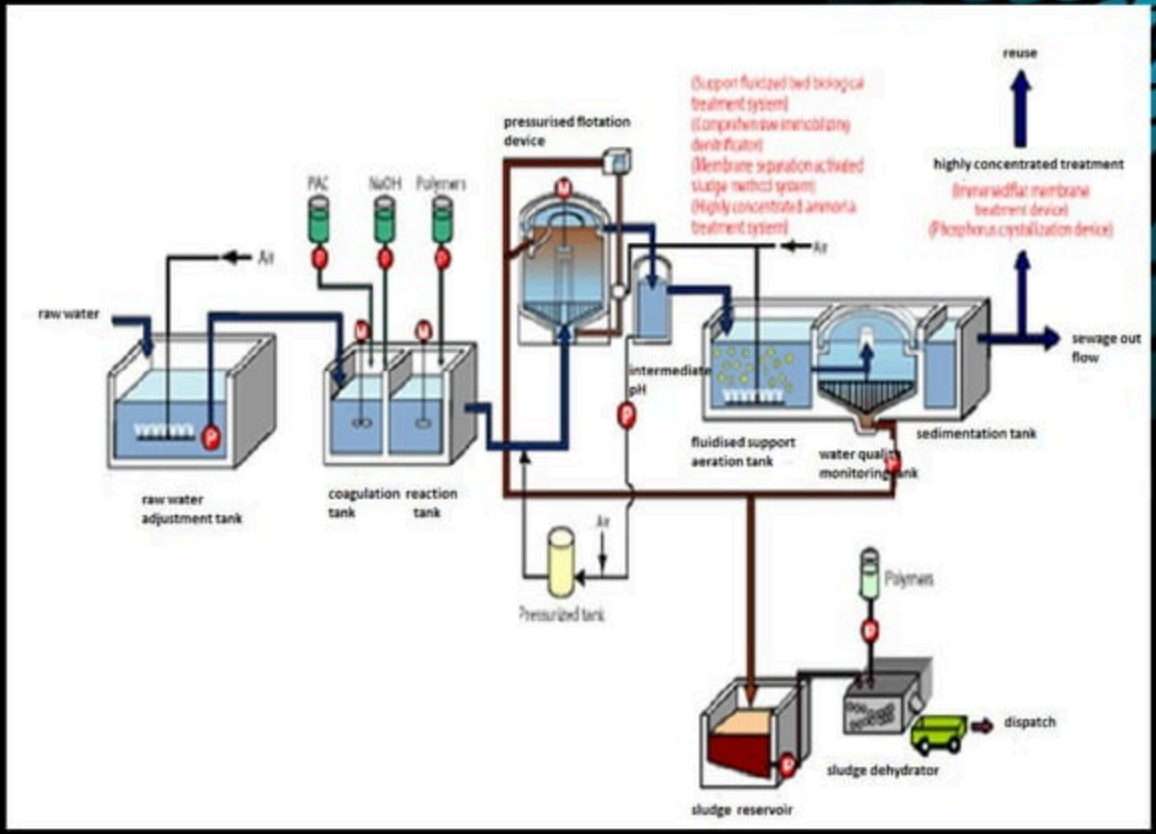
Primary treatment:

- Screens
- Grid chamber
- Gravity sedimentation tank
- Chemical reaction

Purpose: reduces the load facilitating subsequent biological treatment.

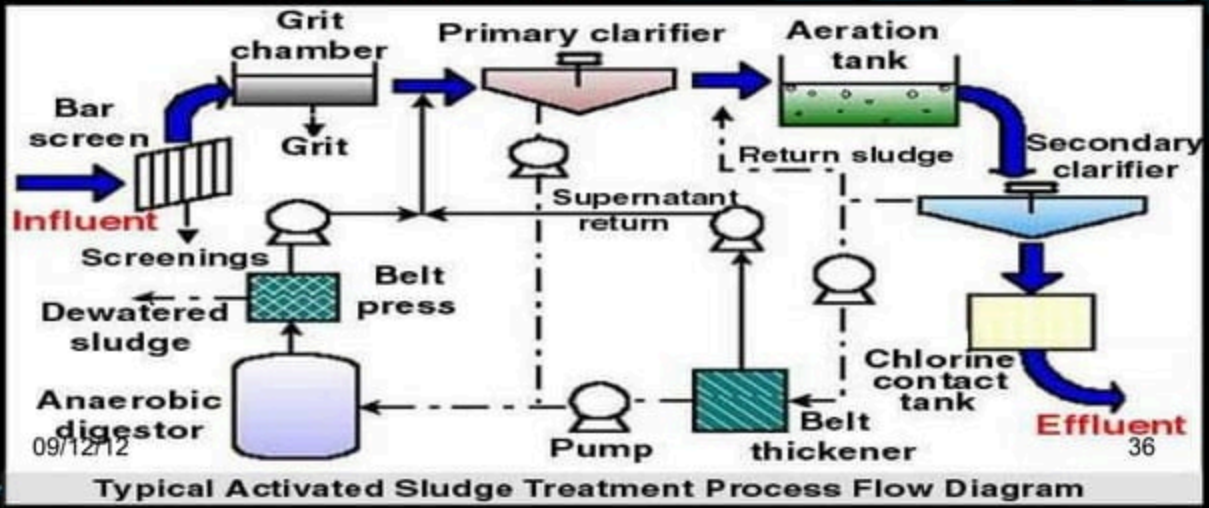


PRIMARY TREATMENT

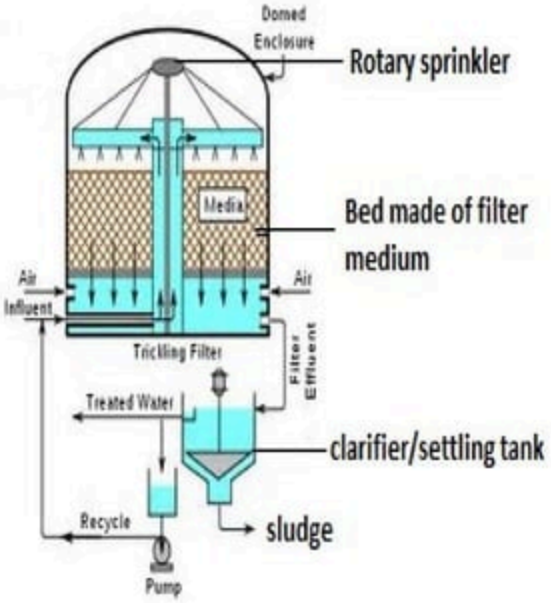


- # Secondary treatment:
- **Purpose:** Secondary treatment is designed to substantially degrade the biological content of the sewage.
- **Methods:** activated sludge process, trickling filtration,oxidation ditch, oxidation ponds, biodiscs and spray irrigation.
- The effluent is subsequently subjected to anaerobic digestion.

- ACTIVATED SLUDGE PROCESS:



TRICKLING FILTRATION



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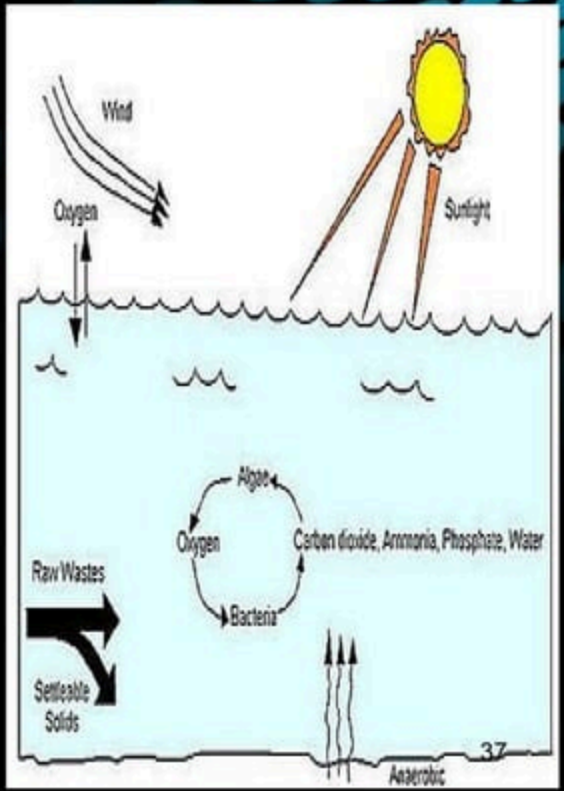
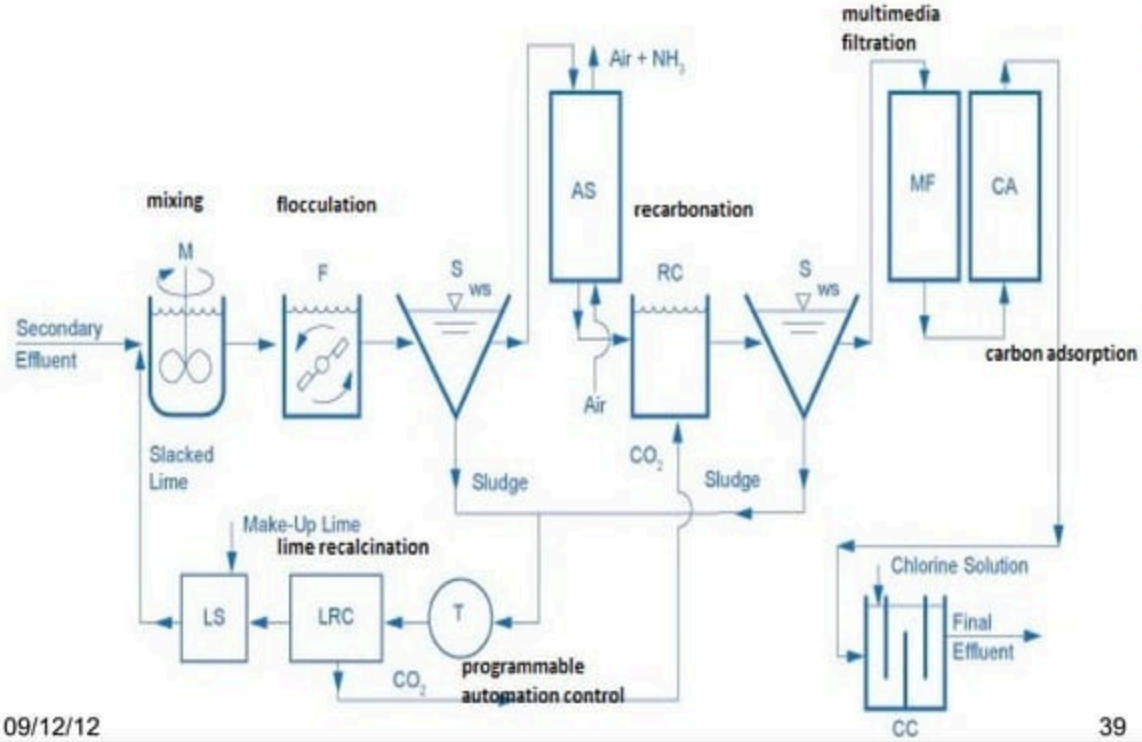
OXIDATION POND OPERATION



Tertiary treatment:

- Coagulation, flocculation, co precipitation
- Membrane separation process
- Adsorption
- Ion exchange
- Breaking
- Neutralization
- Purpose:
- Final step of polishing the effluents when the effluent obtained from secondary treatment is not satisfactory.

Tertiary Treatment of a Secondary Effluent by Physical-Chemical Methods

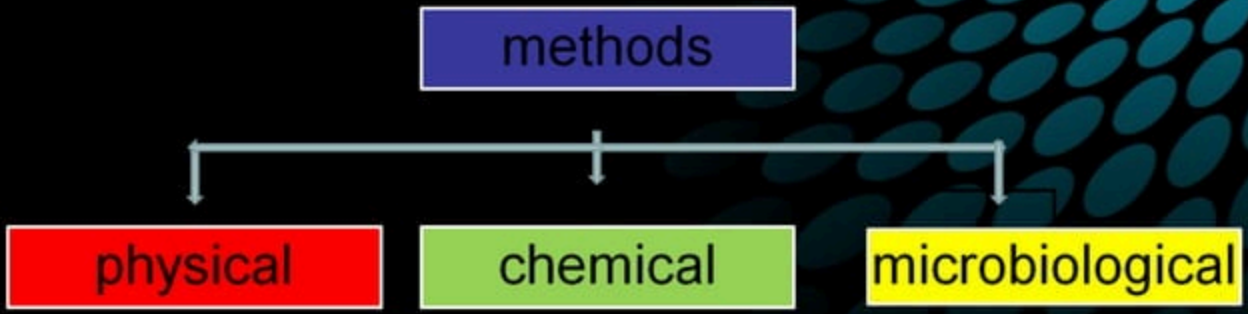


EFFLUENT TESTING AND TREATMENT

- EFFLUENT:
- Effluent is an out flowing of water or gas from a natural body of water or from a human made structure.

- Effluent is defined by the United States Environmental Protection Agency (US EPA, 2006) as “wastewater ± treated or untreated water that flows out of a treatment plant, sewer, or industrial outfall”
- EFFLUENT TESTING DONE ACCORDING TO :
- American People Health and Association (APHA, 1989), ASTM (Standard Method for the Examination of Water and Wastewater, 20thEdition) and Laboratory Manual for Environmental Science

Effluent testing methods



1) Temperature
2) Turbidity
3) Conductivity
4) pH
5) Dissolve Oxygen (DO)
6) Suspended Solids (SS)

1) Biological Oxygen Demand (BOD)
2) Chemical Oxygen Demand (COD)
3) Ammonical Nitrogen (NH3-N)

1) Total bacterial count.
2) coliform test.
3)e.coli test

Note:EPA acceptable limits is 0 colonies per plate.

Effluent treatment for formulation industry

- Segreation of waste streams

neutralisation

Emulsions and colloidal wastes can be removed using coagulants($FeCl_3$,$FeSO_4$,lime)

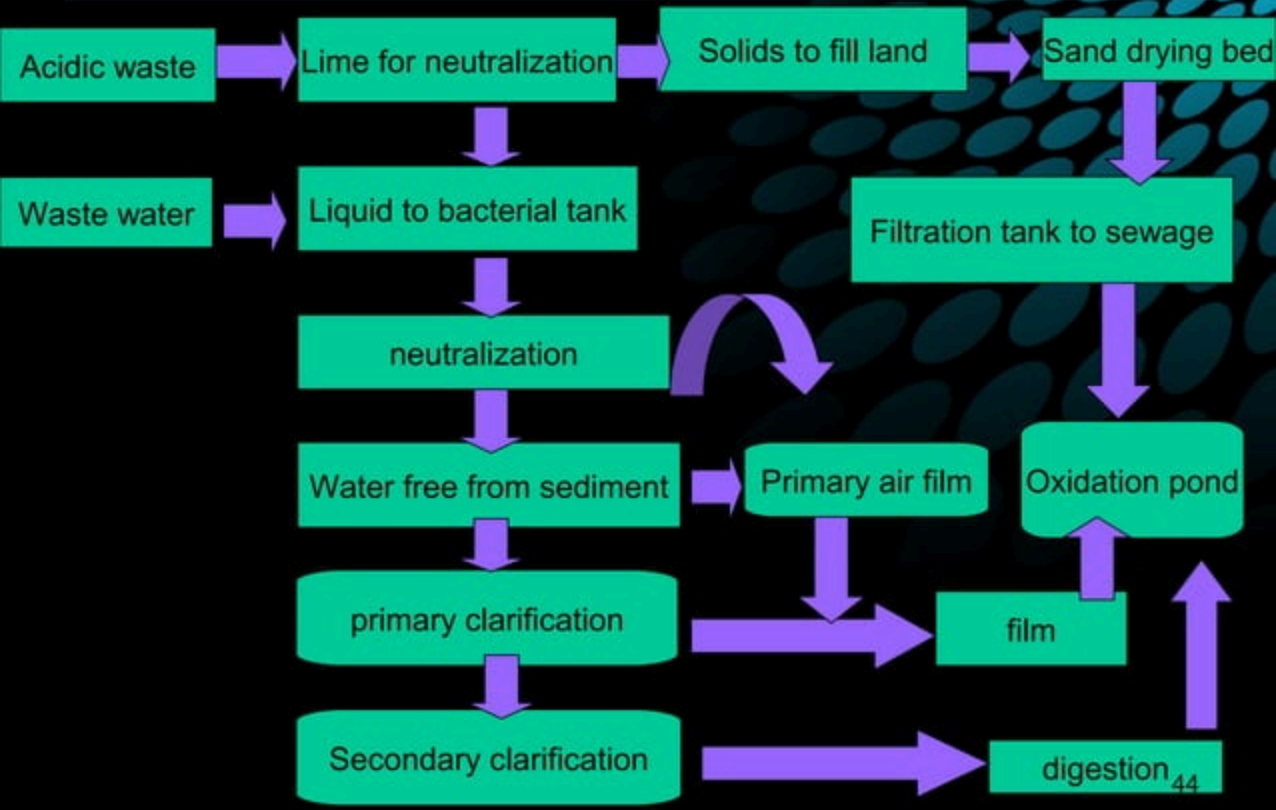
Dissolved salts precipitated

Volatile materials removed by aeration

Organic chemicals removed by biological oxidation

Parameter	Tolerance limit
ph	5.5-9
Oil and grease	10
Total suspended solid	100
BOD	30
Mercury	0.01
Arsenic	0.2
Chromium	0.1
Lead	0.1
Cyanide	0.1
Sulphides	2
Phosphates	5
Bioassay test	90%survival of fish after 96 hrs in 100% effluent

EFFLUENT TREATMENT FOR SYNTHETIC PLANT



Parameter	Inland surface water	Public sewage	Land for irrigation	Marine coastal areas
Ph	5.5-9	5.5-9	5.5-9	5.5-9
Suspended solids	100	600	200	100
Dissolved solids	2100	-	2100	-
BOD	30	350	100	100
COD	250	-	-	250
Oils and grease	10	20	10	20
Ammonical nitrogen	50	50	-	50
cyanide	0.2	2	0.2	0.2
Arsenic	0.2	0.2	0.2	0.2

Effluent treatment in fermentation plant:

- Antibiotics, vitamins, acids and alcohols are produced by fermentation process . The effluent has objectionable odor and effects the biological system.

- A few types of effluents from fermentation are :

-liquor of fermentation, mostly nutrient broth.
-Washed water of the floor and equipment
-Acids, bases and solvents used for extraction and purification
-Filaments or mycelium or organisms.

Effluent treatment in antibiotic plant