FST 508
Industrial Food Waste Management
(2 Units)

O.A BABARINSA Ph.D

Course requirements

- Number of units: 2 units
- Lecture period: 2 hour /week(30 hours/semester)
- 75% attendance is required to qualify to sit final examination
- Grading

take home assignment	10%
A short quiz in class	20%
Final Examination	70%

Course Learning Objectives

Upon successful completion of the course students should:

- Various wastes of Food Industries
- Effects of wastes on environment
- Oxygen demand
- Physical and Chemical treatments of waste

Course Outline

- Various wastes of food industries i.e. solid waste and waste water, their treatment and disposal.
- Effect of solid waste on environment, utilization of waste as fuel, fertilizer, animal feed and cellulose acetate.
- Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD).
- Calculation in waste effluents from food processing plants.
- Physical treatment of waste i.e. sedimentation, centrifugation, concentration, flotation methods, absorption processes, ultra filtration, reverse osmosis and electrolysis.
- Chemical treatment of wastewater i.e. coagulation, emission-breaking process, trickling filter, aerated lagoons, stabilization ponds, anaerobic biological processes, aerobic, facultative anaerobic process

WASTE

Introduction

- Wastes are materials that are not prime products (that is products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose.

- Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities.

- Residuals recycled or reused at the place of generation are excluded."

Types of Waste

Municipal Solid Waste

- Municipal solid waste (MSW) is generated from households, offices, hotels, shops, schools and other institutions.

- The major components are food waste, paper, plastic, rags, metal and glass, although demolition and construction debris is often included in collected waste, as are small quantities of hazardous waste, such as electric light bulbs, batteries, automotive parts and discarded medicines and chemicals.

Types of Waste

Industrial Solid Waste

- Industrial solid waste, encompasses a wide range of materials of varying environmental toxicity. Typically this range would include paper, packaging materials, waste from food processing, oils, solvents, resins, paints and sludges, glass, ceramics, stones, metals, plastics, rubber, leather, wood, cloth, straw, abrasives, etc.

Agricultural Waste and Residues

- Expanding agricultural production has naturally resulted in increased quantities of livestock waste, agricultural crop residues and agro-industrial by-products.

Waste Management

- Waste management is the collection, transport, processing, recycling or disposal, managing and monitoring of waste materials.
- The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics.
- Waste management is also carried out to recover resources from it. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each.

Waste Management

- Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers.

- Management for non-hazardous waste residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator.

ENVIRONMENTAL EFFECTS OF WASTE MANAGEMENT

Introduction

- When we are talking about environmental effects it implies negative or positive impact, and these impact may either be direct or indirect.
- When it is direct, it means that the impact is linked with waste itself, and when it is indirect, it means it linked with other activities that is associated with waste management.
- Waste problems in developing countries are different and often greater than in developed countries.
- In developing countries waste disposal is base on controlled dumping on unsuitable e.g river banks, streets, canals, small and large rubbish heap.

ENVIRONMENTAL ASPECTS

Waste results in Slum

- Most of the wastes generated are in form of metal scraps, glass, cardboards, plastics, textiles.

- These are deposited in heaps on our settlements. Waste heaps are not often common in affluent environment because of regular collection.

- Therefore, the land that would have been useful in better ways has been designated during sites in most of the environment of developing countries

ENVIRONMENTAL ASPECTS

Foul odours

- Most of the waste environment often consists of organic matter e.g vegetable scraps and excrements from animal and humans.
- Such are areas are characterized by bad smell and large ant of files and rodents

Impacts on soil

- Leachates from the waste during sites percolate into the soil, this percolation continues in porous soil media or stop and accumulate in the non-porous impermeable soil media. This ways, the metal load of the soil is increased.

ENVIRONMENTAL ASPECTS

Impact on air

- Waste gas normally contains heavy metals like Hg, Cd, Pb and Zn. Also, this includes gas flaming in the oil and gas industries.
- Waste gases also include fumes from chemical industries.
- The incineration process of waste normally lead to the increase of gases like Acid gas Hg, So, H2S nitrous oxide and also harmful components like PH and dioxins

Impacts on water

- Water flowing from the waste can leach into the underground i.e aquifer, thereby polluting it.
- It can also get through the drains out nearby rivers, especially the wastes deposited at the banks of the rivers and this leads to metal accumulation of the river and eutrophication.

ENVIRONMENTAL ASPECTS

Impacts on flora and fauna

- Eutrophication resulting from leachates from the waste dumpsites will lead to deoxygenation and extermination of natural flora and fishes.

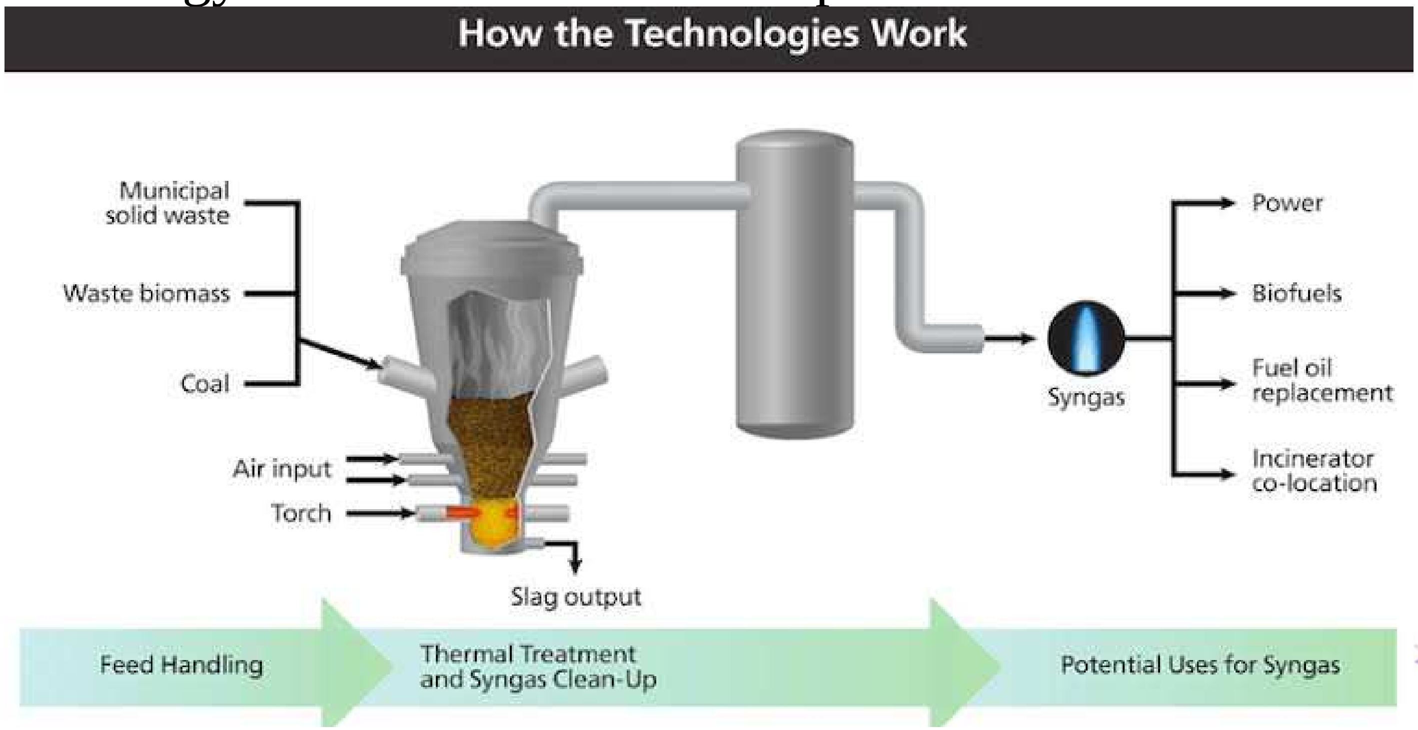
- The solubility of poisonous minerals like Al and Cd from waste may increase and clamage roots of plants thereby reducing their nutrients intake and uptake.

UTILIZATION OF WASTE

Waste as Fuel

- Biomass can be converted into heat and electricity in a number of ways. Depending on its source, these processes include: combustion, pyrolysis, gasification, liquefaction, anaerobic digestion or fermentation.

- Thermo-chemical processes convert biomass into higher-value or more convenient products. The process releases a gas (~6 MJ/kg), a liquid (~17-22 MJ/kg) and/or a char (~18MJ/kg), and depending on the technology one of these is the final product.



UTILIZATION OF WASTE

Waste as Fertilizer

UTILIZATION OF WASTE

Waste as Animal Feed

Waste can be converted to Animal feeds.
Most Agro-waste are rich energy source.

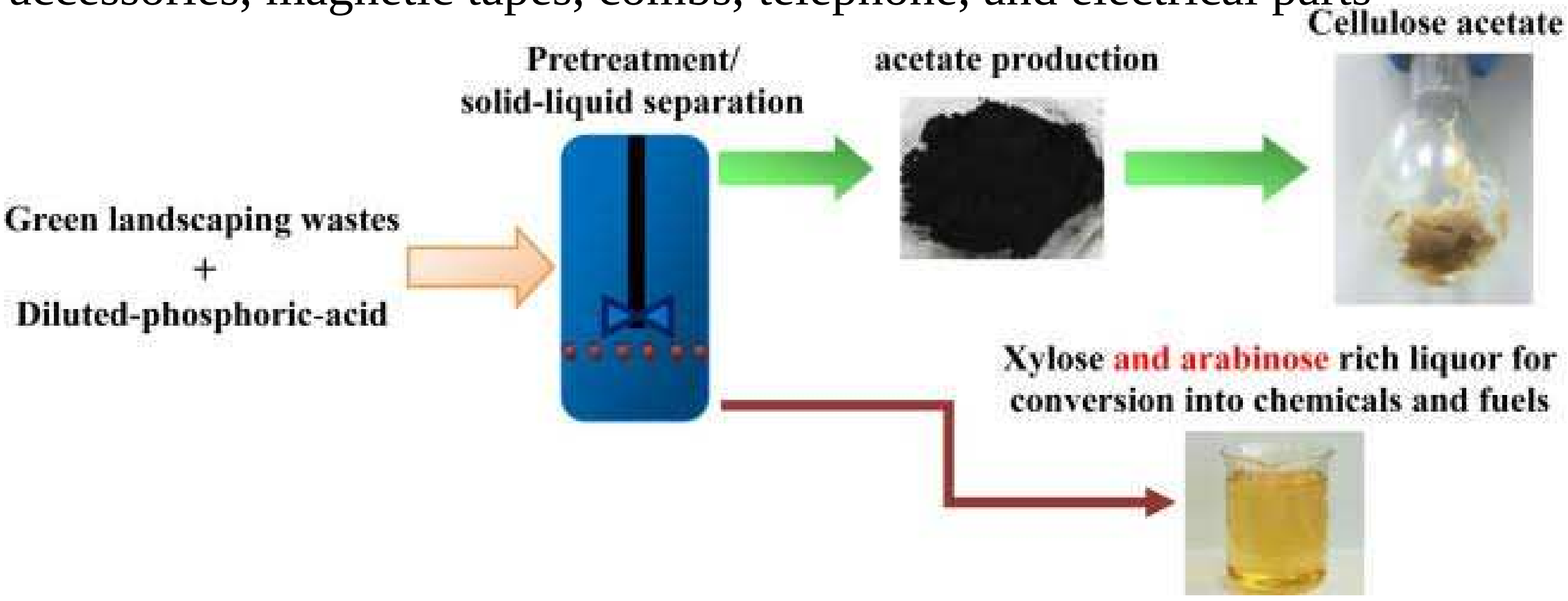
UTILIZATION OF WASTE

Waste for Cellulose Acetate

- Agricultural waste can be converted to commercially useful products such as Pulp and cellulose acetate.

- Cellulose acetate are produced from agro-waste such as jute stick, cotton linters, woodchips, rice straw, wheat hull and corn fiber.

- It has many uses such as in the production of plastics films, lacquers, photographic films, thermoplastic moulding, transparent sheeting, camera accessories, magnetic tapes, combs, telephone, and electrical parts



INDUSTRIAL WASTE WATER

Industrial Water Waste

- Industrial wastewater means used up water from industries. The characteristics of waters depend on the nature of industry.

- The industrial wastes either join the streams or other natural water bodies directly, or are emptied into the municipal sewers. These wastes affect the normal life of stream or the normal functioning of sewerage and sewage treatment plant. Streams can assimilate certain amount of wastes before they are "polluted".

Physical pollution	**Temperature, Colour, Odour, Taste, Solids**
Chemical pollution	pH, Acidity, Dissolved salts
Organic pollution	Organic Matter
Biological pollution	Biological Activities

Pollution Properties

Impact of Pollutant on Water

- The impact which discharged pollutants have on receiving waters is evaluated by measuring certain water quality parameters.

- These measurements are made by analyzing samples collected from the wastewater or from the receiving stream after mixing has occurred.

- The parameters of primary concern to food processors are discussed below.
  - Dissolved oxygen
  - Temperature
  - Oxygen demand

Dissolved oxygen

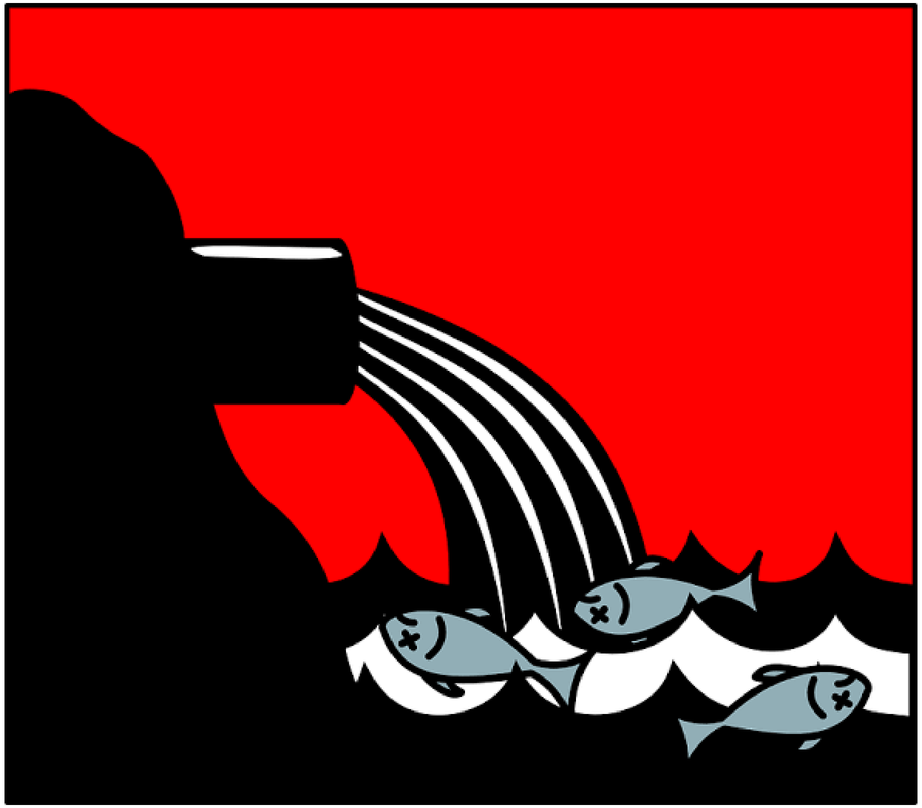
- A stream normally possesses the ability to purify itself.
- Water flowing in a stream becomes aerated (oxygen enriched) as it tumbles over rocks and other natural obstacles. The dissolved oxygen in turn enables the water to sustain a variety of oxygen-dependent microorganisms, as well as other aquatic life.
- These microorganisms are primarily responsible for the stream's self-purifying capability. When plant debris and other waste materials are deposited into water, the microorganisms quickly utilize these materials, ultimately converting the organic matter to cell mass and carbon dioxide. Dissolved oxygen in the water is consumed during the biological process.
- The rate at which dissolved oxygen is consumed is directly related to the concentration of pollutants present in water.
- Waste discharges, whether domestic sewage or industrial wastewaters, impose demands upon the assimilative capacity of the receiving water. When a heavy load exceeding the assimilative capacity is discharged, the dissolved oxygen content of the stream will be greatly depressed.
- However, provided no further waste discharges occur downstream, the dissolved oxygen content of the stream will eventually be reestablished.

Temperature

- The solubility of oxygen in water is inversely proportional to temperature.

- The temperature of water also affects aquatic organisms - some species can only survive in relatively cool waters while others require a warmer environment.

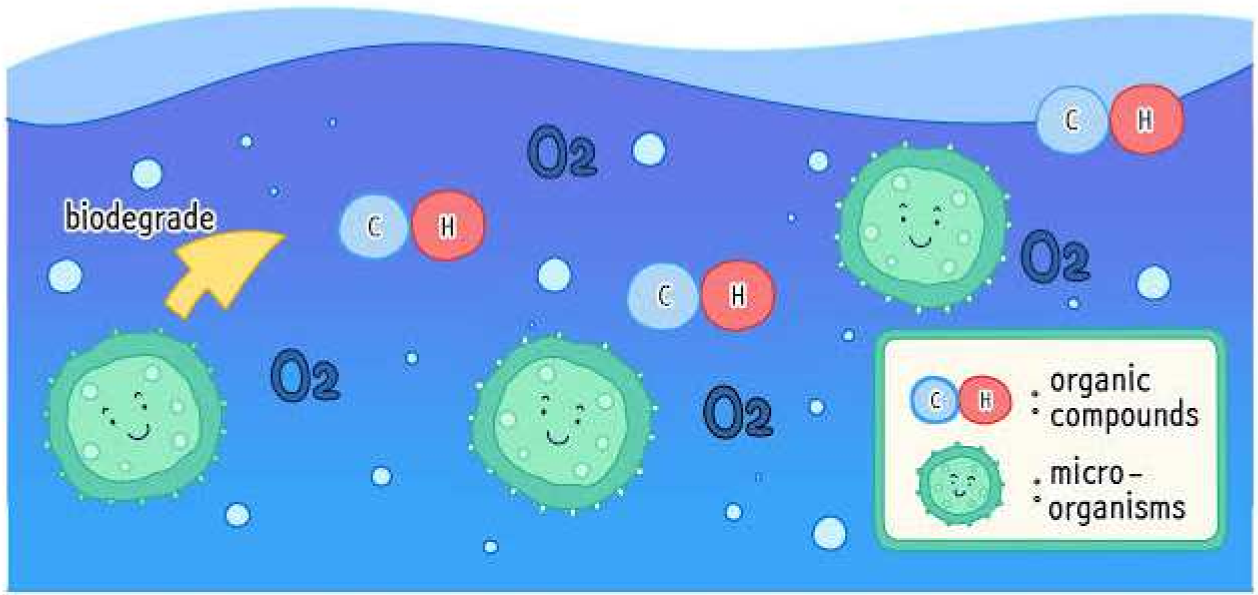
- The level of microbiological activity is also affected by temperature. Thus, temperature is considered to be an important parameter.



Oxygen Demand

- Oxygen demand is defined as that quantity of oxygen required to degrade, and thereby stabilize, the organic constituents of wastewaters. Under natural conditions in receiving streams the oxygen source is the dissolved oxygen contained in the water.

- Oxygen demand can be further divided into
  - Biochemical Oxygen Demand (BOD)
  - Chemical Oxygen Demand (COD)



Biochemical Oxygen Demand

- The biochemical oxygen demand is the quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specified temperature, and under specified conditions. BOD is a standard test used in assessing wastewater strength.
- The normally-used BOD test procedure requires a five-day sample incubation period; the results are reported as five-day BOD or BOD5. It is assumed that during this period most carbonaceous and other readily oxidizable materials have been biochemically degraded.
- Other waste constituents, especially nitrogenous compounds, are degraded more slowly; only a portion of these materials are measured during the five-day test. For this reason, BOD determinations are sometimes made after a twenty-day incubation period and are reported as 20-day BOD (BOD_{20}).
- Ultimate BOD determinations require prolonged incubation periods and are generally only of academic interest.
- A typical BOD rate curve is illustrated in Figure below. Unless otherwise stated, reported BOD values are always five-day BOD

Biochemical Oxygen Demand

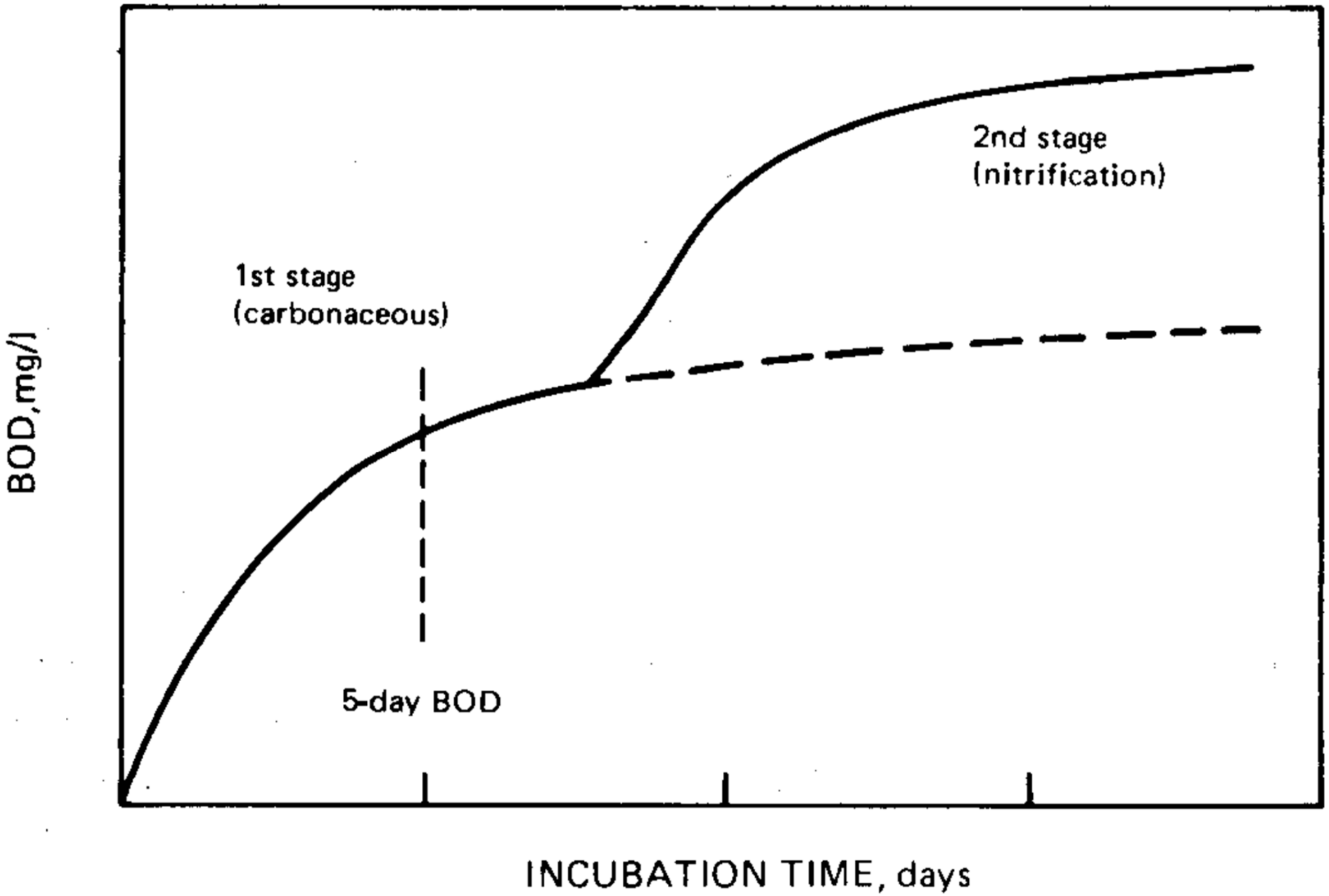


Figure: A typical BOD reaction curve for untreated wastewater.

Biochemical Oxygen Demand

Stages involves in Biochemical Oxygen Demand:

First-Stage Biochemical Oxygen Demand

- That part of oxygen demand associated with biochemical oxidation of carbonaceous, as distinct from nitrogenous, material. Usually, the greater part, if not all, of the carbonaceous material is oxidized before the second stage, or substantial oxidation of the nitrogenous material, takes place. Nearly always, at least a portion of the carbonaceous material is oxidized before oxidation of nitrogenous material even starts.
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Second-Stage Biochemical Oxygen Demand

- That part of the oxygen demand associated with the biochemical oxidation of nitrogenous material. As the term implies, the oxidation of the nitrogenous materials usually does not start until a portion of the carbonaceous material has been oxidized during the first stage.

Biochemical Oxygen Demand

Other BOD Terms

BOD load

- The BOD content, usually expressed in pounds per unit of time, of wastewater passing into a waste treatment system or to a body of water.

Immediate biochemical oxygen demand

- It is the initial quantity of oxygen used by polluted liquid immediately upon being introduced into water containing dissolved oxygen. It may be exercised by end products of prior biochemical action or by chemical substances avid for oxygen.
- In the standard laboratory procedure, the apparent BOD for 15 minutes at 20oC.

Ultimate Biochemical Oxygen Demand

- Commonly, the total quantity of oxygen required to satisfy completely the first-stage biochemical oxygen demand.
- More strictly, the quantity of oxygen required to satisfy completely both the first-stage and the second-stage biochemical oxygen demands.

Chemical Oxygen Demand

- The relative pollutional strength of wastewaters is often measured by the chemical oxygen demand (COD) test.
- It is a measure of the oxygen consuming capacity of inorganic and organic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test. It does not differentiate between stable and unstable organic matter and thus does not necessarily correlate with biochemical oxygen demand.
- There are two procedures for the test, the oxygen demand as measured by this test is based upon chemical reactions between the constituents in the wastewater and the test reagents, as compared to biochemical reactions which are measured by BOD analysis.
- Because some wastewater constituents are not biologically degradable but can be chemically oxidized, COD values are higher than BOD values. However, the relative rapidity - two hours vs. five days - of the COD test makes it useful for routinely monitoring wastewater discharges.
- Correlation factors between COD and BOD can generally be established for each individual waste stream.

Calculations in Oxygen Demand

- Analytical results from the BOD or COD test are expressed as milligrams per liter (mgll) - i.e., the milligrams of dissolved oxygen consumed under test conditions per liter of wastewater.
- Organic loads contained in industrial effluents are frequently expressed as pounds of BOD. Laboratory data (mg/l) may be converted to organic loads (lbs) by the following equation:

$$\text{pounds BOD} = \frac{C \times V \times 8.34}{1{,}000{,}000}$$

Where
C = concentration (mg/l or ppm BOD)
V = volume of wastewater (gallons)
8.34 = weight, in pounds, of one gallon of water

Calculations in Waste Effluent

$$\boxed{\textbf{load} = \textbf{population} \times \textbf{per capita load}}$$

$$\text{load (kg/d)} = \frac{\text{population (inhab)} \times \text{per capita load (g/inhab.d)}}{1000\,\text{(g/kg)}}$$

or

$$\boxed{\textbf{load} = \textbf{concentration} \times \textbf{flow}}$$

$$\text{load (kg/d)} = \frac{\text{concentration (g/m}^3) \times \text{flow (m}^3\text{/d)}}{1000\ \text{(g/kg)}}$$

Note: $g/m^3 = mg/L$

$$\boxed{\textbf{concentration} = \textbf{load/flow}}$$

$$\text{concentration (g/m}^3) = \frac{\text{load (kg/d)} \times 1000\ \text{(g/kg)}}{\text{flow (m}^3\text{/d)}}$$

Calculations in Waste Effluent

Note

1 cubic Meter (M^3) = 1000 Litres

1 Kg = 1000g

l day = 24 hours = 1440 minutes = 86400 seconds

mg/L = g/m^3

Calculations in Waste Effluent

Calculate the total nitrogen load in the influent to a WWTP, given that:

- concentration = 45 mgN/L
- flow = 50 L/s

Solution:

Expressing flow in m^3/d, :

$$Q = \frac{50\ L/s \times 86400\ s/d}{1000\ L/m^3}$$

The nitrogen load is:

$$\text{load} = \frac{45\ g/m^3 \times 4320\ m^3/d}{1000\ g/kg} = 194\ kgN/d$$

b) In the same works, calculate the total phosphorus concentration in the influent, given that the influent load is 40 kgP/d.

$$\text{concentration} = \frac{40\ kg/d \times 1000\ g/kg}{4320\ m^3/d} = 9.3\ gP/m^3 = 9.3\ mgP/L$$

Calculations in Waste Effluent

Population Equivalent

Population equivalent (PE) is an important parameter for characterising industrial wastewaters. PE reflects the equivalence between the polluting potential of an industry (commonly in terms of biodegradable organic matter) and a certain population, which produces the same polluting load. For instance, when an industry is said to have a population equivalent of 20,000 habitants, it is the equivalent to saying that the BOD load of the industrial effluent corresponds to the load generated by a community with a population of 20,000 inhabitants. The formula for the calculation of population equivalent based on BOD is:

$$\text{PE (population equivalent)} = \frac{\text{BOD load from industry (kg/d)}}{\text{per capita BOD load (kg/inhab.d)}}$$

In the case of adopting the value frequently used in the international literature for the per capita BOD load of 54 gBOD/inhab.d, PE may be calculated by:

$$\text{PE (population equivalent)} = \frac{\text{BOD load from industry (kg/d)}}{\text{0.054 (kg/inhab.d)}}$$

Calculations in Waste Effluent

Calculate the Population Equivalent (PE) of an industry that has the following data:

- flow = 120 m^3/d
- BOD concentration = 2000 mg/L

Solution:

The BOD load is:

$$\text{load} = \text{flow} \times \text{concentration} = \frac{120\,\text{m}^3/\text{d} \times 2000\,\text{g/m}^3}{1000\,\text{g/kg}} = 240\ \text{kgBOD/d}$$

The Population Equivalent is:

$$\text{PE} = \frac{\text{load}}{\text{per capita load}} = \frac{240\ \text{kg/d}}{0.054\ \text{kg/hab.d}} = 4{,}444\ \text{inhab}$$

Thus, the wastewater from this industry has a polluting potential (in terms of BOD) equivalent to a population of 4,444 inhabitants.

Calculations in Waste Effluent

Estimation of BOD in Industrial Waters

Example

A slaughterhouse processes 30 heads of cattle and 50 pigs per day. Estimate the characteristics of the effluent.

Solution:

Using the table of industrial wastewater characteristics (Table 2.28), and adopting an average value of 3.0 kgBOD/cattle slaughtered (1 cow ≈ 2.5 pigs):

a) **BOD load produced**

$$\text{–cows:} \quad \frac{3\ \text{kgBOD}}{\text{cow}} \cdot \frac{30\ \text{cow}}{\text{d}} = 90\ \text{kgDBO/d}$$

$$\text{–pigs:} \quad \frac{3\ \text{kgDBO}}{2.5\ \text{pigs}} \cdot \frac{50\ \text{pigs}}{\text{d}} = 60\ \text{kgDBO/d}$$

$$\text{–total:} \quad 90 + 60 = 150\ \text{kgBOD/d}$$

b) **Population Equivalent (PE)**

$$\text{PE} = \frac{\text{BODload}}{\text{per capita BODload}} = \frac{150\,\text{kgDBO/d}}{0.054\,\text{kgDBO/inhab.d}} = 2.77\ \text{inhab}$$

Calculations in Waste Effluent

c) Wastewater flow

Using Table 2.28, and adopting an average value of 2.0 m^3/cattle slaughtered (or for 2.5 pigs slaughtered):

$$-\text{cows:}\quad \frac{2.0\ \text{m}^3}{\text{cow}}.\frac{30\ \text{cow}}{\text{d}} = 60\ \text{m}^3/\text{d}$$

$$-\text{pigs:}\quad \frac{2.0\ \text{m}^3}{2.5\ \text{pigs}}.\frac{50\ \text{pigs}}{\text{d}} = 40\ \text{m}^3/\text{d}$$

$$-\text{total:}\quad 60 + 40 = 100\ \text{m}^3/\text{d}$$

d) BOD concentration in the wastewater

$$\text{concentration} = \frac{\text{load}}{\text{flow}} = \frac{150\ \text{kg/d BOD}}{100\ \text{m}^3/\text{d}}.1000\ \text{g/kg} = 1{,}500\ \text{g/m}^3$$

$$= 1{,}500\ \text{mg/L}$$

WASTE WATER TREATMENT PROCESSES

Introduction

- Wastewater treatment broadly consists of four major steps –
  - Preliminary Treatment
  - Primary treatment
  - Secondary treatment
  - Tertiary Treatment

Level	Removal
Preliminary	• Coarse suspended solids (larger material and sand)
Primary	• Settleable suspended solids • Particulate (suspended) BOD (associated to the organic matter component of the settleable suspended solids)
Secondary	• Particulate (suspended) BOD (associated to the particulate organic matter present in the raw sewage, or to the non settleable particulate organic matter, not removed in the possibly existing primary treatment) • Soluble BOD (associated to the organic matter in the form of dissolved solids)
Tertiary	• Nutrients • Pathogenic organisms • Non-biodegradable compounds • Metals • Inorganic dissolved solids • Remaining suspended solids

Removal Efficiency

The *removal efficiency* of a pollutant in the treatment or in a treatment stage is given by the formula:

$$E = \frac{C_o - C_e}{C_o}.100 \qquad (4.1)$$

where:

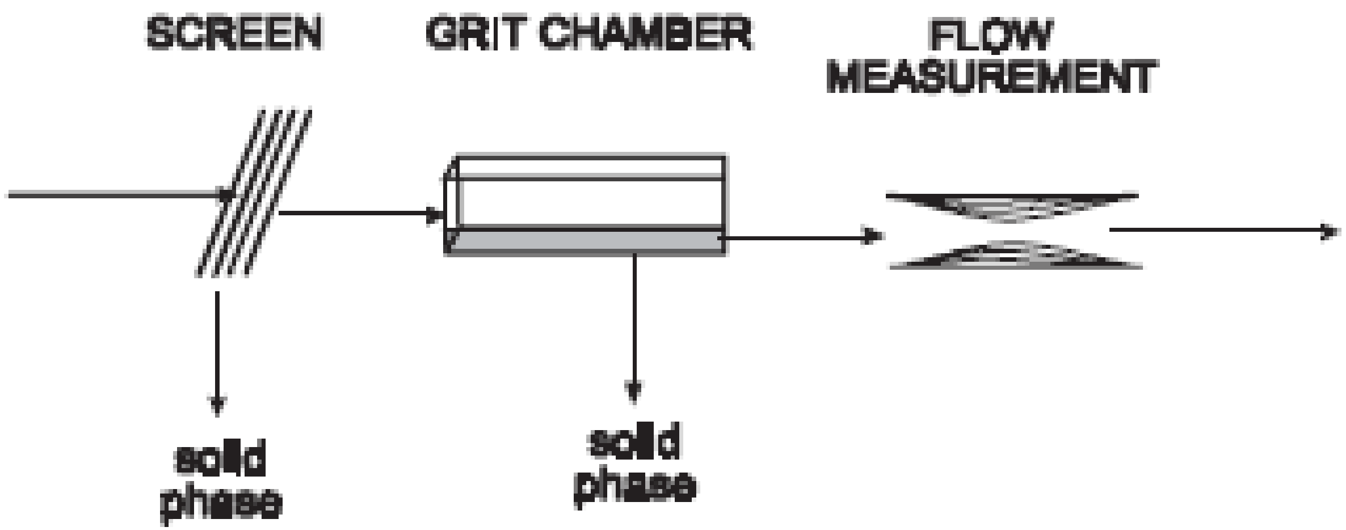
E = removal efficiency (%)
C_o = influent concentration of the pollutant (mg/L)
C_e = effluent concentration of the pollutant (mg/L)

Example

In a primary WWTP, the waste water before entering a sedimentation tank had a BOD of Concentration of 400 mg/L and after treatment had 120 mg/L. Calculate the efficiency of the Sedimentation Tank.

Preliminary treatment

- Preliminary treatment is required to remove the coarse solids and other large materials from raw wastewater.
- The operations include use of screens and grates for removal of large materials, comminutors for grinding of coarse solids, pre-aeration for odour control.
- Sometimes pH correction and removal of oil & grease is also done.



Primary treatment

- Primary wastewater treatment, at times, is the first step in the wastewater treatment process or it may be the second step after the preliminary treatment.

- It involves physical separation of suspended solids (total suspended solids) from the wastewater using primary clarifiers.

- The objective of primary treatment is to remove of settle-able organic and inorganic solids by sedimentation and removal of materials that float (scum) by skimming.

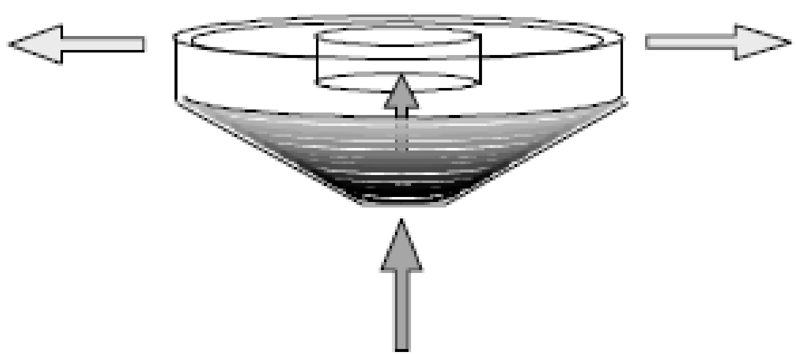
- Some organic nitrogen, organic phosphorus, and heavy metals associated with solids are removed during primary sedimentation but colloidal and dissolved constituents are not affected.

- The effluent from primary sedimentation units is referred to as primary effluent.

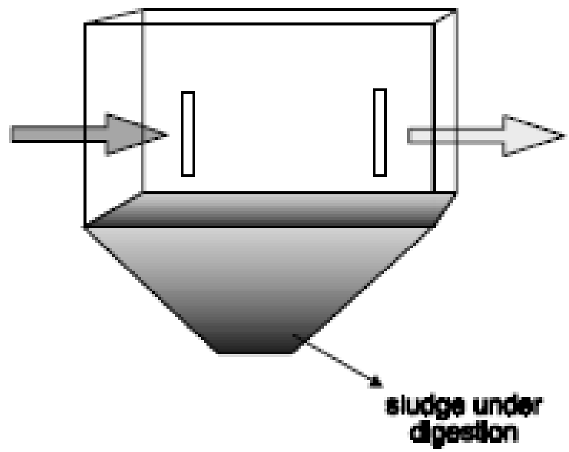
Primary treatment

- Sedimentation chambers are the main units involved in primary treatment but various auxiliary processes such as fine screening, flocculation and floatation may also be used.
- The second step may be chemical treatment (generally with lime and alum) which is sometimes preceded by flocculation.
- The purpose is to remove metals by precipitation but it also removes some associated colloidal BOD.
- The process generates chemical sludge.

PRIMARY SEDIMENTATION TANK



SEPTIC TANK

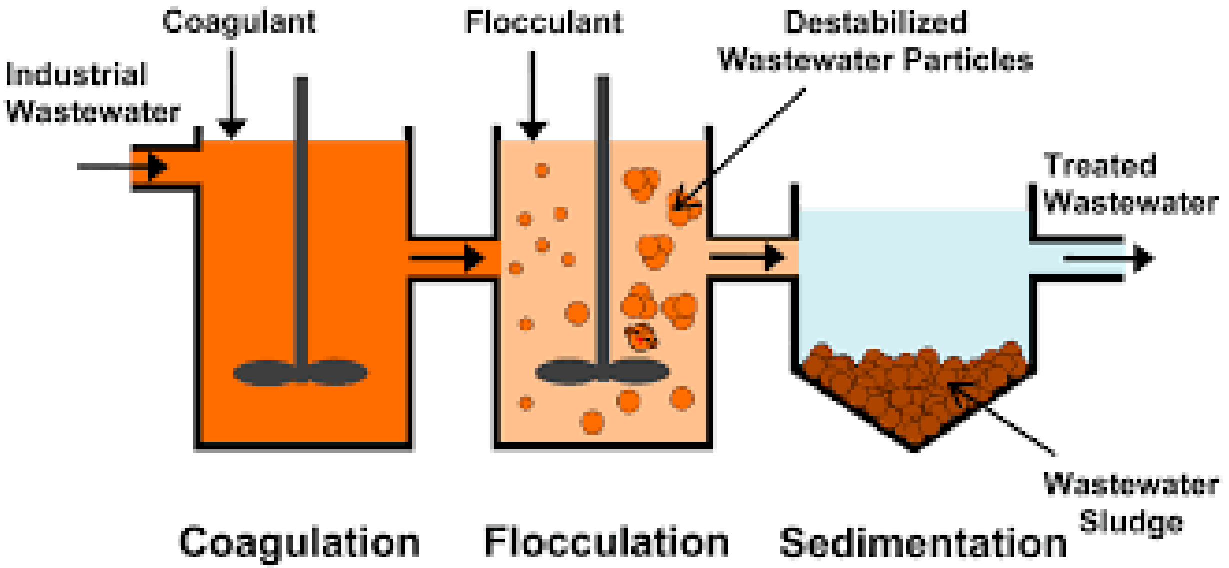


Primary treatment

Primary treatment involves various physical-chemical processes:.

Flocculation - a physico-chemical process for the aggregation of coagulated colloidal and finely divided suspended matter by physical mixing or chemical coagulant aids. The process involves mixing of wastewater stream with coagulants in a rapid mix tank, which is then passed on to the flocculation basin.

Sedimentation - this process is aimed to remove easy to settle solids. Sedimentation chambers may also include baffles and oil skimmers to remove grease and floatable solids and may include mechanical scrapers for removal of sludge at the bottom of the chamber.



Primary treatment

Dissolved Air Floatation - air-bubbles are introduced into the waste water, they attach themselves to the particles, thus causing them to float. This process of diffused air flotation can be used to remove suspended solids and dispersed oil and grease from oily wastewater.

Clarification- in a clarifier, wastewater is allowed to flow slowly and uniformly, permitting the solids to settle down. The clarified water flows from the top of the clarifier over the weir. Solids get collected at the bottom and sludge are periodically removed, dewatered and safely disposed.

Primary treatment

Chemical treatment processes.

Chemical treatment may be used at any stage in the treatment process as and when required (preferably before biological treatment as it removes toxic chemicals which may kill the microbes). Mainly used methods are:

Neutralization- incoming untreated wastewater has a wide range of pH. Neutralization is the process used for adjusting pH to optimize treatment efficiency. Acids such as sulphuric or hydrochloric may be added to reduce pH or alkalis such as dehydrated lime or sodium hydroxide may be added to raise pH values.

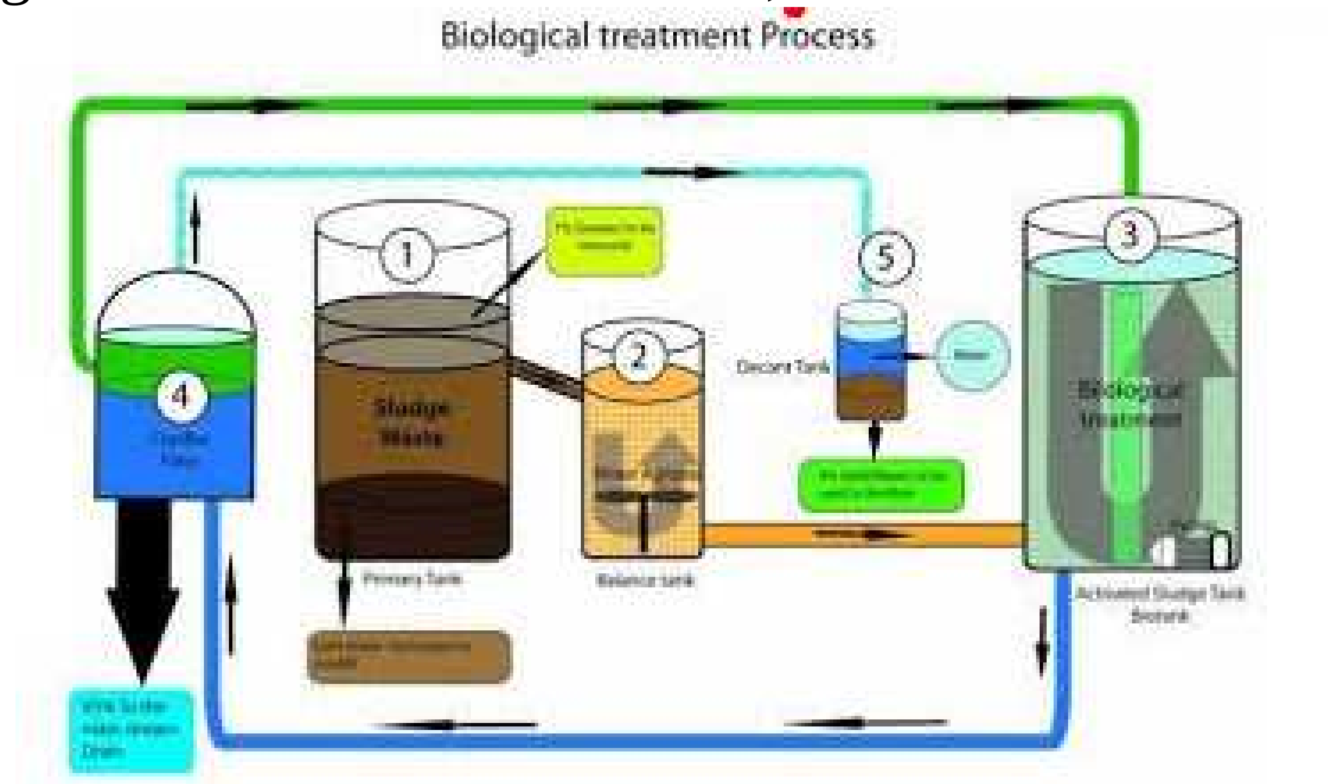
Precipitation - precipitation is carried out in two steps: in the first step, precipitants are mixed with wastewater allowing the formation of insoluble metal precipitants; in the second step, precipitated metals are removed from wastewater through clarification and/or filtration and the resulting sludge are properly treated, recycled or disposed.

Secondary treatment

- This process involves decomposition of suspended and dissolved organic matter in waste water using microbes.

- The mainly used biological treatment processes are activated sludge process or the biological filtration methods.

- Biological treatment can be aerobic, anaerobic or facultative.



Secondary treatment

Activated sludge process

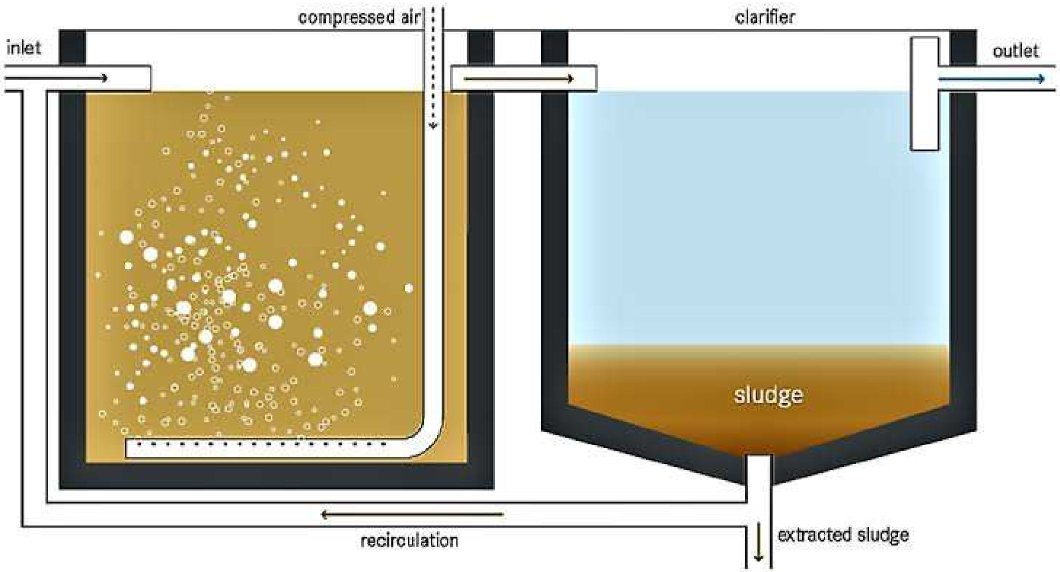
A continuous flow, aerobic biological treatment process that involves suspended growth of aerobic micro-organisms to biodegrade organic contaminants.

Influent is introduced in the aeration basin and allowed to mix with the contents. A suspension of aerobic microbes is maintained in the aeration tank.

A series of biochemical reactions in the basin degrade the organics and generate new bio mass. Microorganisms oxidize the matter into carbon dioxide and water using the supplied oxygen.

These organisms agglomerate colloidal and particulate solids. The mixture is passed to a settling tank or a clarifier where micro-organisms are separated from the treated water.

The settled solids are recycled back to the aeration tank to maintain a desired concentration of micro-organisms in the reactor and some of the excess solids are sent to sludge handling facilities.



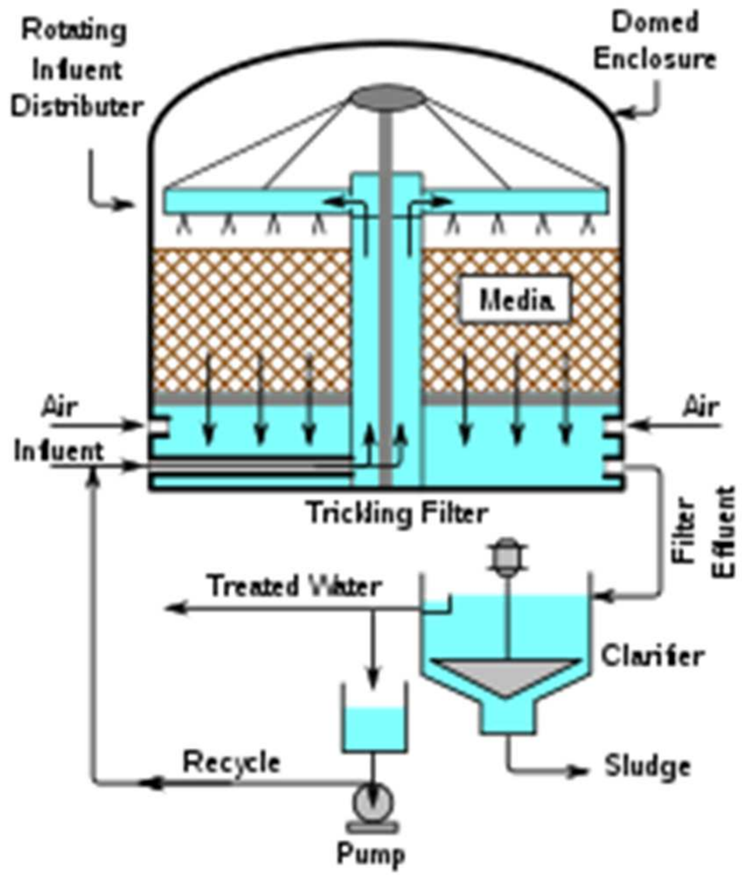
Secondary treatment

Biological filters

These filters are biological reactors filled with media which provide a surface that is repeatedly exposed to wastewater and air and on which a microbial layer can grow. The two most common types of biological filters are;

a) **Trickling Filters:** in trickling filters treatment is provide by a fixed film of microbes that forms on the surface which adsorbs organic particles and degrades them aerobically. Wastewater is distributed over a bed made of rock or plastic and flows over the media by gravity.

b) **Rotating Biological Contractor (RBC):** the setup consists of a series of discs; about 40% of the area is immersed in wastewater. The RBC provides a surface for microbial slime layer. The alternating immersion and aeration of a given portion of the disc enhances growth of the attached micro-organisms and facilitates oxidation of organic matter in a relatively short time and provides a high degree of treatment

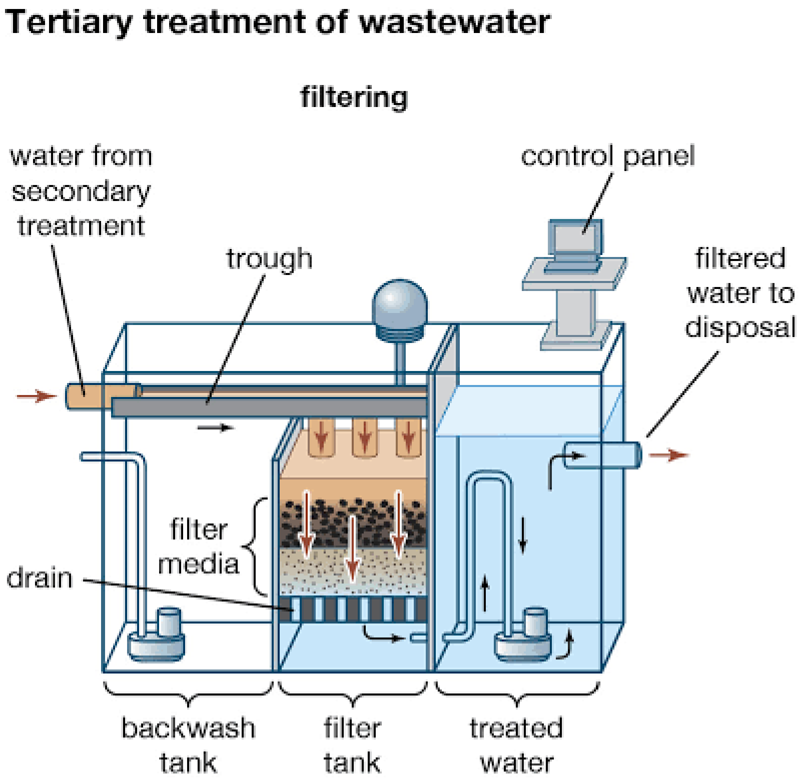


Tertiary treatment

- Tertiary treatment is the final cleaning process that improves wastewater quality before it is reused, recycled or discharged to the environment.

- Tertiary treatment can involve physical-chemical separation techniques such as activated carbon adsorption, flocculation/precipitation, membranes filtration, ion exchange, de-chlorination and reverse osmosis.

- Advanced treatment processes which generally constitute of or are part of the tertiary treatment may also sometimes be used in primary or secondary treatment or used in place of secondary treatment.



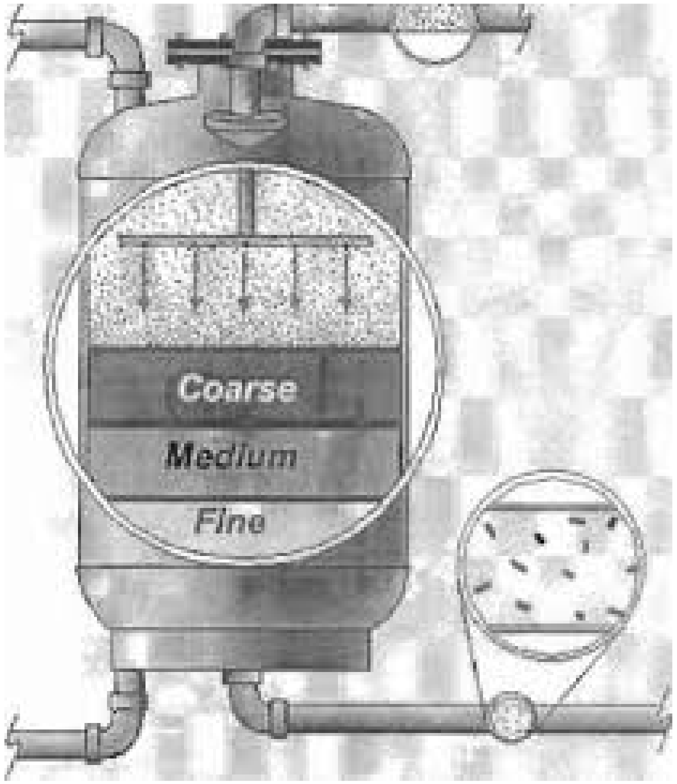
Tertiary treatment

Some of the common tertiary treatment processes are described below:

Granular Media Filtration- Many processes fall under this category and the common element being the use of mineral particles as the filtration medium.
It removes suspended solids mainly by physical filtration. Two common types of these granular media filers are:

- **a) Sand filters:** the most common type which consists of either a fixed or moving bed of media that traps and removes suspended solids from water passing through media.
- **b) Dual or multimedia filtration:** consists of two or more media and it operates with the finer, denser media at the bottom and coarser, less dense media at the top. Common arrangement is granite base at the bottom, sand in the middle and anthracite coal at the top. Flow pattern of multimedia filters is usually from top to bottom with gravity flow. These filters require periodic back washing to maintain their efficiency.

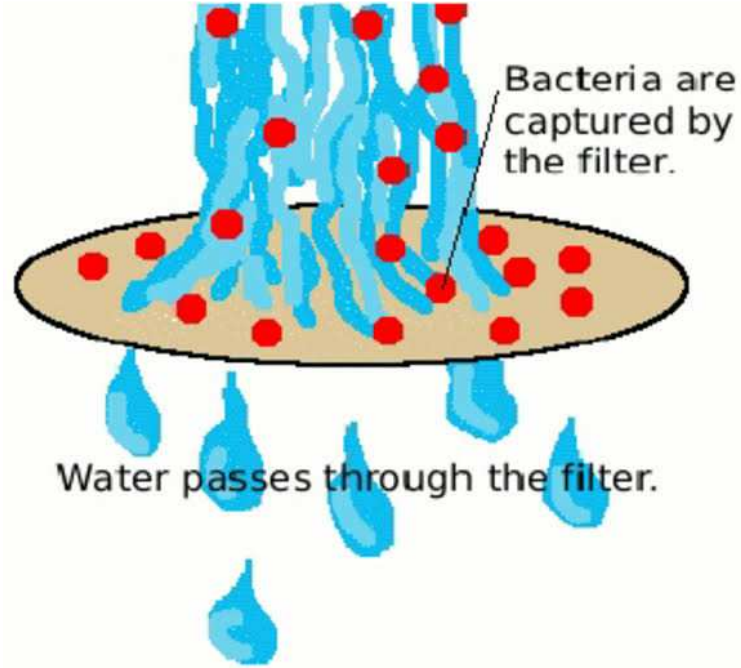
These processes are most commonly used for supplemental removal of residual suspended solids from the effluents of chemical treatment processes.



Tertiary treatment

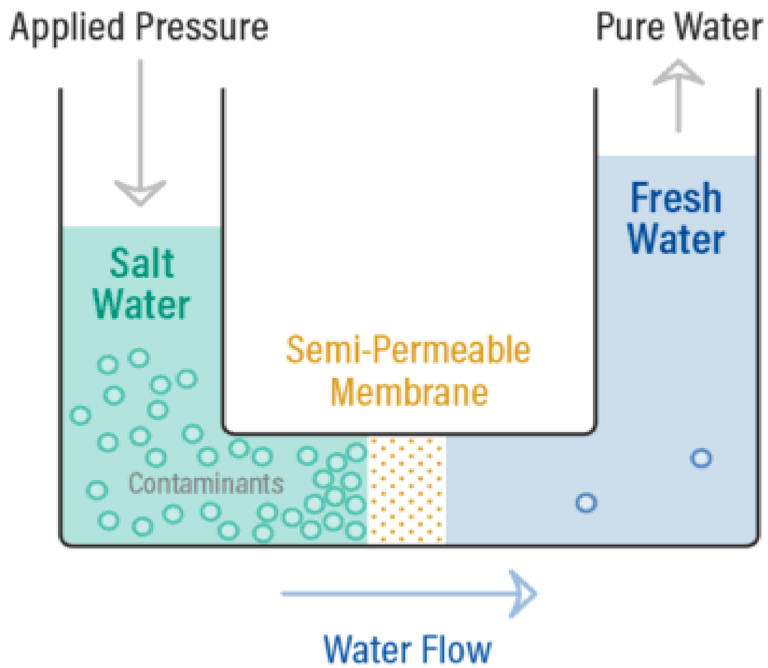
Membrane Filtration: In membrane filtration, a solvent is passed through a semipermeable membrane.

The membrane's permeability is determined by the size of the pores in the membrane. Microfiltration, ultrafiltration and Nano-filtration are examples of membrane filtration techniques.



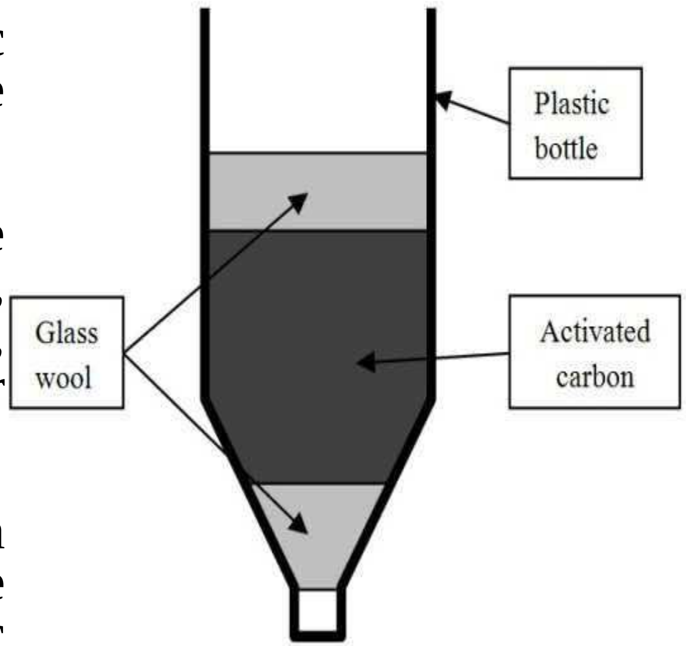
Reverse Osmosis Systems– This is also a membrane separation method that is used to remove several types of large molecules and ions from solutions through application of pressure to the wastewater on one side of a selective membrane.

The result is that the contaminant is retained on the pressurized side of the membrane and the treated waste water is allowed to pass to the other side.



Tertiary treatment

Activated carbon- Powdered as well as granular activated carbons are used for the purpose of de-chlorination of organic compounds. Organic compounds in waste water are adsorbed on to the surface of the activated carbon.



A number of factors affect the effectiveness of the activated carbon. These include pore size, composition and concentration of the contaminant, temperature and pH of the water and the flow rate or contact time of exposure.

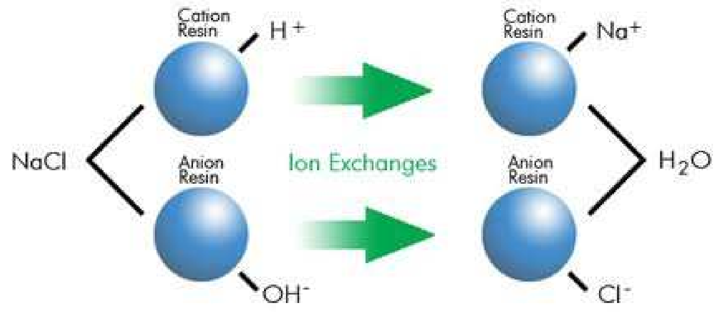
Activated carbon can be applied on a broad spectrum of organic pollutants and is typically used to remove contaminants from water such as pesticides, aromatic compounds such as phenol, absorbable organic halogens, non-biodegradable organic compounds, colour compounds and dyes, chlorinated/halogenated organic compounds, toxic compounds, compounds that normally inhibits biological treatments, oil removal in process condensates, halogens, especially chlorine that oxidizes downstream processes and organics that have the potential to foul ion exchange resins or reverse osmosis membranes.

Tertiary treatment

Ion Exchange –Ion Exchange can be used in wastewater treatment plants to swap one ion for another for the purpose of demineralization.

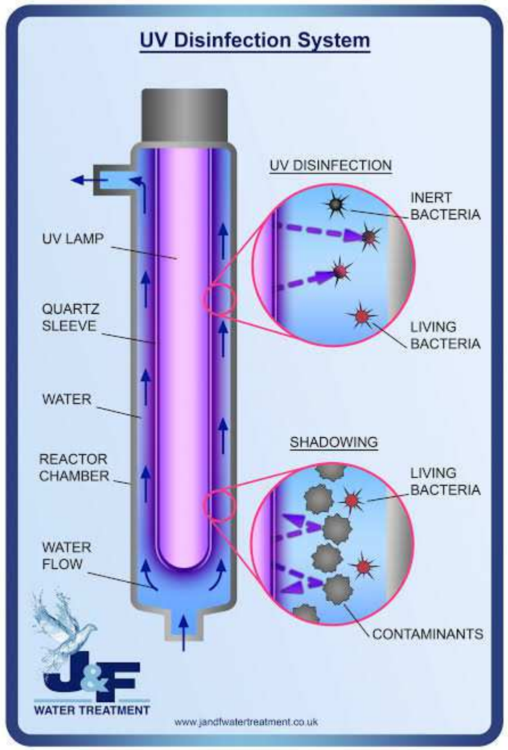
There are basically two types of ion exchange systems, the anion exchange resins and the cation exchange resins.

It can be used for softening, purification, decontamination, recycling, removal of heavy metals from electroplating wastewaters and other industrial processes, polish wastewater before discharging, removal of ammonium ion from wastewaters, salt removal, purify acids and bases for reuse, removal of radioactive contaminants in the nuclear industry, etc.



- **Ultraviolet (UV) Disinfection** – This technique is primarily employed as a disinfection process that inactivates waterborne pathogens without use of chemicals.

Additionally, UV is also effective for residual TOC removal, destruction of chloramines and ozone.



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