INDUSTRIAL WASTEWATER TREATMENT

Course code: ACE526

III B. Tech II semester

Regulation: IARE R-16

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CO’s	Course outcomes
CO1	Distinguish between the quality of domestic and industrial water requirements and Wastewater quantity generation.
CO2	Understand the industrial process, water utilization and waste water generation.
CO3	Acquire the knowledge on operational problems of common effluent treatment plants.

COs	Course Outcome
CO4	Impart knowledge on selection of treatment methods for industrial wastewater.
CO5	Specify design criteria for physical, chemical, and biological unit operations.

UNIT – I
CHARACTERISTICS OF INDUSTRIAL WASTE WATER

CLOs	Course Learning Outcome
CLO1	Know the different sources of wastewater pollution from industries.
CLO2	Understand the Physical, chemical, organic and biological properties of industrial wastes.
CLO3	Define the Characteristics and composition of waste water.
CLO4	Effects of industrial effluents on sewers and natural water bodies.

Definition

Industrial wastewater treatment describes the processes used for treating wastewater that is produced by industries as an undesirable by-product. After treatment, the treated industrial wastewater (or effluent) may be reused or released to a sanitary sewer or to a surface water in the environment.

- Industrial wastewater treatment covers the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re-use.
- Most industries produce some wet waste although recent trends in the developed world have been to minimize such production or recycle such waste within the production process.

Why do we need to treat wastewater ?

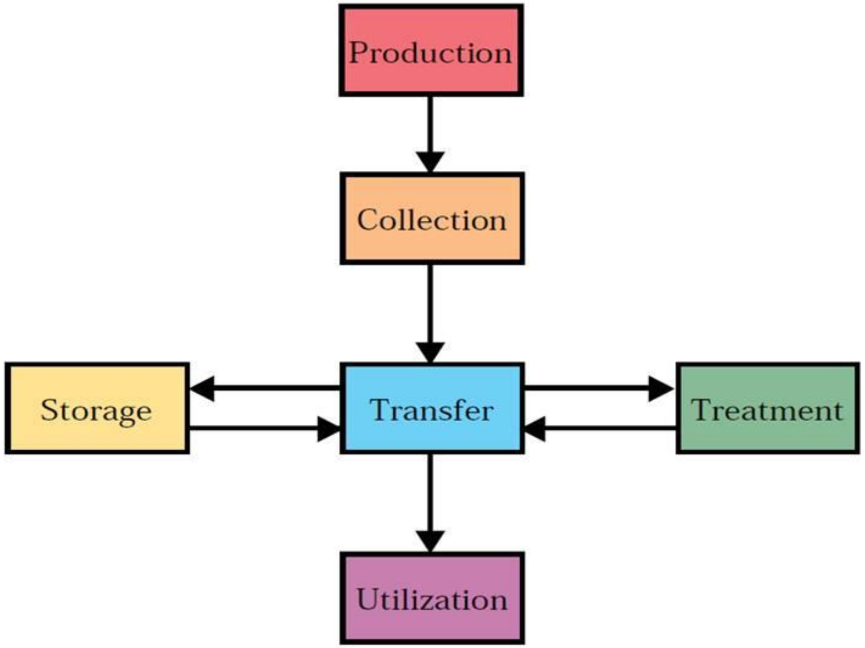
- To prevent groundwater pollution
- To prevent sea shore
- To prevent soil
- To prevent marine life
- Protection of public health
- To reuse the treated effluent

- For agriculture use
- ground water recharge
- For industrial recycle
- Solving social problems caused by the accumulation of wastewater

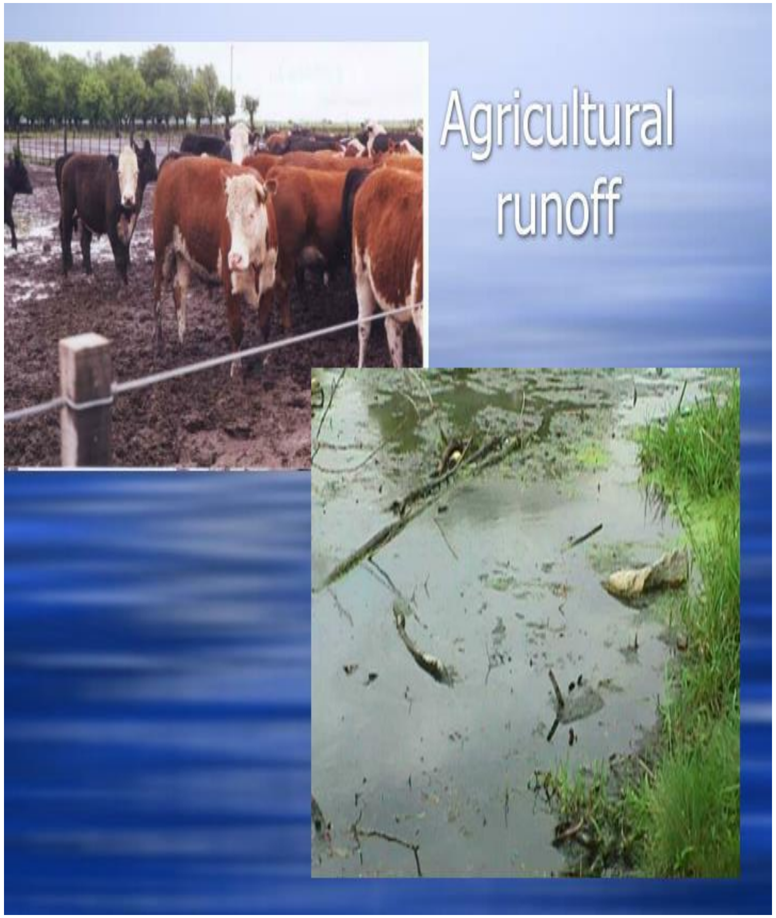
Protecting the public health:

- Wastewater contains pathogenic microorganisms lead to dangerous diseases to humans and animals.
- Hazardous matter such as heavy metals that are toxic. Produces odorous gases and bad smell.

Waste Reduction Principle



Agricultural wastewater



Agricultural wastewater

- Agricultural wastewater treatment relates to the treatment of wastewaters produced in the course of agricultural activities.

- Agriculture is a highly intensified industry in many parts of the world, producing a range of wastewaters requiring a variety of treatment technologies and management practices.

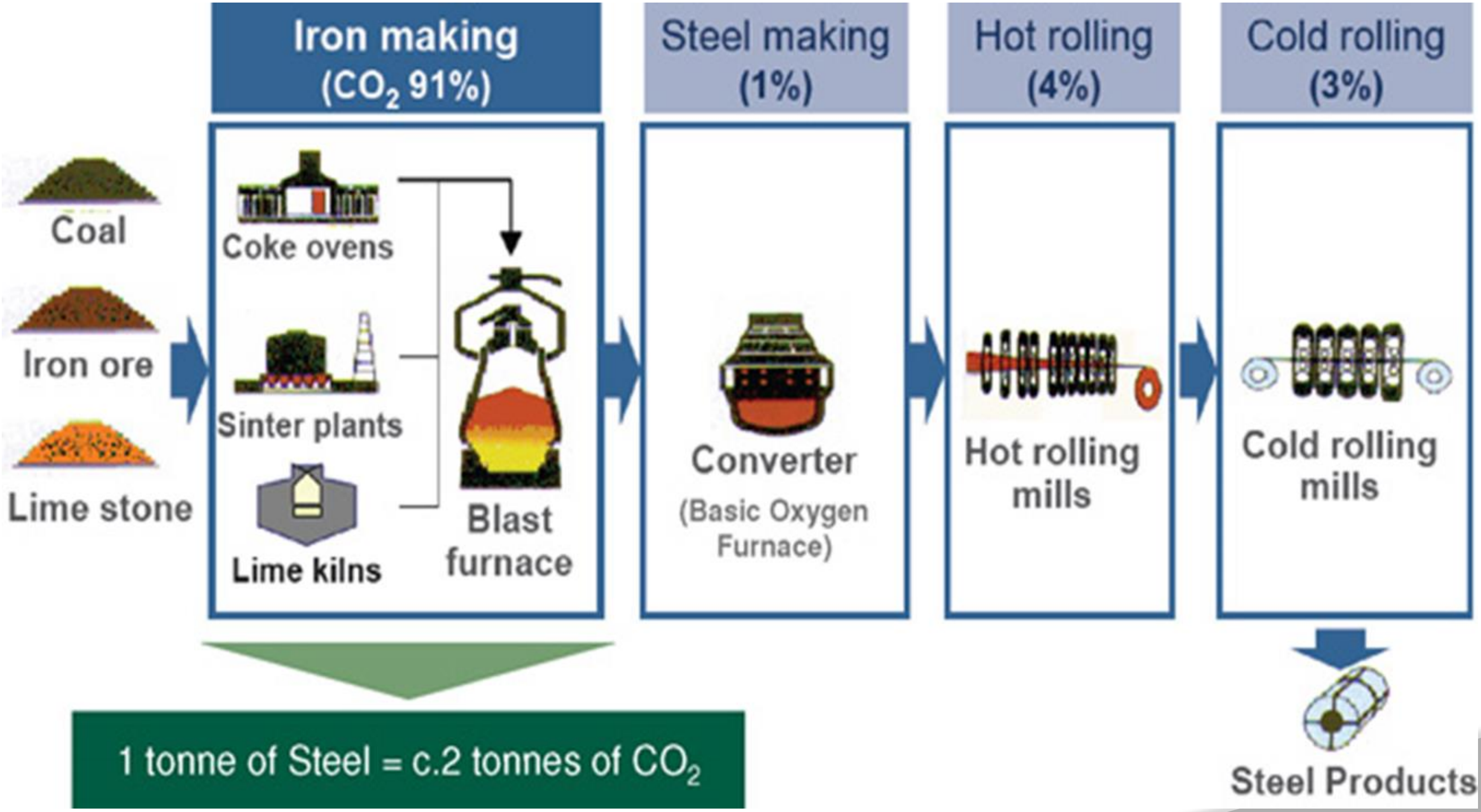
- Agricultural wastewater treatment is a farm management agenda for controlling pollution from surface runoff that may be contaminated by chemicals in fertilizer, pesticides, animal slurry, crop residues or irrigation water.

Iron and steel industry

Iron and steel industry

- The production of iron from its ores involves powerful reduction reactions in blast furnaces. Cooling waters are inevitably contaminated with products especially ammonia and cyanide.
- Production of coke from coal in coking plants also requires water cooling and the use of water in by-products separation.
- Contamination of waste streams includes gasification products such as benzene, naphthalene, anthracene, cyanide, ammonia, phenols, cresols together with a range of more complex organic compounds known collectively as polycyclic aromatic hydrocarbons (PAH).

- The conversion of iron or steel into sheet, wire or rods requires hot and cold mechanical transformation stages frequently employing water as a lubricant and coolant.
- Contaminants include hydraulic oils, tallow and particulate solids.
- Final treatment of iron and steel products before onward sale into manufacturing includes pickling in strong mineral acid to remove rust and prepare the surface for tin or chromium plating or for other surface treatments such as galvanization or painting.



Iron making
(CO_2 91%)
Steel making
(1%)
Hot rolling
(4%)
Cold rolling
(3%)
Coal
Iron ore
Lime stone
Coke ovens
Sinter plants
Lime kilns
Blast furnace
Converter
(Basic Oxygen Furnace)
Hot rolling mills
Cold rolling mills
Steel Products
1 tonne of Steel = c.2 tonnes of CO_2

- The two acids commonly used are hydrochloric acid and sulfuric acid. Wastewaters include acidic rinse waters together with waste acid.
- Although many plants operate acid recovery plants, (particularly those using Hydrochloric acid), where the mineral acid is boiled away from the iron salts, there remains a large volume of highly acid ferrous sulfate or ferrous chloride to be disposed of.
- Many steel industry wastewaters are contaminated by hydraulic oil also known as soluble oil.

Mines and quarries

- The principal waste-waters associated with mines and quarries are slurries of rock particles in water.
- These arise from rainfall washing exposed surfaces and haul roads and also from rock washing and grading processes.
- Volumes of water can be very high, especially rainfall related arising on large sites.
- Some specialized separation operations, such as coal washing to separate coal from native rock using density gradients, can produce wastewater contaminated by fine particulate hematite and surfactants.

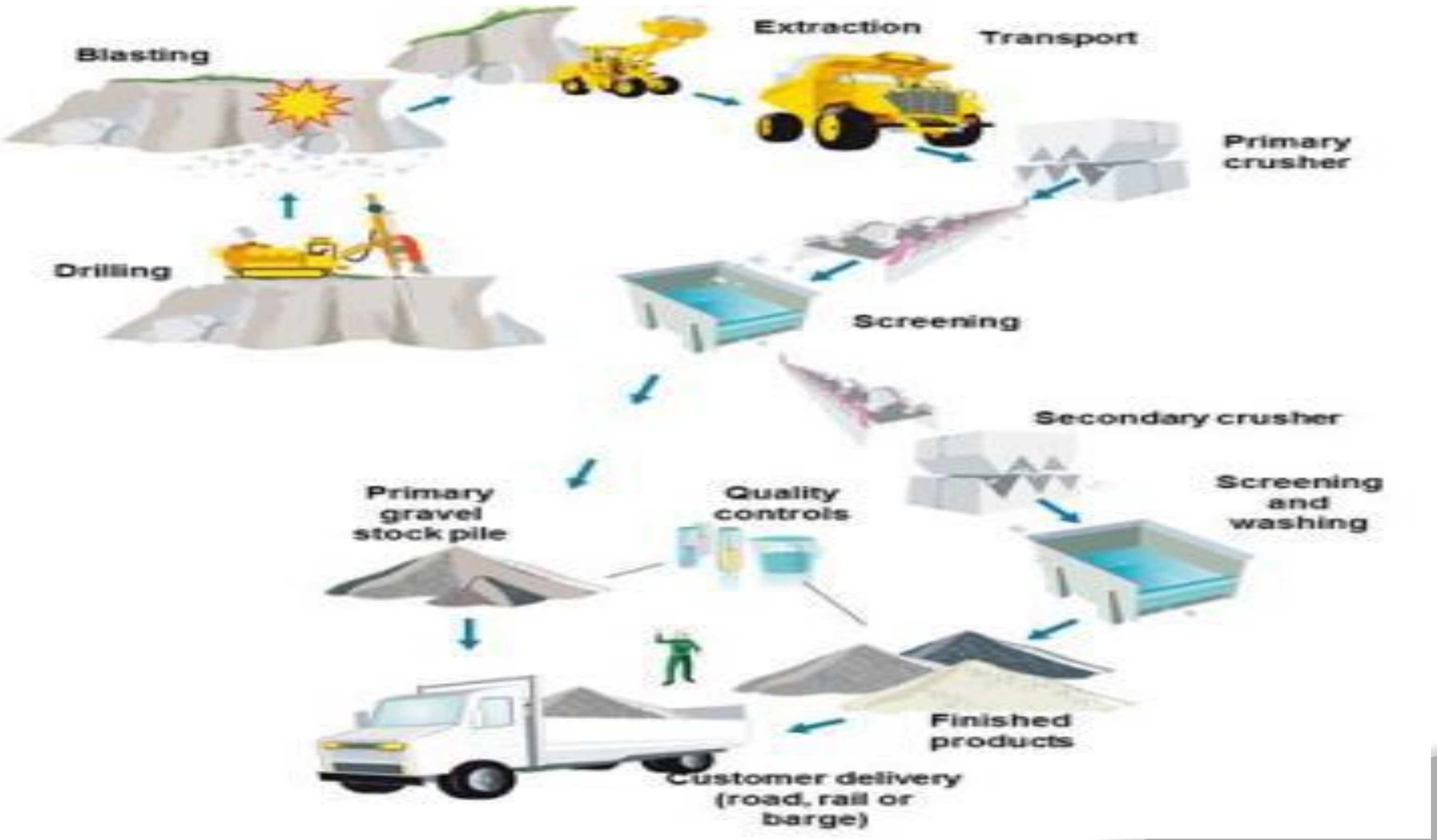
- Oils and hydraulic oils are also common contaminants.

- Wastewater from metal mines and ore recovery plants are inevitably contaminated by the minerals present in the native rock formations.

- Following crushing and extraction of the desirable materials, undesirable materials may become contaminated in the wastewater.

- For metal mines, this can include unwanted metals such as zinc and other materials such as arsenic.

- Extraction of high value metals such as gold and silver may generate slimes containing very fine particles in where physical removal of contaminants becomes particularly difficult.


Blasting
Extraction
Transport
Primary crusher
Drilling
Screening
Secondary crusher
Primary gravel stock pile
Quality controls
Screening and washing
Finished products
Customer delivery (road, rail or barge)

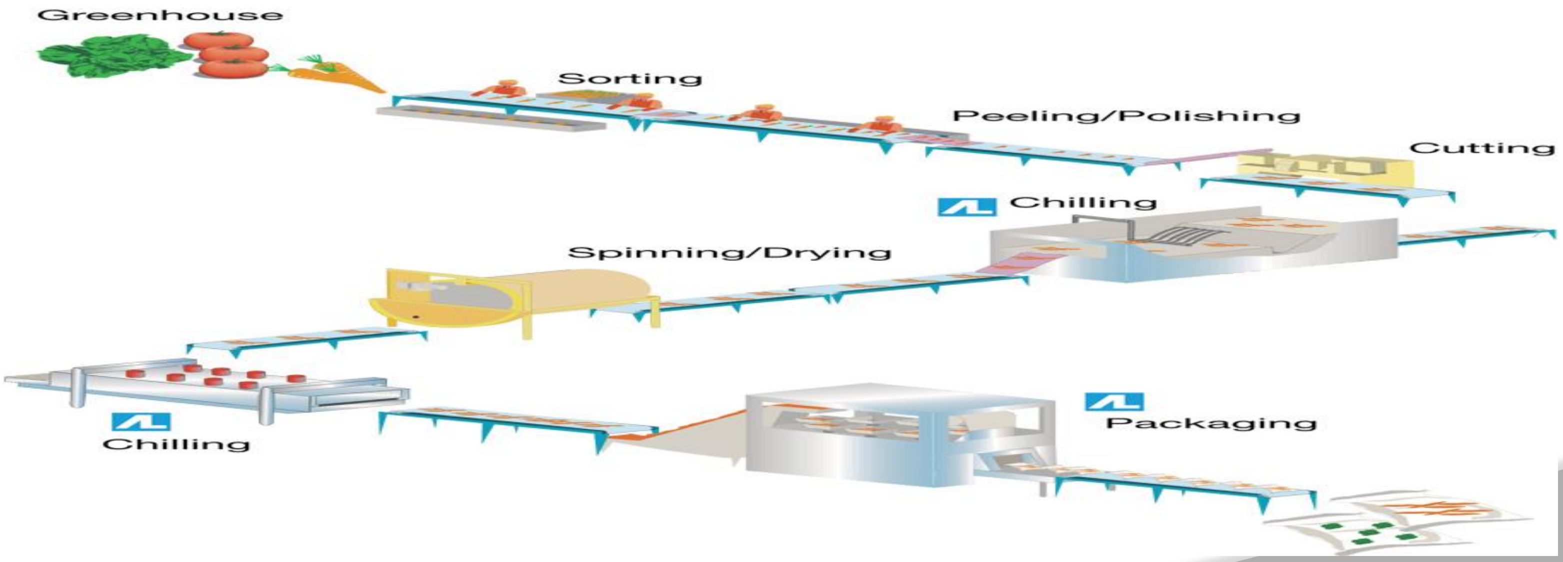
Food Processing Industry

- Wastewater generated from agricultural and food operations has distinctive characteristics that set it apart from common municipal wastewater managed by public or private wastewater treatment plants throughout the world: it is biodegradable and nontoxic, but that has high concentrations of biochemical oxygen demand (BOD) and suspended solids (SS).
- The constituents of food and agriculture wastewater are often complex to predict due to the differences in BOD and pH in effluents from vegetable, fruit, and meat products and due to the seasonal nature of food processing and post harvesting.
- Processing of food from raw materials requires large volumes of high grade water.

- Vegetable washing generates waters with high loads of particulate matter and some dissolved organics.
- It may also contain surfactants.

- Animal slaughter and processing produces very strong organic waste from body fluids, such as blood, and gut contents.
- This wastewater is frequently contaminated by significant levels of antibiotics and growth hormones from the animals and by a variety of pesticides used to control external parasites.

- Insecticide residues in fleeces is a particular problem in treating waters generated in wool processing.
- Processing food for sale produces wastes generated from cooking which are often rich in plant organic material and may also contain salt, flavourings, colouring material and acids or alkali. Very significant quantities of oil or fats may also be present.



Complex organic chemicals industry

- A range of industries manufacture or use complex organic chemicals. These include pesticides, pharmaceuticals, paints and dyes, petro-chemicals, detergents, plastics, paper pollution, etc.
- Waste waters can be contaminated by feed-stock materials, by-products, product material in soluble or particulate form, washing and cleaning agents, solvents and added value products such as plasticizers.
- Treatment facilities that do not need pH control of their effluent typically opt for a type of aerobic treatment, i.e. Aerated Lagoons.

- **Radioactive waste** is a waste product containing radioactive material. It is usually the product of a nuclear process such as nuclear fission, though industries not directly connected to the nuclear power industry may also produce radioactive waste.
- Radioactivity diminishes over time, so in principle the waste needs to be isolated for a period of time until it no longer poses a hazard
- This can mean hours to years for some common medical or industrial radioactive wastes, or thousands of years for high-level wastes from nuclear power plants and nuclear weapons reprocessing.

Nuclear industry

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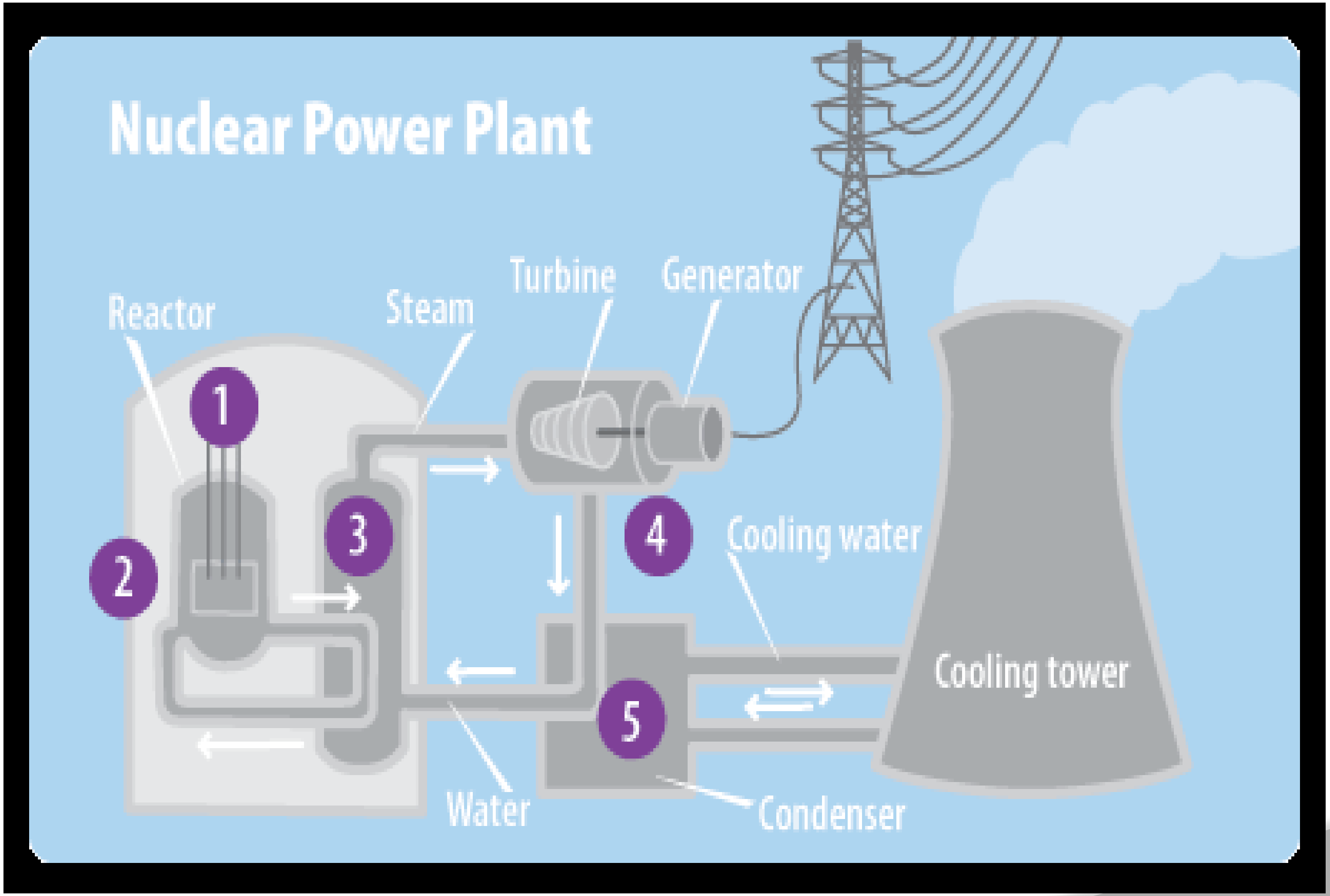
- The majority of radioactive waste is "low-level waste", meaning it has low levels of radioactivity per mass or volume.
- The main approaches to managing radioactive waste to date have been segregation and storage for short-lived wastes, near-surface disposal for low and some intermediate level wastes, and deep burial or transmutation for the long-lived, high-level wastes.



Nuclear Power Plant
Reactor
Steam
Turbine
Generator
1
2
3
4
Cooling water
Cooling tower
5
Water
Condenser

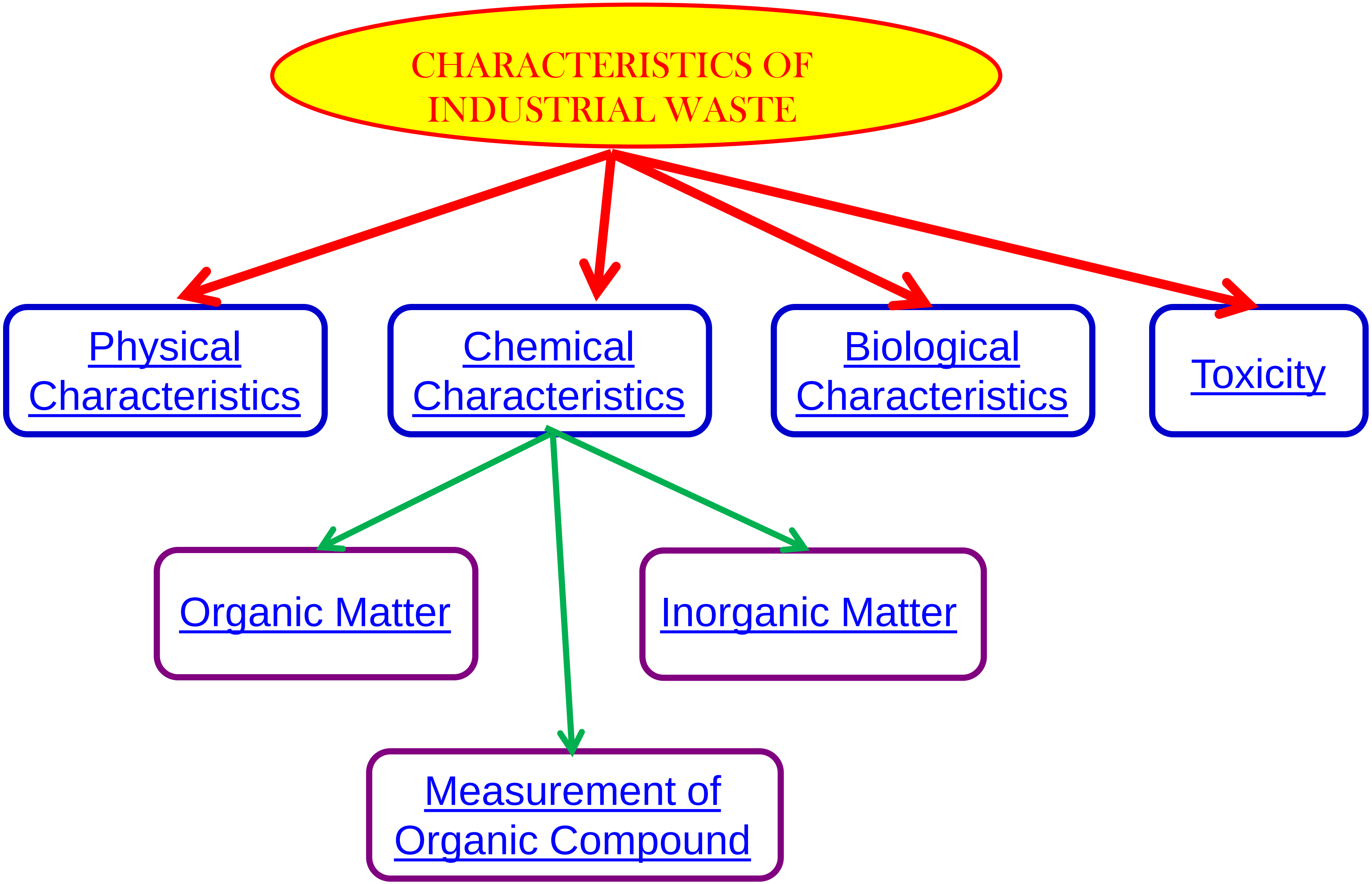
Protecting the environment

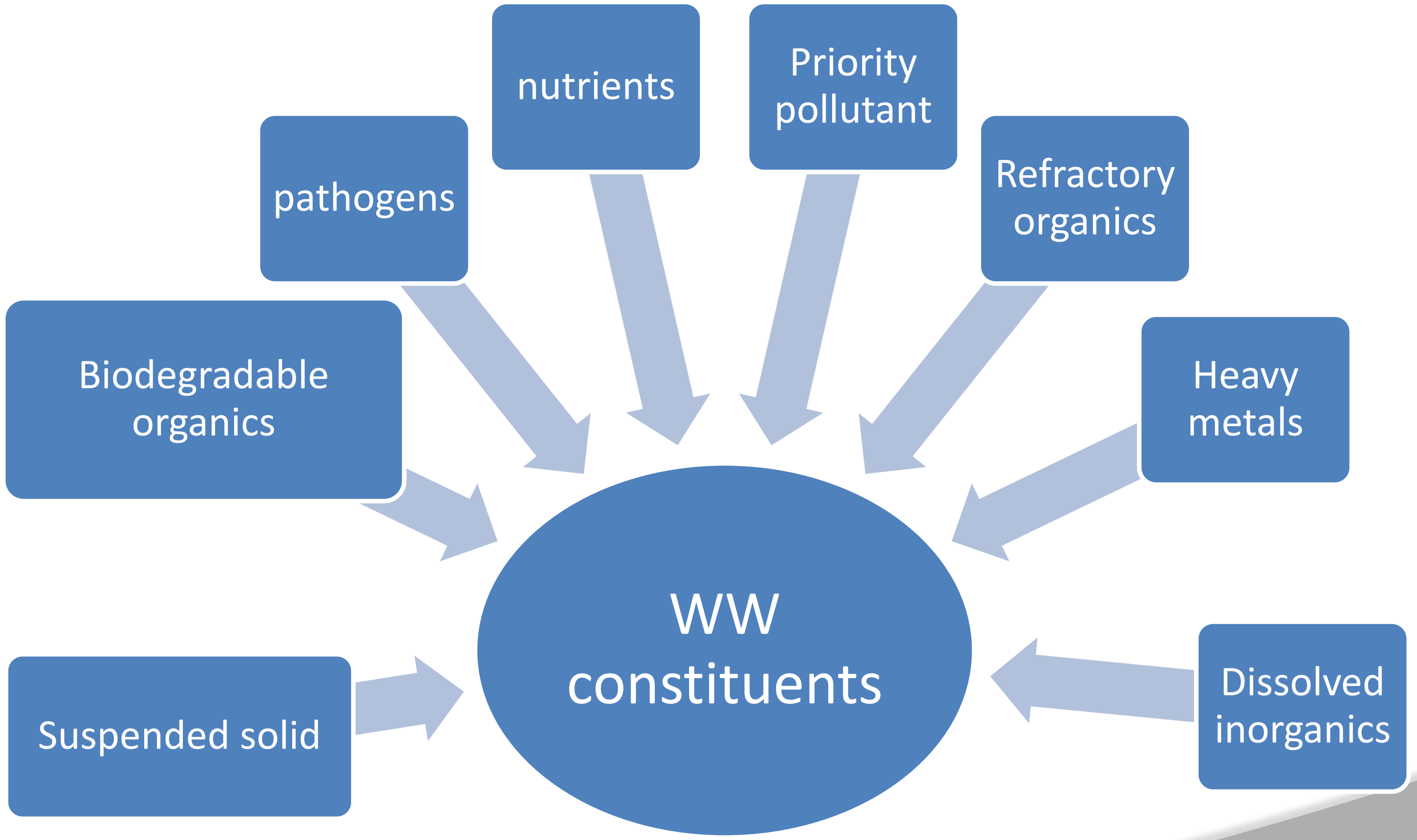
- Raw Wastewater leads to septic conditions in the environment and consequently leads to the deterioration of surface and groundwater quality and pollutes the soil.
- Raw wastewater is rich with nitrogen and phosphorus (N, P) and leads to the phenomena of EUTROPHICATION.
- Raw wastewater is rich with organic matter which consumes oxygen in aquatic environment.
- Raw wastewater may contains toxic gases and volatile organic matter.

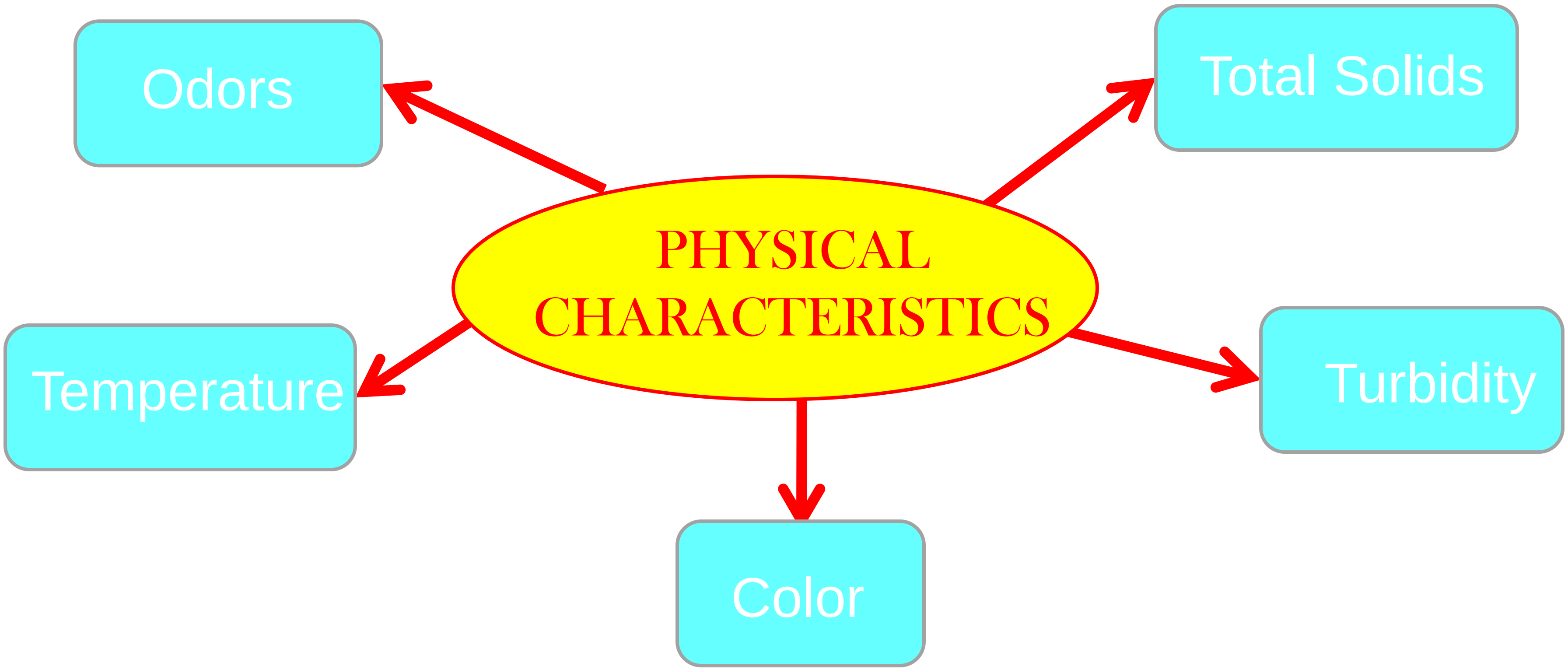
Physical, chemicals and biological properties of wastewater

Characteristic	Sources
Physical properties: Color	Domestic and industrial wastes, natural decay of organic materials
Odor	Decomposing wastewater, industrial wastes.
Solids	Domestic water supply, domestic and industrial wastes, soil erosion, inflow infiltration
Temperature	Domestic and industrial wastes
Chemical constituents: Organic: Carbohydrates	Domestic, commercial, and industrial wastes
Fats, oils, and grease	Domestic, commercial, and industrial wastes
Pesticides	Agricultural wastes
Phenols	Industrial wastes
Proteins	Domestic, commercial, and industrial wastes
Priority pollutants	Domestic, commercial, and industrial wastes

Surfactants	Domestic, commercial, and industrial wastes
Volatile organic compounds	Domestic, commercial, and industrial wastes
Other	Natural decay of organic materials
Inorganic: Aikalinity	Domestic wastes, domestic water supply, groundwater infiltration
Chlorides	Domestic wastes, domestic water supply, groundwater infiltration
Heavy metals	Industrial wastes
Nitrogen	Domestic and agricultural wastes
PH	Domestic, commercial, and industrial wastes
Phosphorus	Domestic, commercial, and industrial wastes natural runoff
Priority polluter Sulfur	Domestic water supply; doestic, commercial. And industrial wastes
Gases: Hydrogen sulfide	Decomposition of domestic wastes
Methane	Decomposition of domestic wastes
Oxygen	Domestic water supply , surface- water infiltration
Biological constituents: Animals	Open watercourses and treatment plants
Plants	Open watercourses and treatment plants
Eubacteria	Domestic wastes, surface water infiltration, treatment plants .
Archaebacteria	Domestic wastes, surface-water infiltration, treatment plants
Viruses	Domestic wastes


CHARACTERISTICS OF INDUSTRIAL WASTE
Physical Characteristics
Chemical Characteristics
Biological Characteristics
Toxicity
Organic Matter
Inorganic Matter
Measurement of Organic Compound


nutrients
Priority pollutant
pathogens
Refractory organics
Biodegradable organics
Heavy metals
WW constituents
Suspended solid
Dissolved inorganics


PHYSICAL CHARACTERISTICS
Odors
Total Solids
Temperature
Turbidity
Color

Total Solids (TS)

Sludge is solids removed from WW during treatment.

Solids that are treated further are term biosolids

TS content

- Floating matter
- Settleable matter
- Colloidal matter
- Matter in solution

Solid classification

Total Solids (TS)

- Mass remaining after a WW sample has been evaporated at 103–105 °C

Total Suspended Solids (TSS)

- Mass remaining on Whatman GF/C after drying at 105 °C
- After WW sample has been filtered, the preweighted filter paper is placed in an aluminium dish for drying before weighing.

Total Dissolved Solids (TDS)

- Solid that pass through the filter, & are then evaporated at specific temp.
- Contains a high fraction of colloidal solids.

Volatile Suspended Solids (VSS)

- Solid that can be volatilized & burned off when the TSS are ignited at 500 ± 50°C.

Turbidity

Turbidity

- A measure of the light-transmitting properties of water due to the presence of colloidal & residual suspended matter
- Measurement based on comparison of the intensity of light scattered by a sample to the light scattered by a reference suspension under the same conditions.
- Unit → Nephelometric Turbidity Unit (NTU)
- Colloidal matter will scatter or absorb light and this prevent its transmission.

color

Color

- Refer to degree of absorption of light energy in visible spectrumm (400 – 700 nm)
- Fresh WW color → light brownish-gray
- Then changes to gray, dark gray & black color due to the formation of metallic sulfide (sulfide produced under anaerobic conditions)
- When the color of the WW is black, the WW is often described as septic

Temperature

Temperature

Temp. of WW >>Temp. of local water supply due to the addition of warm water from households and industrial activities.

Very important because of its effect on chemical reaction & light reaction rates, aquatic life & suitability of the water for the beneficial uses

At high temp.

- O_2 is less soluble in warm water
- High mortality rate of aquatic life
- Foster the growth of undesirable water plants & WW fungus
- Increase in rate of biochemical reactions, thus decrease the quantity of oxygen present in surface waters.

Odors

Caused by gases produced by the decomposition of organic matter or by substance added to the WW.

of organic matter or by substance added to the WW.

Industrial WW may contain odorous compounds or compounds that produce odors during the process of WW treatment.

light

Effect of odors

Vomitting

Caused poor appetite for food

Lowered water consumption

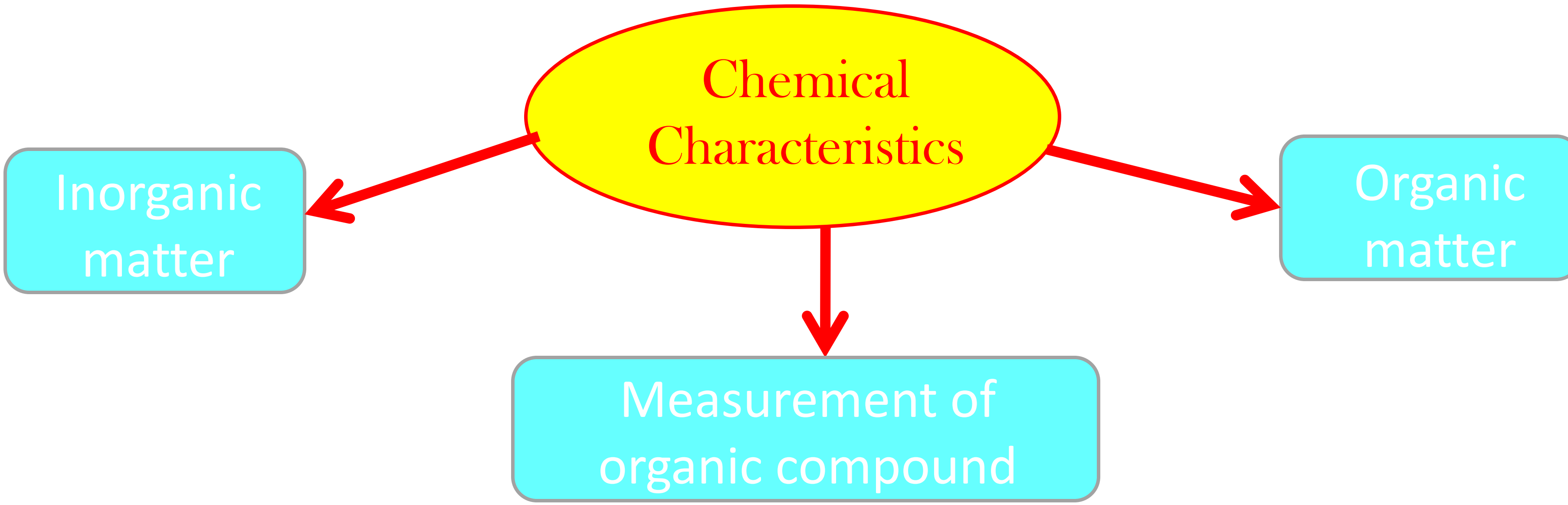
H_2S toxic at elevated concentration

Can create psychological stress on human being at low concentration

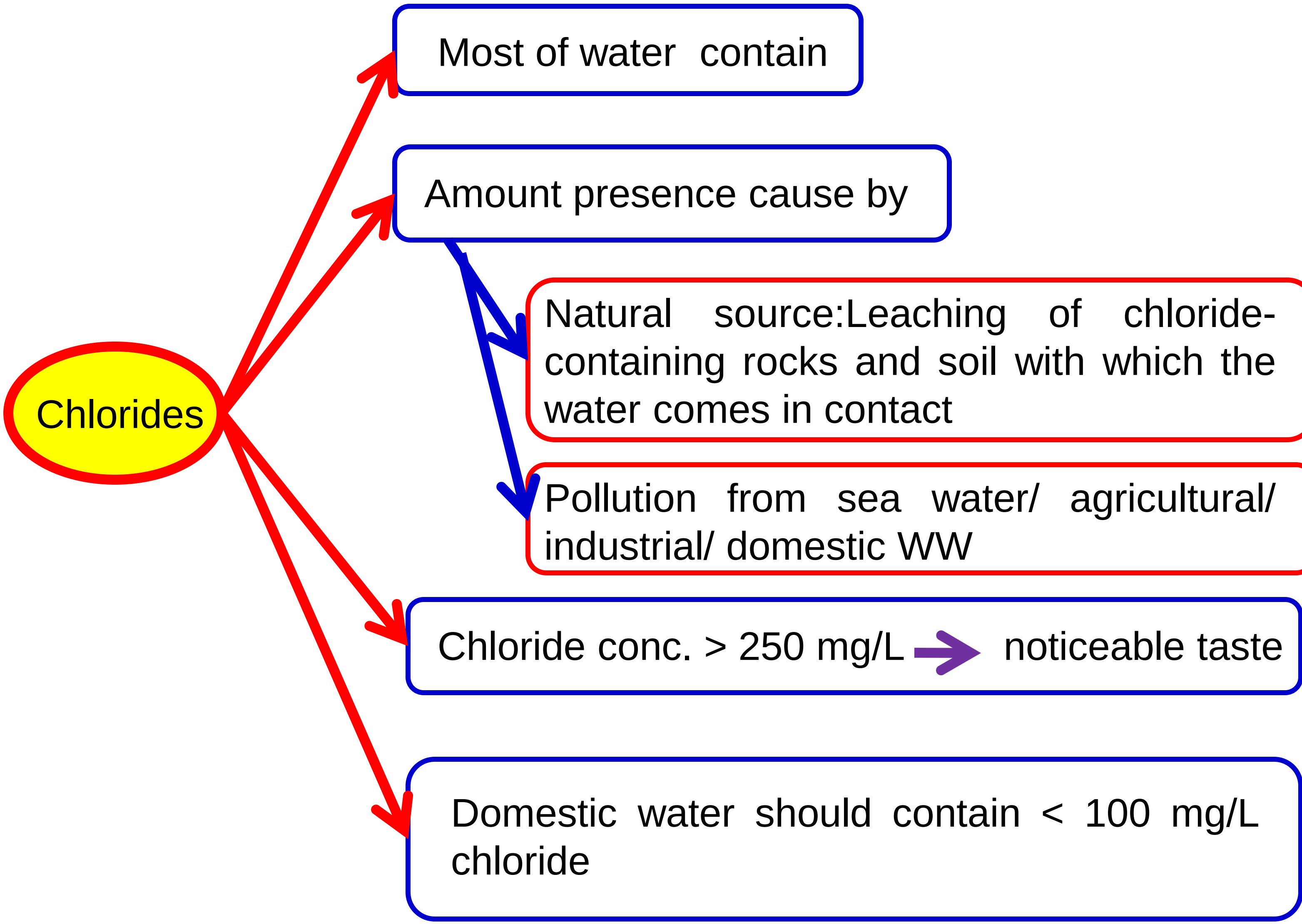
Ph

- The hydrogen-ion concentration is an important parameter in both natural waters and wastewaters.
- It is a very important factor in the biological and chemical wastewater treatment.
- Water and wastewater can be classified as neutral, alkaline or acidic according to the following ranges:
- **PH = 7 neutral, PH > 7 Alkaline, PH < 7 Acidic.**
- Wastewater with an adverse concentration of hydrogen ion is difficult to treat by biological means, and if the concentration is not altered before discharge, the wastewater effluent may alter the concentration in the natural waters.

CHEMICAL CHARACTERISTICS



INORGANIC MATTER



INORGANIC MATTER

Nitrogen

- Essential to the growth of microorganisms, plants & animals (known as nutrients)
- Because of N_2 is an essential building block in the synthesis of protein, N_2 data will be required to evaluate the treatability of WW by biological processes.
- Insufficient N_2 can necessitate the addition of N_2 to make the waste treatable.
- Where control of algal growths in the receiving water is necessary, removal or reduction of N_2 in WW prior to discharge may be desirable.
- Total N_2 is comprised of organic N_2, ammonia, nitrite & nitrate

INORGANIC MATTER

Phosphorus

- Phosphorus is also essential to the growth of algae and other biological organisms.
- Forms of Phosphorus
  - Orthophosphate
  - Polyphosphate
  - Organic Phosphate
- •Should be controlled
  •Municipal WW – 4-16 mg/L

Sulfur

- required in the synthesis of protein, released in their degradation
- Sulfate is reduced biologically under anaerobic conditions to sulfide, which in turn can combine with hydrogen to form hydrogen sulfide (H_2S).
- The accumulated H_2S can then be oxidized biologically to sulfuric acid, which is corrosive to steel pipes and equipment.

INORGANIC MATTER

- Common gases in WW – N_2, O_2, CO_2, H_2S, NH_3 and CH_4

H_2S

- Formed by anaerobic decomposition of organic matter containing sulfur or from reduction of mineral sulfites and sulfates
- Is toxic

Methane

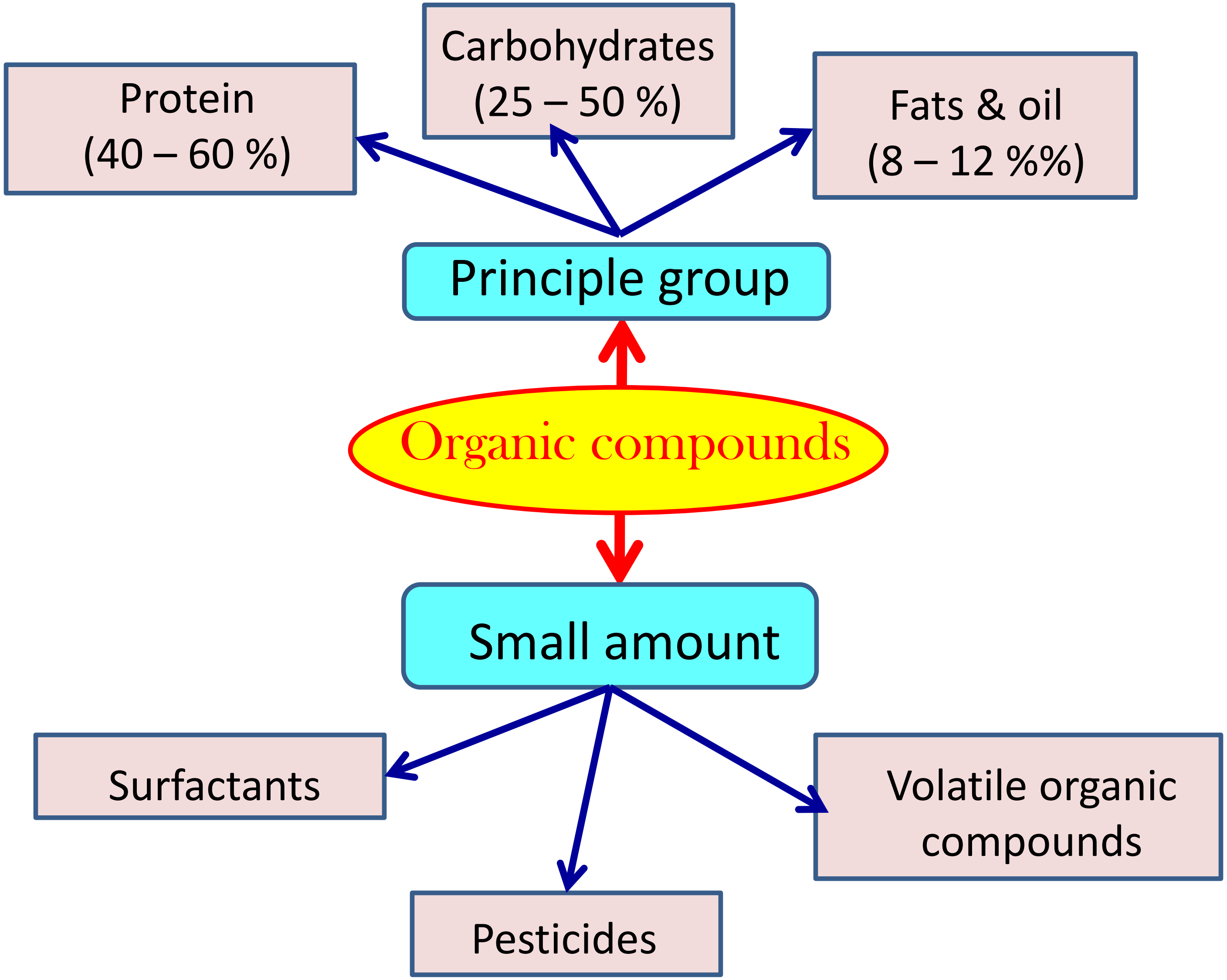
- The principal byproduct from the anaerobic decomposition for the organic matter in WW
- Is a colorless, odorless & combustible in hydrocarbon of high fuel value

INORGANIC MATTER

Metals

- The trace quantities of many metals such as cadmium (Cd), cronium (Cr), Copper (Cu), Iron (Fe), lead (Pb), mercury (Hg), manganese (Mn), nickel (Ni) & zinc (Zn) are important constituents of most waters.
- Many of these metals are classified as priority pollutants
- Most of these metals are necessary for growth of biological life (absence of sufficient quantities of them could limit growth of algae)
- Are toxic in excessive quantities.

CHEMICAL CHARACTERISTICS
ORGANIC MATTER



OIL & GREASE

Oil & grease

- Origin in WW from butter, margarine, vegetables fats & oil.
- They also obtained nuts, cereals & some fruits.
- They float & interfere with biological treatment process & also cause maintenance problem.

SMALL AMOUNT OF ORGANIC MATTER IN WW

Surfactants

- Surfactants or surface-active agents are large organic molecules, slightly soluble in WW & cause foaming in WW treatment plants

Priority Pollutants

- Priority pollutants were selected on the basis of their known or suspected carcinogenicity, mutagenicity, or high acute toxicity.
- Many of the organic priority pollutants are classified as volatile compounds (VOCs)

SMALL AMOUNT OF ORGANIC MATTER IN WW

VOCs

- Organic compounds that have a boiling point ≤ 100 °C and/or a vapor pressure > 1mm Hg at 25°C are generally considered to be VOCs (e.g. vinyl chloride)
- Are great concern because:
  - Once such compounds are in the vapor state are much more mobile, therefore more likely to be released to the environment.
  - The presence of some of these compound in atmosphere may pose a significant public health risk
  - They contribute to a general increase in reactive hydrocarbons in the atmosphere, which can lead to the formation of photochemically oxidants.

Pesticides

- Are toxic to many organism and can be significant contaminants of surface waters.

MEASUREMENT OF ORGANIC SUBSTANCES

- The analysis used to **measure aggregate organic material** may be divided into 2;
  - To measure **gross** conc. of organic substance **greater than 1.0 mg/L**
  - To measure **trace** conc. in the range of **10^{-12} to 10^{0} mg/L**

- **Laboratory methods** commonly used today to measure **gross amounts** of organic matter (typically **greater than 1mg/L**) in wastewater include;
  - Biochemical oxygen demand (BOD)
  - Chemical oxygen demand (COD)
  - Total organic carbon (TOC)

- Complementing of these laboratory tests is the theoretical oxygen demand (ThOD), which is determined from the **chemical formula** of the organic matter.

BIOCHEMICAL OXYGEN DEMAND(BOD)

- The most widely used parameter of **organic pollution**

- 5-day BOD (BOD_5) – involved the measurement of the **dissolved oxygen used by microorganisms** in the **biochemical oxidation of organic matter.**
- BOD test results are **used to**;
  - Determine the appropriate **quantity of oxygen that will be required** to biologically stabilize the organic matter present.
  - Measure the **efficiency** of some treatment process
  - Determine the **size** of waste treatment facilities.
  - Determine compliance with wastewater discharge permits.

- BOD at **20^{o}C for 5 days** is used as **standard test** (measure after 5 days in incubation at 20^{o}C).

- **Use bacteria to oxidize biodegradable organic** in wastewater sample after incubation.
- BOD can be calculates by measuring **DO before & after incubation**.

LIMITATIONS IN THE BOD TEST

- A high concentration of active, acclimated seed bacteria is required.
- Pretreatment is needed when dealing with toxic wastes, and the effects of nitrifying organisms must be reduced.
- Only the biodegradable organics are measured.
- The test does not have stoichiometric validity after the soluble organic matter present in solution has been used.
- Long period of time is required to obtain results.

COD

COD

To measure the oxygen equivalent of the organic material in WW that can be oxidized chemically using strong chemical agent (dichromate in an acid solution)

Higher than UBOD because

- Many organic substances can be oxidized chemically compared to oxidized biologically (Example: lignin)
- Inorganic substances that are oxidized by the dichromate increase the apparent organic content of sample
- Certain organic substances may be toxic to the microorganisms used in the BOD test
- The dichromate can react with the inorganic substance

Advantage:

COD test can be completed in 2.5 h

DIFFERENCES BETWEEN BOD & COD

BOD	COD
Measures biodegradable organics	Measures biodegradable and non biodegradable organics
Uses oxidizing microorganism	Uses a strong chemical agent
Affected by toxic substance	Not affected
Affected by temperature	Not affected
5 days incubation	2.5 hrs
Accuracy $\pm$ 10%	Accuracy $\pm$ 2%

TOTAL ORGANIC CARBON (TOC)

TOC

- To determine total organic carbon in an aqueous sample.
- The test methods for TOC utilize heat & oxygen, ultraviolet radiation, chemical oxidants, or some combination of these **methods to convert organic carbon to carbon dioxide** which is measured with an infrared analyzer or by other means.
- TOC can be used as a measure of its pollution characteristics and in some cases, it has been possible to relate TOC to BOD and COD values.
- TOC test can be completed in 5-10 min.

THEORETICAL OXYGEN DEMAND (ThOD)

ThOD

- ThOD is the stoichiometric amount of O_2 required to oxidize completely a given compounds
- It can only be evaluate when chemical formula of organic matter is available (with related assumptions).

BIOLOGICAL CHARACTERISTICS

General classification of microorganisms found in surface water & WW

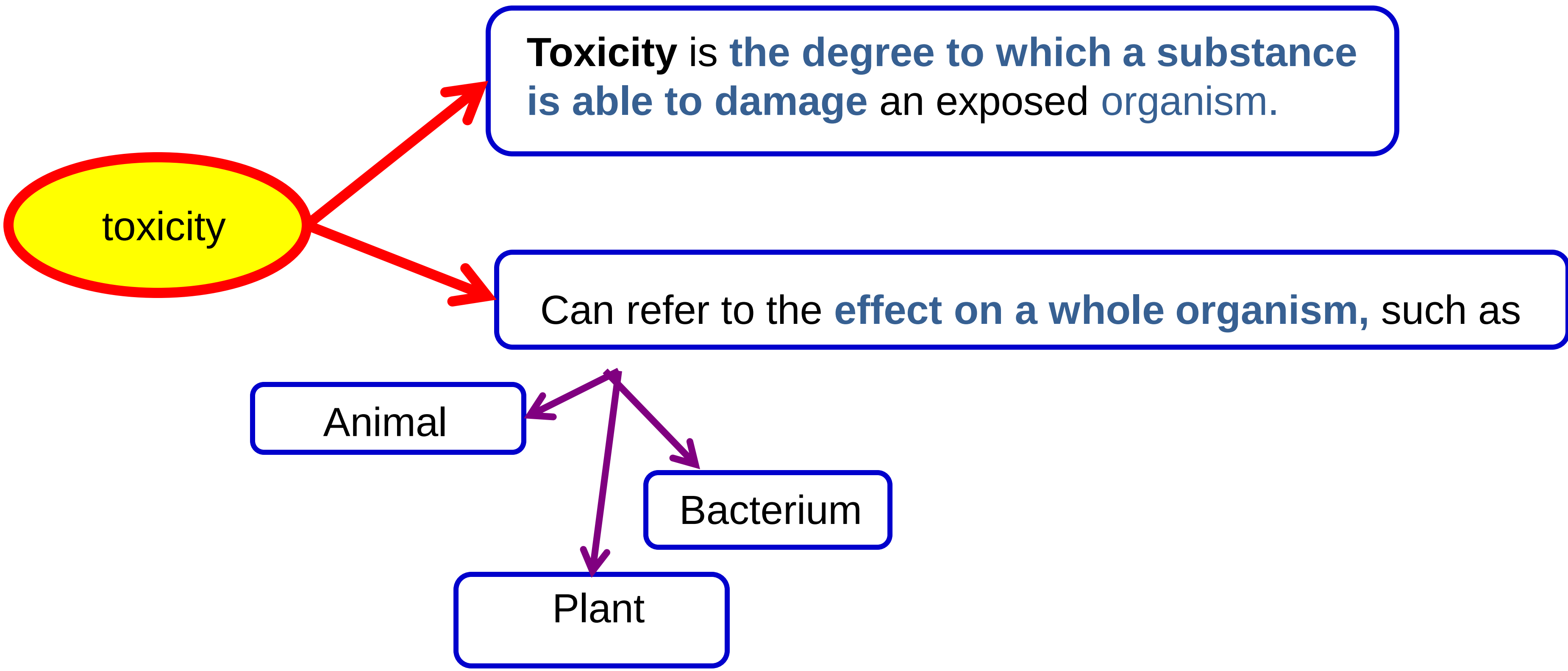
Prokaryote		Eukaryote
Simplest	Cell structure	Complex
Absent	Nuclear membrane	present
Bacteria, blue-green algae (cyanobacter) & archaea	Representative members	Plants & animals & single-celled organisms (protozoa, fungi & green algae)

Pathogenic organisms

Pathogenic organisms found in WW may be excreted by human beings & animals who are infected with disease or who are carries a particular infectious disease.

	Organism	Disease	Symptoms
Bacteria	Salmonella	Salmonellosis	Food poisoning
	Salmonella Typhi	Typhoid fever	High fever, diarrhea
	Vibrio cholera	cholera	Extremely heavy diarrhea, dehydration
Protozoa	Cryptosporidium parvum	cryptosporidiosis	Diarrhea
	Cyclospora cayetanensis	cyclosporasis	Severe diarrhea, stomach cramps,nausea & vomitting lasting for extended periods
	Giardia lamblia	Giardiasis	Mild to severe diarrhea, nausea,indigestion
Helminths	Taenia saginata	Taeniasis	Beef tapeworm
	Taenia solium	Taeniasis	Pork tapeworm
Viruses	Hepatitis A virus	Infectious hepatitis	

TOXICITY


toxicity
Toxicity is **the degree to which a substance is able to damage** an exposed organism.
Can refer to the **effect on a whole organism,** such as
Animal
Bacterium
Plant

Toxicity test are used to;

- Assess the suitability of environmental conditions for aquatic life
- Establish acceptable receiving water concentrations for conventional parameter such as DO, pH, temp. or turbidity.
- Study the effects of water quality parameters on wastewater toxicity.
- Determine the effectiveness of wastewater-treatment method.
- Assess the degree of wastewater treatment needed to meet water
- pollution control requirement.
- Determines compliance with federal & state water quality standard and water quality criteria.
- Establish permissible effluent discharge rate

Effects of Industrial Waste on Streams

Introduction

Stream serves people in many ways Drinking, Bathing, Fishing, Irrigation, Navigation, Recreation, Power Generation.

"Biodegradable" has become a popular word. It is assumed that if something is biodegradable, then disposal is not a problem.

- The improper disposal of biodegradable substances in streams became a cause of concern.
- The receiving waters were quickly polluted.
- Fish in the receiving waters died and

- The water had a very offensive odor.
- A stream must therefore be protected, so that it can serve the best interest of people using it.

Stream Protection

Methods of maintaining a stream

- Effluent Standards
- Stream Standards

- **Effluent Standard**: The Quality Standards established by the waste that has been processed from these units.
- **Stream Standard**: The Standard Quality established in accordance with the designation of water bodies

Effluent Standards

Effluent standards pertain to the quality of the discharge water itself. They are based on economics than on absolute protection of the stream.

- Easy to control
- Detailed stream analysis are not required
- They do not establish an overall level of pollutant loading for a given water body
- Ratio of wastewater to stream flow are not considered

- Ratio of wastewater to stream flow are not considered
- Treatment is obligatory irrespective of the size of industry
- For effective protection of an overloaded stream, the effluent standards are required to be upgraded
- Large industries have an edge over small industry

- Disposal Standards
- Stream Standards
- Stream standards refer to the quality of the receiving water downstream from the origin of the wastewater discharge
- They are based on establishing classification of quality for a stream
- The quality of the receiving water is regulated to maintain established stream classification

- Prevention of excessive pollution/ Loading is limited to what the stream can assimilate
- No consideration of type and location of industry
- Allows public to establish goals for present and future water quality

NEED FOR INDUSTRIAL WASTEWATER TREATMENT PLANTS

Such **treatment should comply with the terms of the legislation** defining the characteristics of the effluent discharging in water streams.

The concept of **planning and development** should be based on the **criteria to protect** land, water resources, aquatic life in streams and rivers and marine life from pollution and to safeguard public health as a high priority.

The **environmental inspection** on wastewater treatment plants aims to support and strengthen the **Protection of both the environment and the public health**, since the pollution generated from the industrial establishments has a negative impact not only on the environment, but also on the health of the individuals.

UNIT – II
COMMMON TYPES OF TREATMENT PROCESS

CLOs	Course Learning Outcome
CLO5	Understand the different stages of pre and primary treatment of Industrial wastewater.
CLO6	Describe the process of Equalization and Proportioning.
CLO7	Explain the Neutralization process.
CLO8	Understand oil separation by floatation process.
CLO9	Describe the waste Reduction, volume reduction processes.
CLO10	Understand the strength Reduction and the process involved in it.

Wastewater Treatment Methods

- Physical
- Chemical
- Biological

Physical

- Screening
- Sedimentation (Clarification)
- Aeration
- Filtration
- Flotation and Skimming
- Degasification
- Equalization

Chemical

- Chlorination
- Ozonation
- Neutralization
- Coagulation
- Adsorption
- Ion Exchange

Biological

- *Aerobic*

  Activated Sludge Treatment Methods

  Trickling Filtration

  Oxidation Ponds

  Lagoons

  Aerobic Digestion

- *Anaerobic*

  Anaerobic Digestion

  Septic Tanks

  Lagoons

Common set of processes Wastewater Treatment

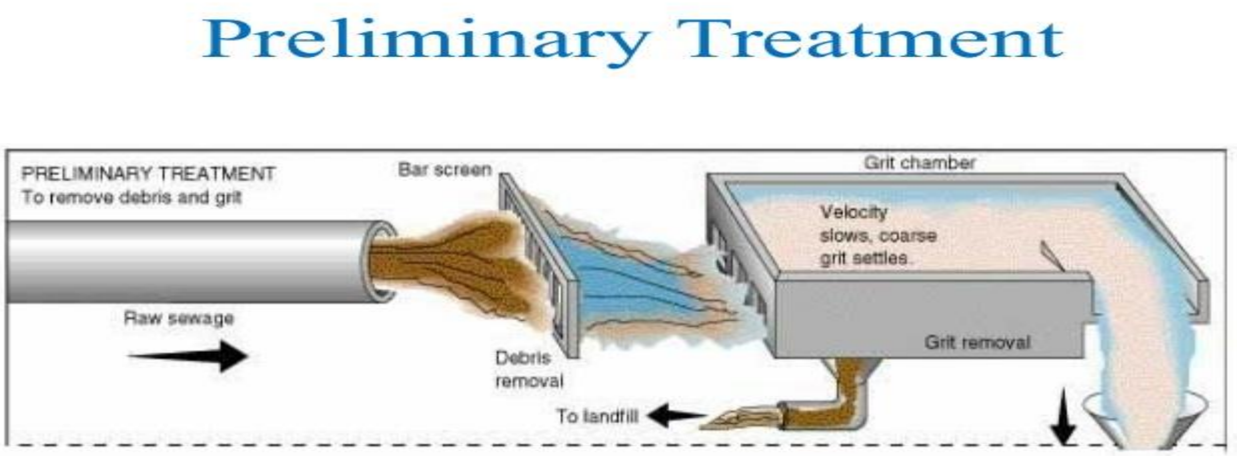
- Preliminary treatment
- Primary treatment
- Secondary treatment
- Tertiary treatment
- Polishing treatment

Treatment of industrial wastewater

- The different types of contamination of wastewater require a variety of strategies to remove the contamination.
- Solids removal
- Oils and grease removal
- Removal of biodegradable organics
- Treatment of other organics
- Treatment of acids and alkalis
- Treatment of toxic materials

Preliminary Treatment:

The purpose of preliminary treatment is to protect the operation of the wastewater treatment plant. This is achieved by removing from the wastewater any constituents which can clog or damage pumps, or interfere with subsequent treatment processes.



Preliminary treatment devices are, therefore, designed to :

- Remove or to reduce in size the large, entrained, suspended or floating solids. These solids consist of pieces of wood, cloth, paper, plastics, garbage, etc. together with some fecal matter.
- Remove heavy inorganic solids such as sand and gravel as well as metal or glass. These objects are called grit.
- Remove excessive amounts of oils or greases. A number of devices or types of equipment are used to obtain these objectives.

Screening

Screening is the removal of large size floating matters by a series of closely spaced bars placed across the flow inclined at 30o – 60o. These floating materials, if not removed, will choke the pipes or adversely affect the working of the sewage pumps. Screens should preferably be placed before the grit chambers.

- The incoming wastewater is passed through the bars or screens and periodically the accumulated material is removed.
- The racks or screens may be cleaned either manually or by means of automatically operated rakes. The solids removed by these units can be disposed of by burial or incineration.

Grit Chambers

- Wastewater usually contains a relatively large amount of inorganic solids such as sand, cinders and gravel which are collectively called grit.
- In grit chambers, the velocity of the water through the chamber is maintained sufficiently high, or air is used, so as to prevent the settling of most organic solids.
- Grit removal is not included as a preliminary treatment step in most small wastewater treatment plants.

Primary Treatment

- Primary treatment is designed to remove organic and inorganic solids by the physical processes of sedimentation and flotation. Primary treatment devices reduce the velocity and disperse the flow of wastewater.
- In primary treatment the velocity of flow is reduced to 1 to 2 feet per minute to maintain a quiescent condition so that the material denser than water will settle out and material less dense than water will float to the surface.
- Approximately 40 to 60 percent of the suspended solids are removed from the waste stream (25 - 35% BOD reduction).

- The solids that remain in suspension as well as dissolved solids will usually be biochemically treated in subsequent processes for physical separation and removal in the final (secondary) settling tanks.

- The size and number of primary tanks is dependent on the estimated wastewater flow and the design detention time.
- Generally, a detention time of 2 to 3 hours will provide a sufficient time period for most particles to settle out.
- Further, the settling rate of a particle depends on the strength and freshness of the wastewater being treated, the weight of the solid compared to the specific gravity of water, the size and shape of the solid and the temperature of the water.
- Water is more dense at lower temperatures ; therefore, the required settling time increases. As the temperatures of the water increases, the required settling time decreases. Equal distribution of flow throughout the tank is critical.

Basic theories

- Strength reduction
- Volume reduction
- Neutralization
- Equalization
- Proportioning

Strength reduction

- Reducing the concentration of waste for better treatment
- The strength of waste may be reduced by
- Process changes
- Equipment modifications
- Segregation of wastes
- Equalization of wastes
- By-product recovery
- Proportioning wastes
- Monitoring waste streams

Process changes

- In reducing the strength of waste through process changes, the sanitary engineer is concerned with wastes that are more troublesome from a pollution stand point.
- His problems and his approach differ from those of the plant engineer.
- Sometimes tremendous resistance by a plant engineer must be overcome in order to effect a change in process.
- Many industries resolve their waste problems through process changes.
- Ex. Textile and metal fabricating industries

UNIT – III
DESCRIPTION OF MAIN TREATMENT METHODS

CLOs	Course Learning Outcome
CLO11	Explain the importance of waste Treatment methods.
CLO12	Understand the process involved in Nitrification and De-nitrification stages of waste water treatment.
CLO13	Understand the process involved in phosphorous removal and Heavy Metal removal.
CLO14	Understand the process involved in Air stripping and Absorption techniques in treatment method.
CLO15	Understand the process involved in Membrane Separation Process

Nitrification-Denitrification

- A certain amount of nitrogen removal (20-30%) occurs in conventional activated sludge systems.
- Nitrogen removal ranging from 70 to 90 % can be obtained by use of nitrification-denitrification method in plants based on activated sludge and other suspended growth systems.
- Biological denitrification requires prior nitrification of all ammonia and organic nitrogen in the incoming waste.

Nitrification

- There are two groups of chemoautotrophic bacteria that can be associated with the process of nitrification.
- One group (*Nitrosomonas*) derives its energy through the oxidation of ammonium to nitrite, whereas the other group (*Nitrobacter*) obtains energy through the oxidation of nitrite to nitrate. Both the groups, collectively called *Nitrifiers*, obtain carbon required, from inorganic carbon forms.
- Nitrification of ammonia to nitrate is a two step process:

$$NH_3 \longrightarrow NH_4 \xrightarrow{\text{Nitrosomonas}} NO_2 \xrightarrow{\text{Nitrobacter}} NO_3$$

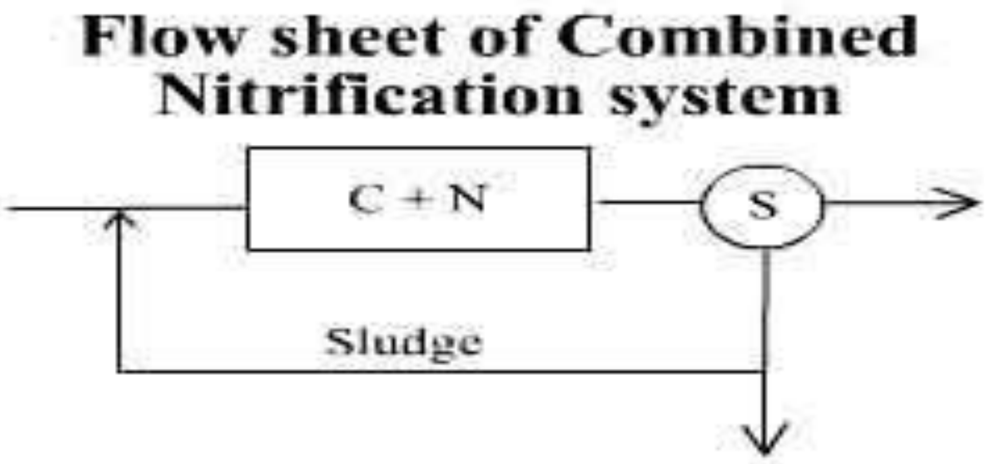
- Stoichiometrically, 4.6 kg of oxygen is required for nitrifying 1 kg of nitrogen.
- Under steady state conditions, experimental evidence has shown nitrite accumulation to be insignificant.
- This suggests that the rate-limiting step for the conversion of ammonium to nitrate is the oxidation of ammonium to nitrite by the genus Nitrosomonas.

  $$qc = \frac{1}{m}$$

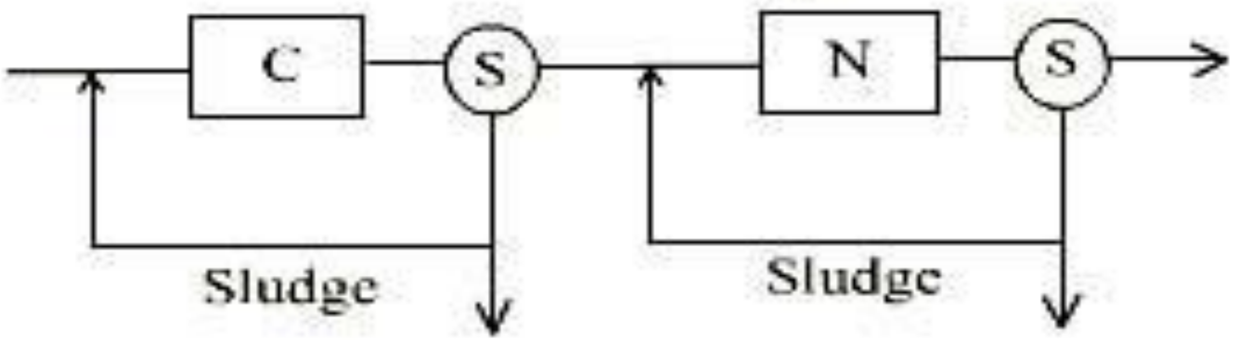
  where m is the growth rate of nitrosomonas at the worst operating temperature.
- Sludge age (or mean cell residence time), qc in a treatment plant must be sufficiently high if nitrification is desired.

Combined and Separate Systems of Biological Oxidatio Nitrification

Following figure shows flow sheets for combined and separate systems for biological oxidation and nitrification.



Flow sheet of Separate Nitrification system



Combined system

- ***Combined system*** is favoured method of operation as it is less sensitive to load variations - owing to larger sized aeration tank - generally produces a smaller volume of surplus sludge owing to higher values of qc adopted, and better sludge settleability.
- Care should be taken to ensure that the oxygenation capacity of aeration tank is sufficient to meet oxygen uptake due to carbonaceous demand and nitrification.
- Recycling of sludge must be rapid enough to prevent denitrification (and rising sludge) owing to anoxic conditions in the settling tank.

separate system

- In ***separate system***, the first tank can be smaller in size since a higher F/M ratio can be used, but this makes the system somewhat more sensitive to load variations and also tends to produce more sludge for disposal.
- An additional settling tank is also necessary between the two aeration tanks to keep the two sludges separate.
- A principal advantage of this system is its higher efficiency of nitrification and its better performance when toxic substances are feared to be in the inflow.

Biological Denitrification

- When a treatment plant discharges into receivingstream with low available nitrogen concentration and with a flow much larger than the effluent, the presence of nitrate in the effluent generally does not adversely affect stream quality.
- However,if the nitrate concentration in the stream is significant, it may be desirable to control the nitrogen contentof the effluent, as highly nitrified effluents can stillaccelarate algal blooms.

- Even more critical is the case where treatment plant effluent is discharged directly into relatively still bodies of water such as lakes or reservoirs.
- Another argument for the control of nitrogen in the aquatic environment is the occurence of infantile methemoglobinemia, which results from high concentration of nitrates in drinking water.
- The four basic processes that are used are: (1) ammonia stripping,
  (2) selective ion exchange, (3) break point chlorination, and
  (4) biological nitrification/denitrification.

- ***Biological nitrification/denitrification*** is a two step process.
- The first step is nitrification, which is conversion of ammonia to nitrate through the action of nitrifying bacteria.
- The second step is nitrate conversion (denitrification), which is carried out by facultative heterotrophic bacteria under anoxic conditions.

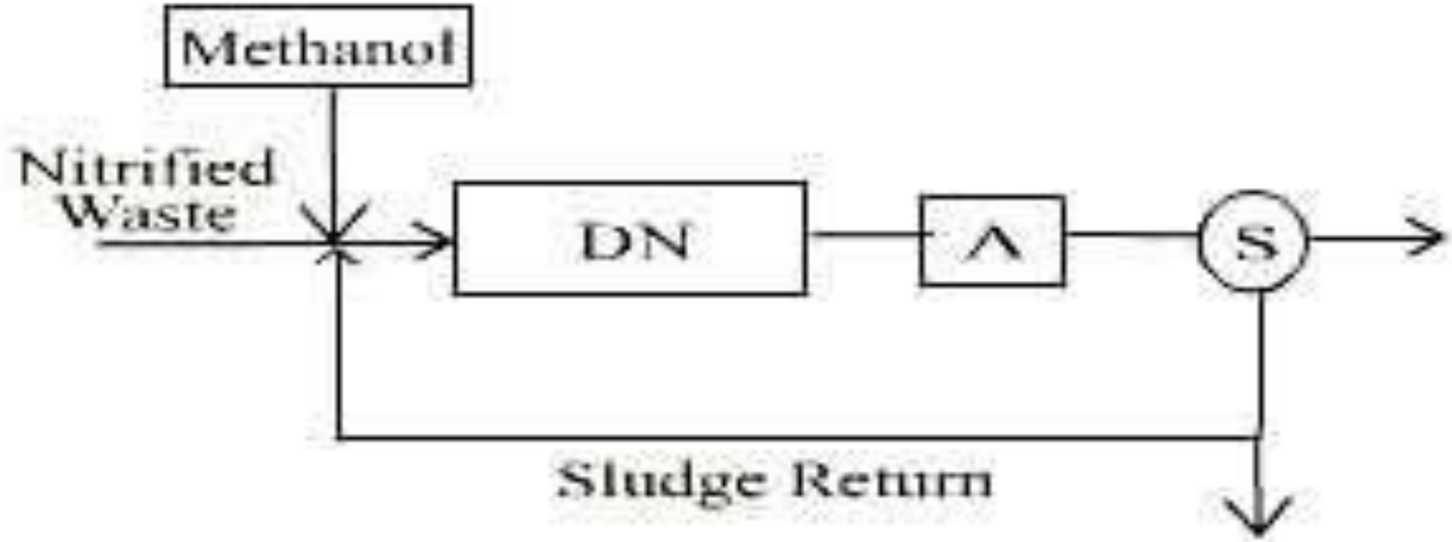
Microbiological Aspects of Denitrification

- Nitrate conversion takes place through both assimilatory and dissimilatory cellular functions. In ***assimilatory denitrification***, nitrate is reduced to ammonia, which then serves as a nitrogen source for cell synthesis. Thus, nitrogen is removed from the liquid stream by incorporating it into cytoplasmic material.
- In ***dissimilatory denitrification***, nitrate serves as the electron acceptor in energy metabolism and is converted to various gaseous end products but principally molecular nitrogen, N2, which is then stripped from the liquid stream.

- Because the microbial yield under anoxic conditions is considerably lower than under aerobic conditions, a relatively small fraction of the nitrogen is removed through assimilation. Dissimilatory denitrification is, therfore, the primary means by which nitrogen removal is achieved.
- A carbon source is also essential as electron donor for denitrification to take place. This source may be in the form of carbon internally available in sewage or artificially added (eg. as methanol). Since most community wastewaters have a higher ratio of BOD:N, the internally available carbon becomes attractive and economical for denitrification.

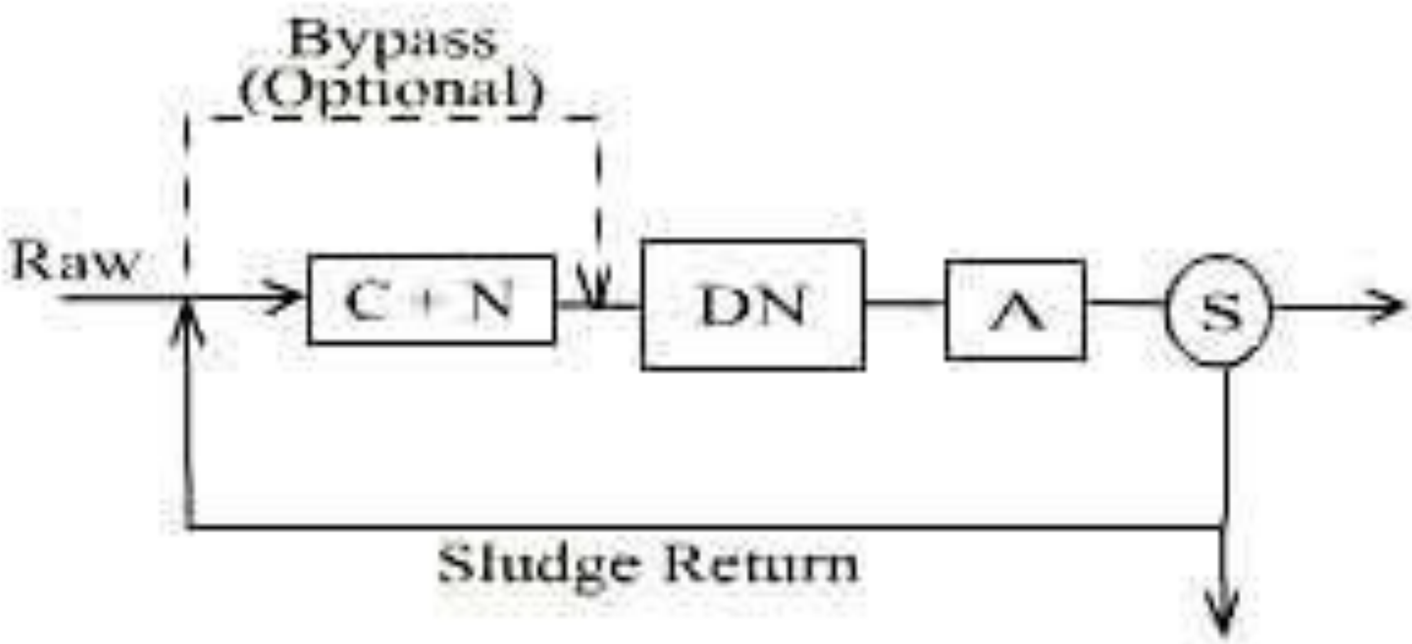
Typical Flowsheets for Denitrification

Flow sheet for Separate Denitrification of Nitrified Wastewater Using Methanol



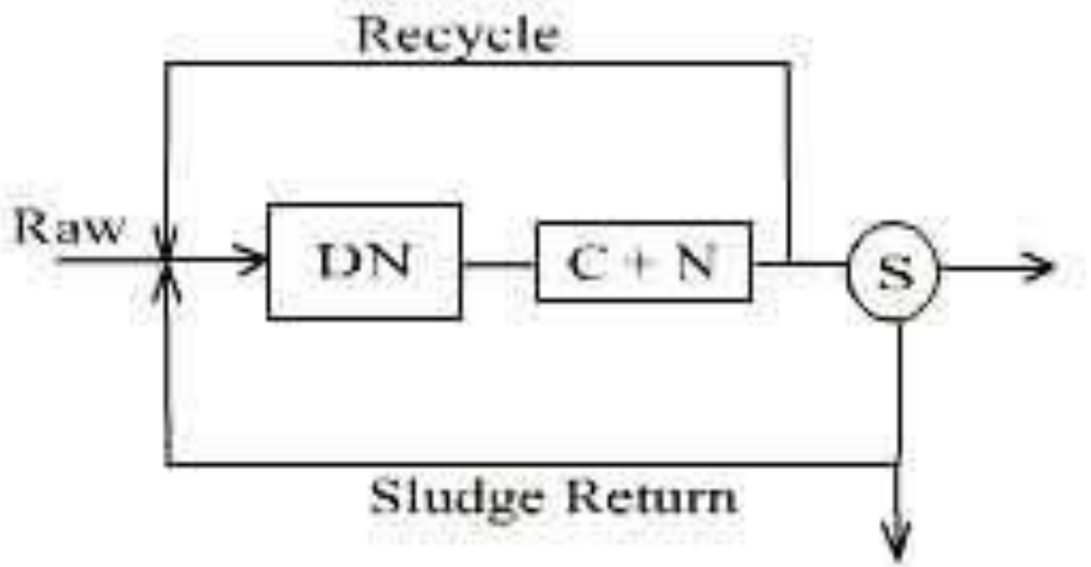
- The use of methanol or any other artificial carbon source should be avoided as far as possible since it adds to the cost of treatment and also some operating difficulties may arise fro dosing rate of methanol.
- Too much would introduce an unnecessary BOD in the effluent while too little would leave some nitrates under nitrified.

Separate Denitrification of Nitrified Wastewater Using Methanol



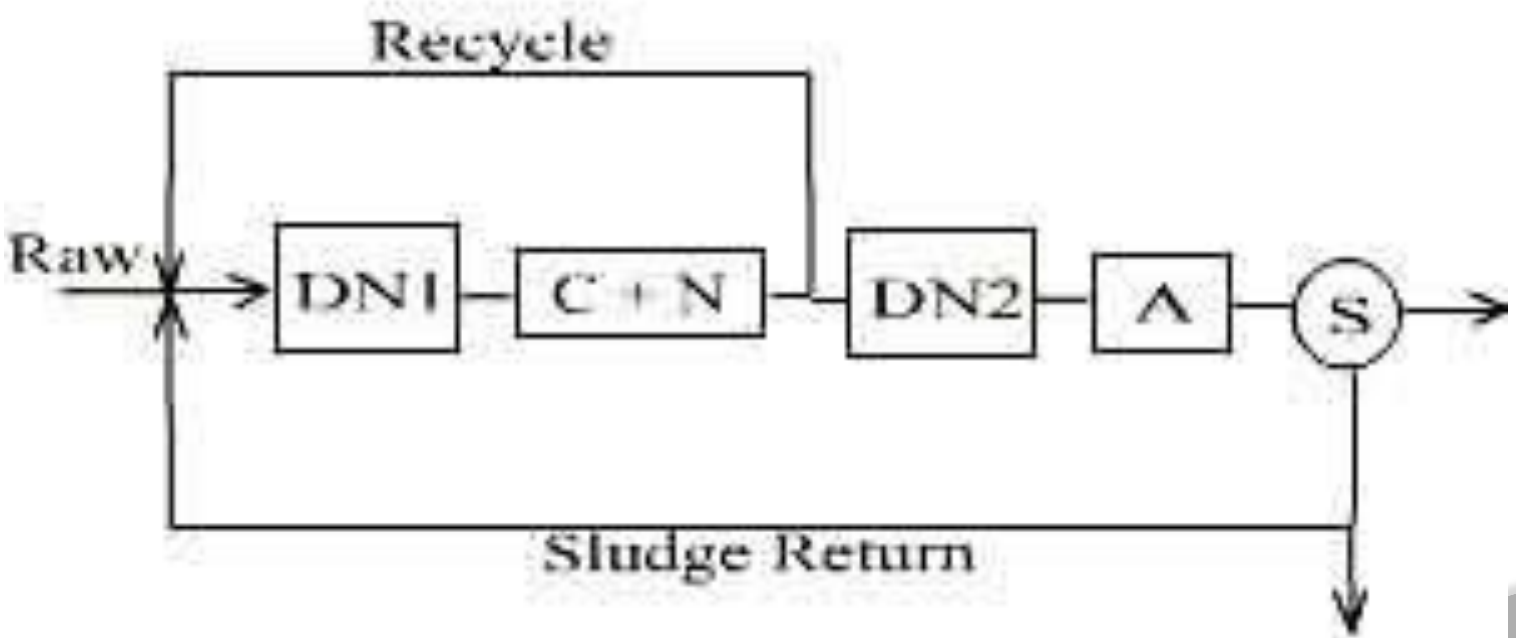
- A more satisfactory arrangement would be to use the carbon contained in the waste itself.
- However, the anoxic tank has to be of sufficient detention time for denitrification to occur which, has a slower rate; since the corresponding oxygen uptake rate of the mixed liquor is mainly due to endogenous respiration and is thus low.
- The denitrification rate, therefore, in a way also depends on the F/M ratio in the prior aeration tank

Pre-denitrification with Recycle of Nitrified Effluent to Anoxic Tank



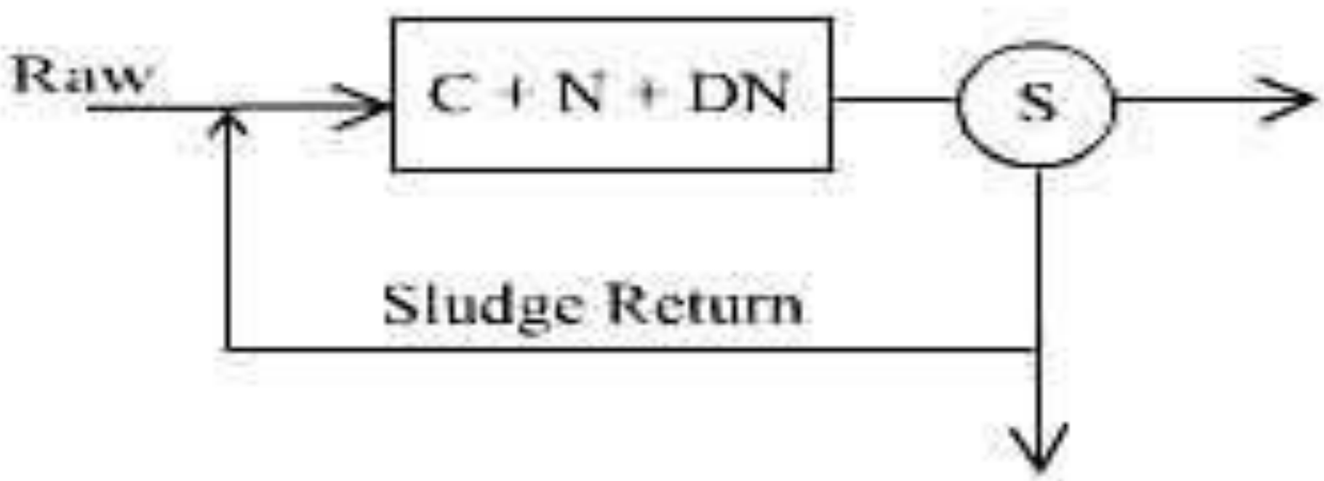
- Consequently, if desired, a portion of the raw waste may be bypassed to enter directly into the anoxic tank and thus contribute to an increased respiration rate.
- This reduces the sizes of both the anoxic and aeration tanks, but the denitrification efficiency is reduced as the bypassed unnitrified ammonia can not be denitrified.

"Bardenpho" Arrangement With two Anoxic Tanks to Give Higher Degree of Denitrification



- By reversing the relative positions of anoxic and aerobic tanks, the oxygen requirement of the waste in its anoxic state is met by the release of oxygen from nitrates in the recycled flow taken from the end of nitrification tank.
- Primary settling of the raw waste may be omitted so as to bring more carbon into the anoxic tank.

Simultaneous Nitrification-denitrificationin the same Tank



- More complete nitrification-denitrification can be achieved by Bardenpho arrangement.
- The first anoxic tank has the advantage of higher denitrification rate while the nitrates remaining in the liquor passing out of the tank can be denitrified further in a second anoxic tank through endogenous respiration.
- The flow from anoxic tank is desirable to reaerate for 10-15 minutes to drive off nitrogen gas bubbles and add oxygen prior to sedimentation.

Phosphorus Removal

- Controlling phosphorous discharged from municipal and industrial wastewater treatment plants is a key factor in preventing eutrophication of surface waters.
- Phosphorous is one of the major nutrients contributing in the increased eutrophication of lakes and natural waters.
- Its presence causes many water quality problems including increased purification costs, decreased recreational and conservation value of an impoundments, loss of livestock and the possible lethal effect of algal toxins on drinking water.
- Phosphate removal is currently achieved largely by chemical precipitation, which is expensive and causes an increase of sludge volume by up to 40%.
- An alternative is the biological phosphate removal

Phosphorous in wastewater

- Municipal wastewaters may contain from 5 to 20 mg/l of total phosphorous, of which 1-5 mg/l is organic and the rest in inorganic.
- The individual contribution tend to increase, because phosphorous is one of the main constituent of synthetic detergents.
- The individual phosphorous contribution varies between 0.65 and 4.80 g/inhabitant per day with an average of about 2.18 g.
- The usual forms of phosphorous found in aqueous solutions include:

- Orthophosphates: available for biological metabolism without further breakdown
- Polyphosphates: molecules with 2 or more phosphorous atoms, oxygen and in some cases hydrogen atoms combine in a complex molecule.
- Usually polyphosphates undergo hydrolysis and revert to the orthophosphate forms.
- This process is usually quite slow.
- Normally secondary treatment can only remove 1-2 mg/l, so a large excess of phosphorous is discharged in the final effluent, causing eutrophication in surface waters.
- New legislation requires a maximum concentration of P discharges into sensitive water of 2 mg/l.

Phosphorous removal processes

- Treatment technologies presently available for phosphorus removal include:
- Physical:
- filtration for particulate phosphorus
- membrane technologies
- Chemical:
- precipitation
- other (mainly physical-chemical adsorption)
- Biological
- assimilation
- enhanced biological phosphorus removal (EBPR)

- The greatest interest and most recent progress has been made in EBPR, which has the potential to remove P down to very low levels at relatively lower costs.
- Membrane technologies are also receiving increased attention, although their use for P removal has been more limited to date.
- The question of sludge handling and treatment of P in side streams is also being addressed

Physical Treatment

- **Filtration for particulate Phosporous**
- Assuming that 2-3% of organic solids is P, then an effluent total suspended solids (TSS) of 20 mg/L represents 0.4-0.6 mg/L of effluent P .
- In plants with EBPR the P content is even higher.
- Thus sand filtration or other method of TSS removal (e.g., membrane, chemical precipitation) is likely necessary for plants with low effluent TP permits

UNIT – IV
WASTE WATER FROM DIFFERENT INDUSTRIES

CLOs	Course Learning Outcome
CLO16	Analyze the special Treatment Methods.
CLO17	Understand the procedure and process of disposing treated waste water.
CLO18	Analyze and understand the characteristics and Composition of waste water.
CLO19	Manufacturing processes of industries like sugar, steel, petroleum refineries.

SUGAR INDUSTRY

- ✓ The sugar industry subsumes the production, processing and marketing of sugars (mostly saccharose and fructose). Globally, most sugar is extracted from sugar cane and sugar beet.

- ✓ Sugar is an essential basis for soft drinks/sweetened beverages, convenience foods, fast food, candy/sweets, confectionery, baking products and the respective industries.

- ✓ Around 460 million tonnes of sugar is produced every year. The largest producers are Brazil (72%), India (15%) and the European Union (10%).

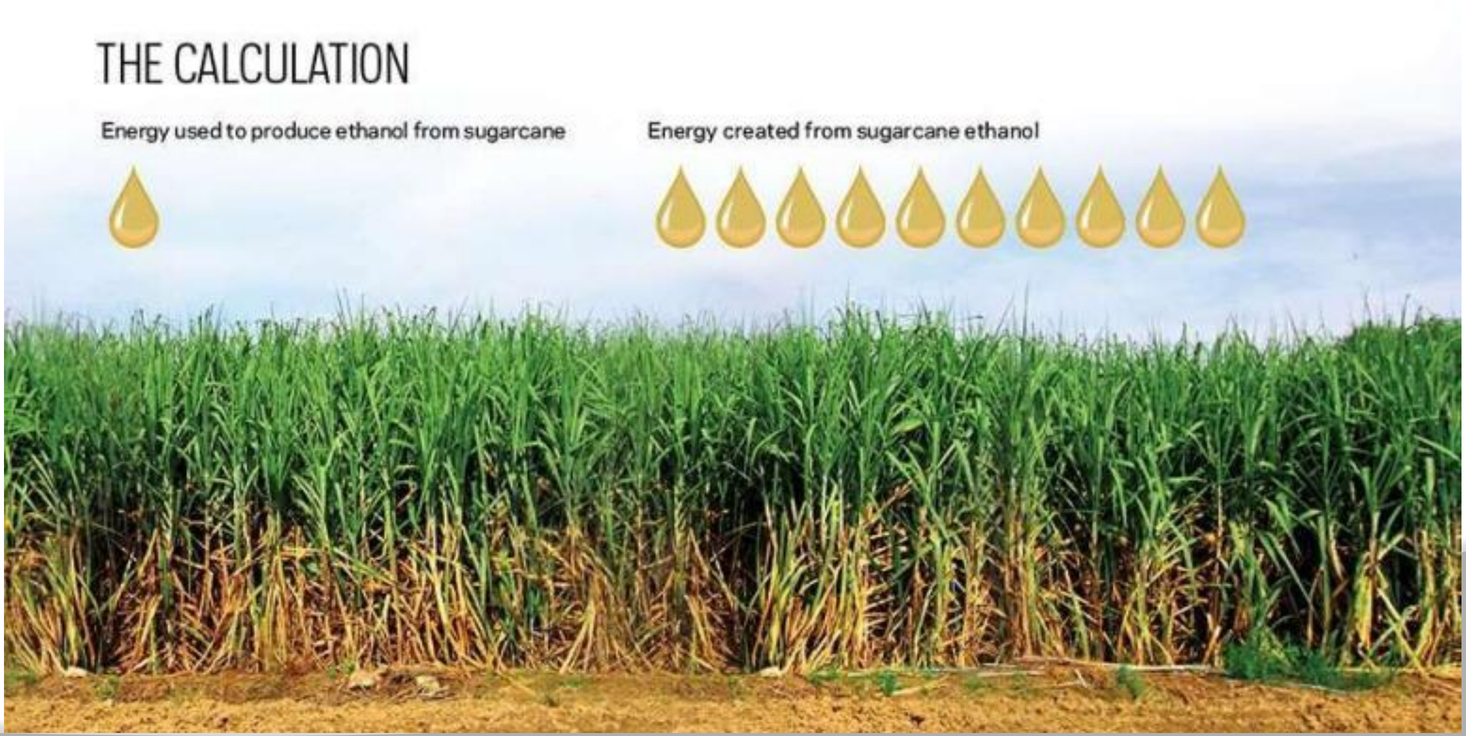
BEET SUGAR

- Beet sugar is derived from sugar beet.
- Sugar beet is a tap root, and it has a conical, white, fleshy root .
- The root of the beet comprises 75%
- water, 20% sugar, and 5% fiber.
- Sugar beets grow entirely in the temperature zone.
- Sugar beets account for 20% of sugar produced.
- Top 5 beet sugar producers in the world are France, the United States, Germany, Russia and Turkey.

CANE SUGAR

- Cane sugar is derived from sugar cane.
- Sugar cane is a tropical tall true grass .
- A mature stalk classically comprises 11-16% fiber, 12-16% soluble sugars, 2-3% non-sugars, and 63-73% water.
- Sugarcane grows entirely in the tropical and subtropical zones.
- Cane accounts of 80% of produced.
- Top 5 cane sugar producers world are Brazil, India, Thailand, Pakistan and Mexico

In the past, sugar industry produced only sugar but nowadays sugar industries are involved in the production of sugar, electricity and ethanol. So sugar industry is now called as the cane industry.



WHY DO WE TREAT WASTEWATER OF SUGAR INDUSTRY

?

SOURCES OF WASTEWATER

Sugar industry wastewaters are produced mainly by cleaning operations.

- Washing of milling house floor, various division of boiling house like evaporators, clarifiers, vacuum pans, centrifugation, etc. generates huge volume of wastewater.
- Periodical cleaning of heat exchangers and evaporators with NaOH and HCl to remove the scales on the tube surface contributes organic and inorganic pollutant loadings to wastewater.
- Leakages from pumps, pipelines, centrifuging house also contribute to wastewater produced.
- Except this, wastewater is also produced from boiler blowdown, spray pond overflow, and from condenser cooling water which is discharged as wastewater when it gets contaminated with cane

Typical Composition of Sugar Industry Wastewater

Sr. No	Parameter	Average Values	Effluent Standard for Discharge on Inland Surface Water	Effluent Standard for Discharge on land for Irrigation
1.	pH	10.69	5.5-9.0	5.5-9.0
2.	COD	5102(mg/L)	250	-
3.	BOD	1998(mg/L)	30	100
4.	TS	4530(mg/L)	-	-
5.	TDS	3758(mg/L)	-	-
6.	TSS	772(mg/L)	100	200
7.	Oil & Grease	14	10	10

- The sugar industry wastewater is characterized by its brown colour, low pH, high temperature, high BOD, high COD, odour problem, total solids, and high percentage of dissolved organic and inorganic matter.

- Wastewater from sugar industry generally contains carbohydrates, nutrients, oil and grease, chlorides, sulfates, and heavy metals.

TREATMENT METHODS

- Treatment of sugar industry wastewater requires a process that combines
  mechanical, chemical, and biological treatment measures.
  - Screening, grit removal, flow equalization, sedimentation, or dissolved air flotation are used to reduce suspended solids (SS) load from sugar industry wastewater.
  - Biological treatment methods are applied for the reduction of soluble organic matter and disinfections. Biological treatment includes aerobic and anaerobic process.
  - Except biological methods, physicochemical methods are also used for sugar industry wastewater treatment.

Since, sugar industry wastewater contains mostly sugars and volatile fatty acids, which are easily biodegradable; therefore all the biological ***(anaerobic and aerobic) treatment processes*** are suitable.

AEROBIC TREATMENT

- ✓ Aerobic biological treatment generally involves degradation of organic inthe occurrenceofoxygen. Conventional aerobic treatment includes activated sludge, tricklingfilters, aerated lagoons, or a combination of all

- ✓ Earlier, lagoons were used for sugar industry wastewater treatment because of being an economic process. However, larger area requirements and emission of unpleasant and annoying odour during the treatment process are some of the disadvantages of lagoons. Aerated lagoons were also used in past and showed lesser residence time and area required compared to lagoons, to treat sugar industry wastewater, but oxygen consumption and HRT(hydraulic retention time) were found to be high, and still large area requirement is disadvantage.

ANAERÓBIC TREATMENT

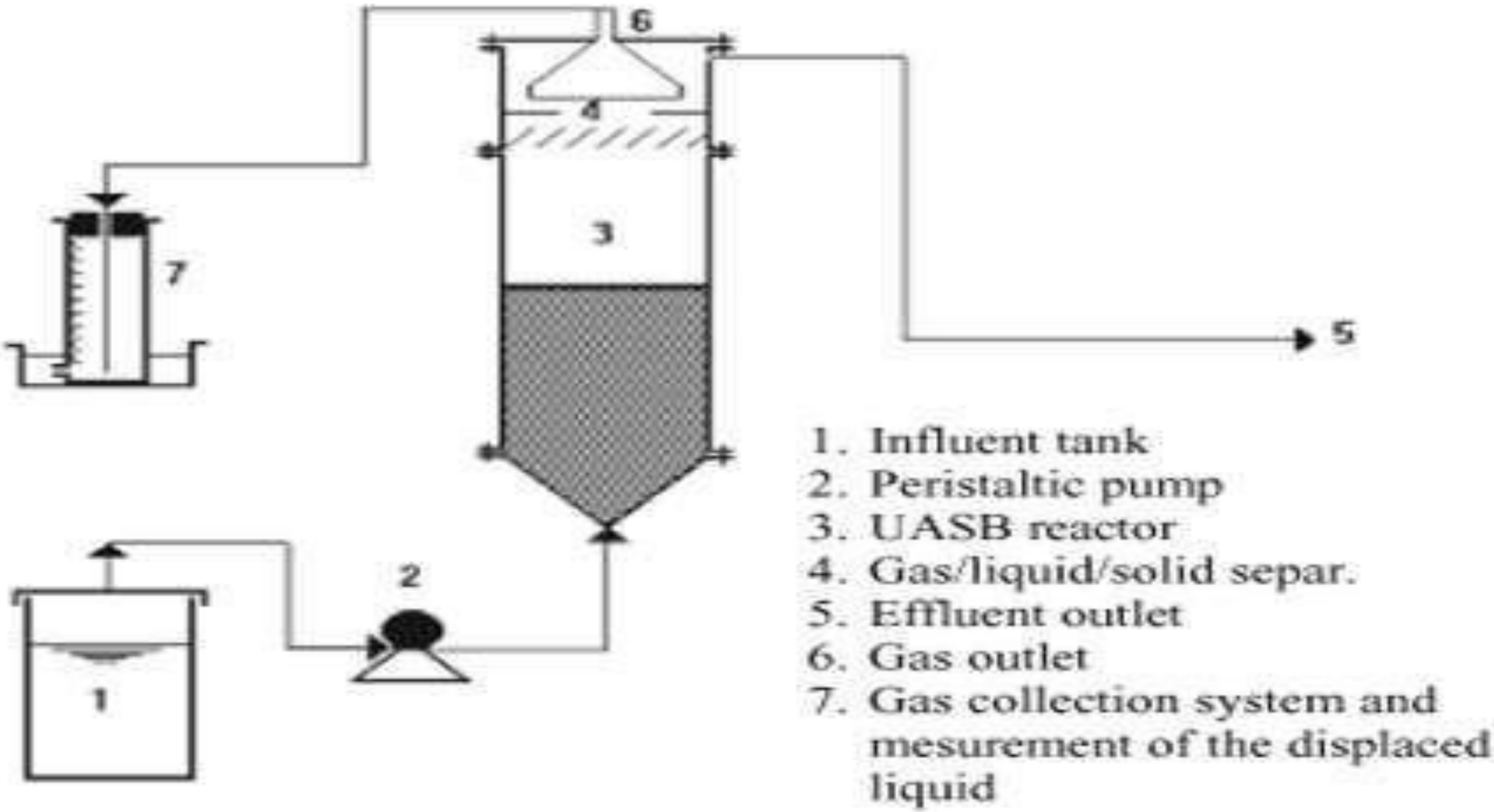
- Anaerobic treatment method for concentrated wastewater, in terms of pollutants (as the sugar industry wastewater), is widely used method in the industries. It has several advantages over aerobic processes, which include the lesser energy required; methane production due to the degradation of organic matters, which is a source of energy; and lesser sludge production, which indirectly reduces sludge disposal costs greatly.
- Sugar industry waste waters are biodegradable except oil and grease which are not easily degraded by anaerobic processes, because oils produce long chain fatty acids during the hydrolysis step which causes retardation in methane production . Long-chain fatty acids were reported to be inhibitory to methanogenic bacteria.

Reactors, generally used for anaerobic treatment of sugar industry wastewater are,

- Anaerobic batch reactor
- Anaerobic Fixed-bed reactors (AFR)
- Up-flow Anaerobic Fixed Bed (UAFB) reactor
- Up-flow Anaerobic Sludge Blanket (UASB) reactor

Up-flow Anaerobic Sludge Blanket (UASB)

- This reactor is used for the anaerobic process.
- In this anaerobic treatment complex organic matter is get converted into methane gas through the stages like hydrolysis, acidogenesis, etc.
- UASB is widely applicable for treating various types of wastewater.
- UASB has advantages over aerobic treatment.
- UASB is used for treating wastewater in sugar industry, distillery, dairy industry, slaughter house and high strength municipal wastewater.


6
4
3
7
5
2
1
1. Influent tank
2. Peristaltic pump
3. UASB reactor
4. Gas/liquid/solid separ.
5. Effluent outlet
6. Gas outlet
7. Gas collection system and mesurement of the displaced liquid

Mainly the following are the four key biological and chemical stages in UASB process:

- Hydrolysis
- Acidogenesis
- Acetogenesis
- Methanogenesis

UNIT – V
COMPOSTION OF WASTE WATER AND COMMON EFFLUENT TREATMENT PLANTS

CLOs	Course Learning Outcome
CLO20	Understand the Characteristics of Industries like Petroleum Refineries.
CLO21	Characteristics and composition of industries like textiles, tanneries, atomic energy plants and other mineral processing industries
CLO22	Joint treatment of raw industrial waste water and domestic sewage.
CLO23	Common effluent treatment plants location, design, and operation and maintenance problems.

Textiles Industry

chemical additions that make the environmental challenge for textile industry not only as liquid waste but also in its chemical composition.

•Main pollution in textile wastewater come from dyeing and finishing processes.

•These processes require the input of a wide range of chemicals and dyestuffs, which generally are organic compounds of complex structure.

•Water is used as the principal medium to apply dyes and various chemicals for finishes.

•Because all of them are not contained in the final product, became waste and caused disposal problems.

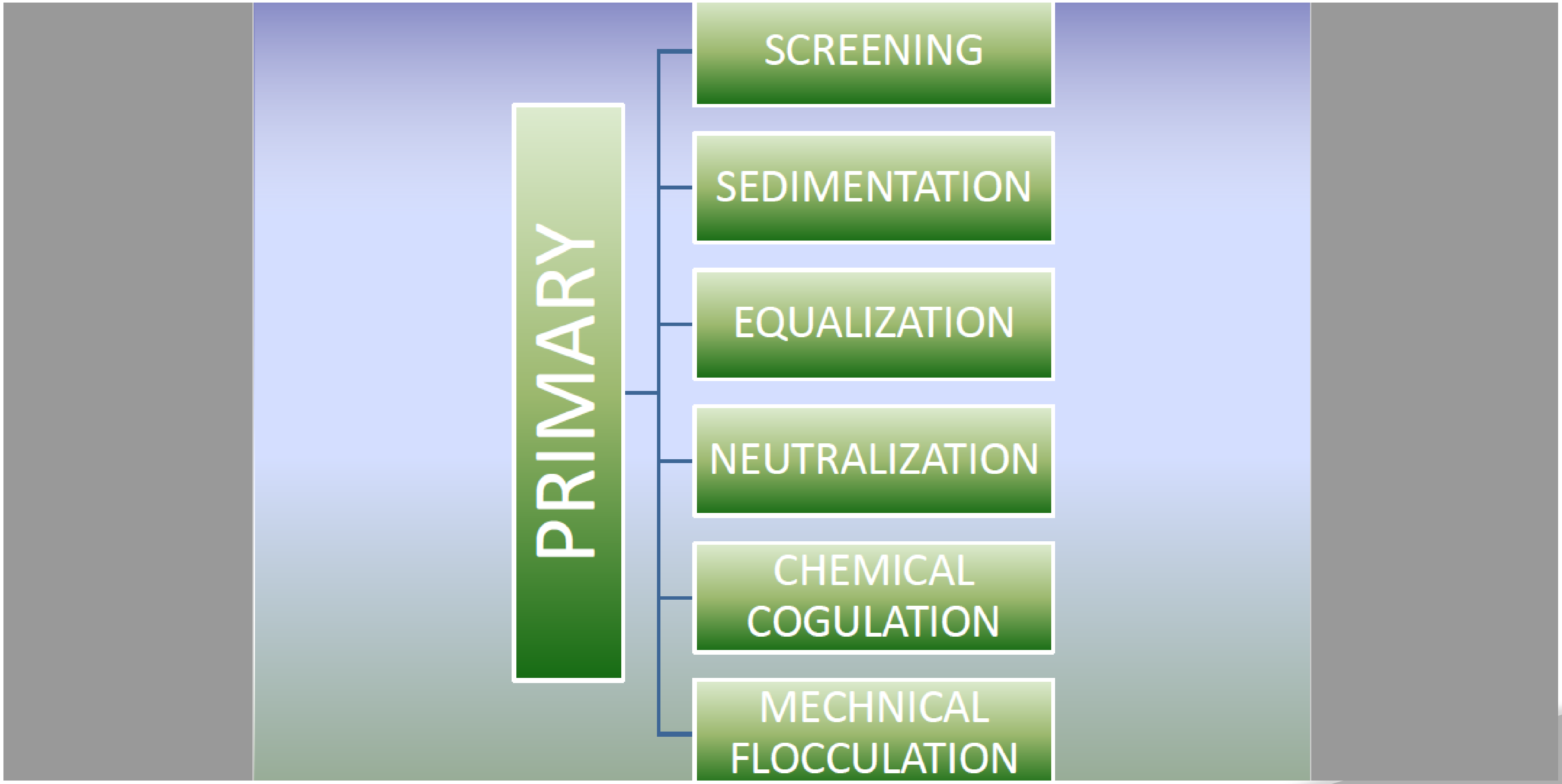
•Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substances.

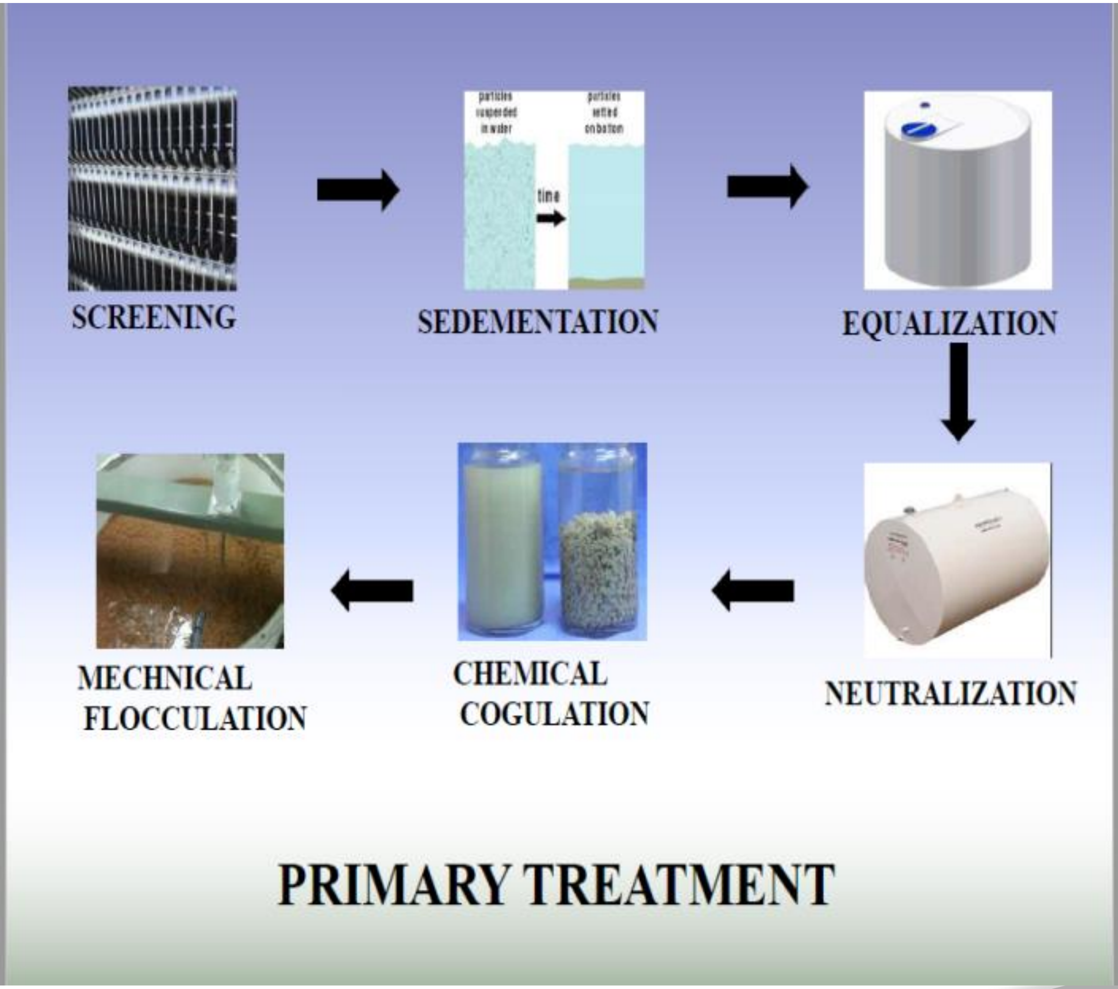
•Substances which need to be removed from textile wastewater are mainly COD, BOD, nitrogen, heavy metals and dyestuffs1,2.

Textiles Mills Wastewater from different processes

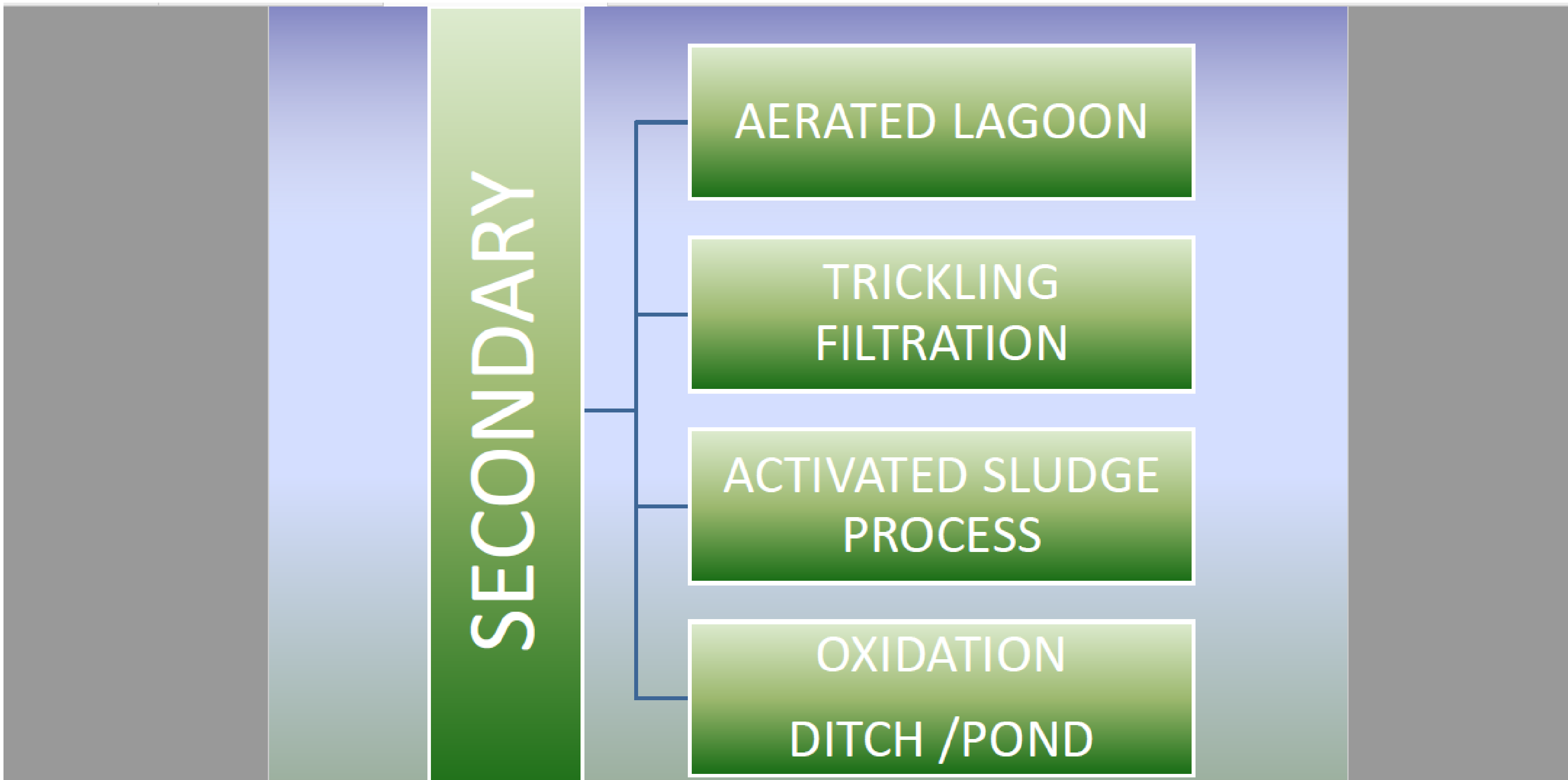
PROCESS	COMPOUNDS
DESIZING	Size, Enzyme, Starch, Ammonia, Waxes
SCOURING	Disinfectants and insecticide residue, NaOH, Surfactants, Soaps, Fats, Waxes , Pectin, Oils, Sizes, Anti – Static agents, Spent Solvents, Enzymes
BLEACHING	H2O2, AOX, Sodium Silicate or Organic Stabilizers, High pH
MERCERIZING	High pH, NaoH
DYEING	Color, Metals. Salts, Surfactants, Organic Processing Assistants, Sulphide, Acidity / Alkalinity, Formaldehyde
PRINTING	Urea, Solvents, Color, Metals.
FINISHING	Resins, Waxes, Chlorinated Compounds , Acetate, Stearate, Spent Solvents, Softeners.

PROCESSES OF Wastewater treatment

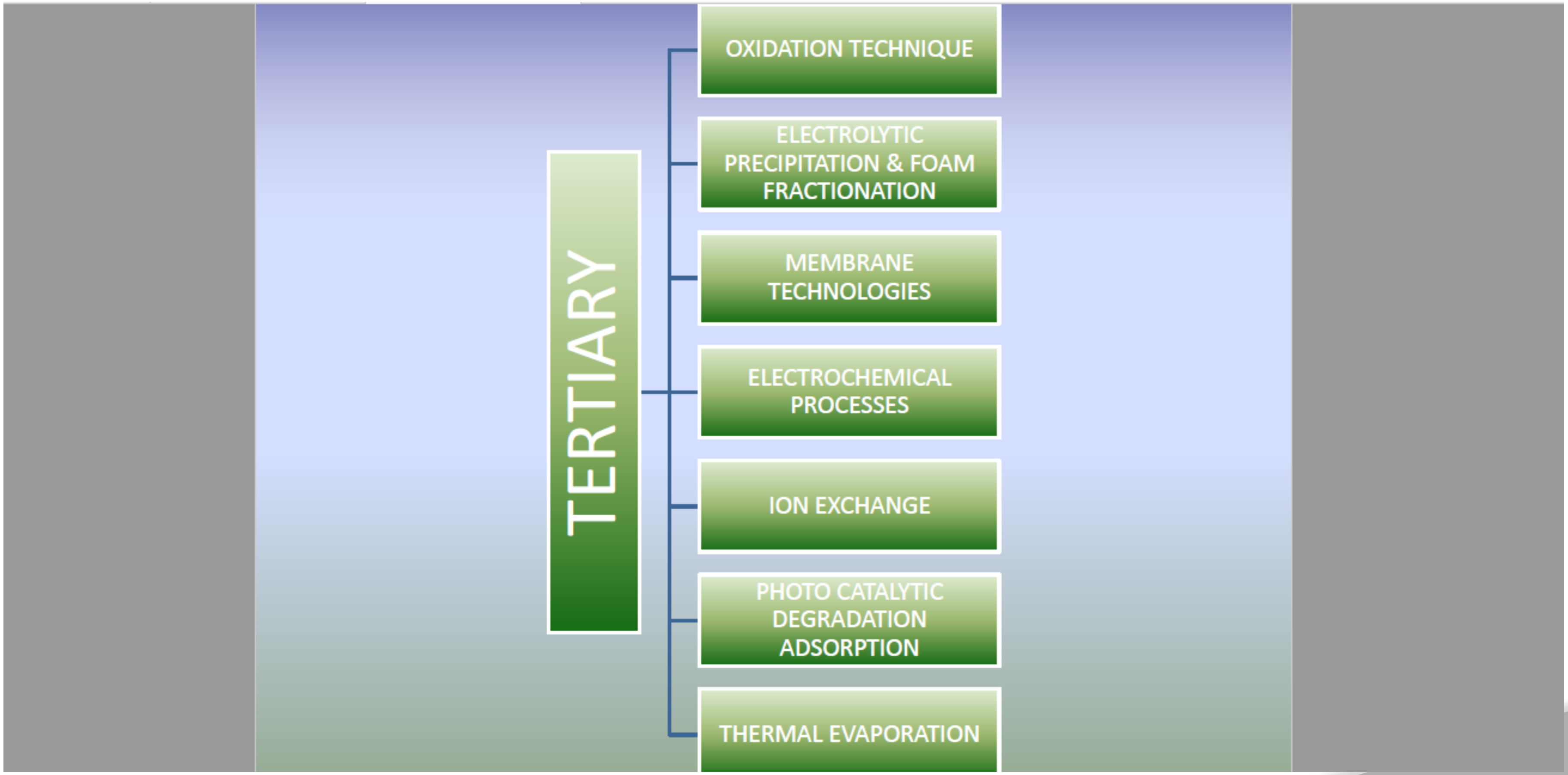




SCREENING
SEDEMENTATION
EQUALIZATION
NEUTRALIZATION
CHEMICAL COGULATION
MECHNICAL FLOCCULATION
PRIMARY TREATMENT


SECONDARY
AERATED LAGOON
TRICKLING FILTRATION
ACTIVATED SLUDGE PROCESS
OXIDATION DITCH /POND

TRETAMENT OF WASTEWATER GENERATED FROM TEXTILE INDISTRY




OXIDATION TECHNIQUE
MEMBRANE TECHNOLOGIES
ION EXCHANGE
ELECTROLYTIC PRECIPITATION & FOAM FRACTIONATION
ELECTROCHEMICAL PROCESSES
PHOTO CATALYTIC DEGRADATION ADSORPTION
THERMAL EVAPORATION
TERTIARY TREATMENT

Composition of composite cotton textile mill waste	
pH	9.8 - 11.8
Total alkalinity	17.35 mg/l as $CaCO_3$
BOD	760 mg/l
COD	1418 mg/l
Total solids	6170 mg/l
Total Chromium	12.5 mg/l

Characteristics of a typical wool waste :	
pH	9-10.5
Total alkalinity	600 mg/l
BOD	900 mg/l
Colour	Brown
Total solids	3000 mg/l
Suspended solids	100 mg/l
Total Chromium	4 mg/l

- The crude waste, if discharged into the streams, causes rapid depletion of the dissolved oxygen of the streams.
- The condition aggravates due to the settlement of the suspended substances and subsequent decomposition of the deposited sludges in anaerobic condition.
- The alkalinity and the toxic substances like sulphides and chromium affect the aquatic life; and also interfere with the biological treatment process; some of the dyes are also found toxic.

Overview of CETP

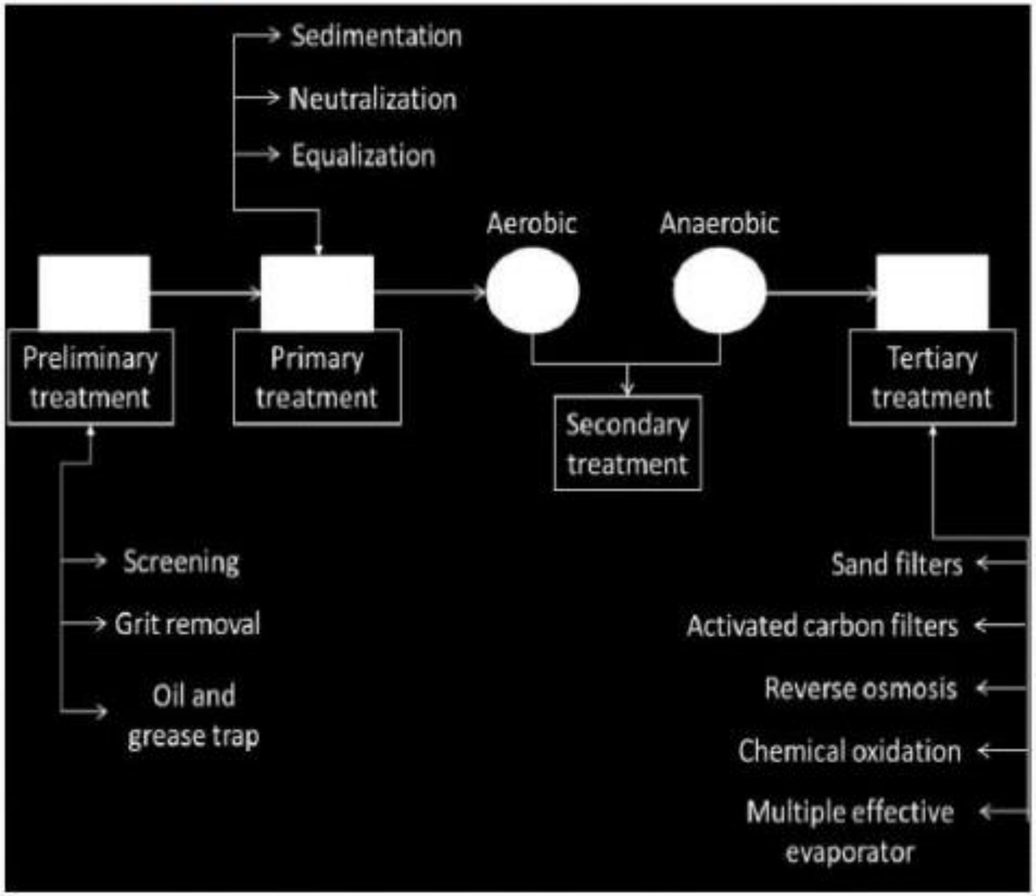
- CETP was originally promoted by the Ministry of Environment and Forests (MoEF) in 1984 with the purpose of minimizing waste water treatment costs for a large number of small and medium scale industries on the Concepts of "**Polluter Pays Principle** ".
- Based on pollution potential, most CETPs are established for the highly polluting Red Category Industries such as tannery, textile, electroplating, chemicals and pharma.
- Environment clearance process was always there on account of potential pollution from the particular project, and EIA is a critical step in this clearance process.

Why CETPs ?

- Water (Prevention and Control of Pollution) Act 1974: mandated every industry for adequate effluent treatment
- More than 300,000 SSIs spread all over India, majorly in about 900 clusters / industrial estates.
- SSIs contribute 40 % of the total industrial output of the country and generate over 44 % of the hazardous waste.
- About 1/6th of the discharge by SSIs presently being treated in CETPs.
- Difficult for the SSIs units to install and operate effluent treatment plant at individual level

Making of Wastewater system

Typical unit Operations of CETP



Wastewater treatment

- Segregation at source of generation.
- Preliminary treatment

  It involves a number of unit processes to eliminate undesirable characteristics of wastewater. Processes include use of screen, grit chambers for removal of sand and large particles, communitors for grinding of coarse solids, pre-aeration for odour control and removal of oil and grease.
- Primary treatment-

  It involves removal of settable solids prior to biological treatment. The general treatment units include: flash mixer + flocculator + sedimentation

Contd

- Secondary treatment- It involves purification of wastewater primarily with dissolved organic matter by microbial action. A number of processes are but the ones that are mainly used are anaerobic and or aerobic treatment methods.
- Tertiary treatment - This mainly includes physical and chemical treatment processes that can be used after the biological treatment to meet the treatment objectives.

Common effluent treatment plant

Advantages

- Strong control over quality and quantity of effluent received at CETP
- Effluent not conforming to inlet norms can be sent back and extra charges can be imposed to the member industries.
- Tracking of effluent transpiration though GPS system will help to stop illegal disposal of effluent to CETP
- Very effective system to prevent mixing of toxic and concentrate effluent with normal effluent

Disadvantages

- Limited transportation capacity.
- Not suitable for industries having high effluent load i.e. textile industries.
- Problems of illegal disposal of untreated effluent if CETP authority fails to keep an eye on tanker movement.
- High cost of transportation
- Risks – Spills, Leakages & pilferage .