

B.Sc (H) CHEMISTRY
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CHEMISTRY - DSE PAPER - INDUSTRIAL CHEMICALS AND
ENVIRONMENT
Unit – Environment and its segments (Water Pollution-
Part-1)

BY

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Water Pollution

World health Organization (WHO) has defined water pollution as inclusion of any foreign material either from natural or other sources into a water body thereby changing the natural qualities of water and making it unstable for its intended purpose. These pollutants include fertilizers and pesticides from agricultural run off; sewage and food processing waste; lead, Mercury and other heavy metals, chemical waste from industrial discharges and chemical contamination from hazardous waste sites.

Water Quality Standards

- Water quality standards indicates the physical, chemical and biological characteristics of water.
- It is a measure of the condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose
- It is most frequently used by reference to a set of standards against which compliance can be assessed
- The most common standard used to assess the water quality relate to the health of ecosystems, safety of human contact and drinking water

Wastewater Sources - Point & Non-Point

	Point Source pollution	Non-Point source (NPS) pollution
What is it ?	An identifiable source of pollution from which pollutants can be measured and discharged as it comes from a single source such as pipes ditches and wells	An indeterminate source of pollution from which pollutants cannot be measured as the pollutants are released in a wide area.
Where does it come from?	<p>Sewage treatment plants</p> <p>Oil refineries</p> <p>Manufacture of chemicals, electronics and automobiles</p> <p>Ships and other watercrafts</p> <p>Septic tanks</p> <p>Landfills</p>	<p>Excess fertilizers and pesticides from agricultural lands and residential areas</p> <p>Paint oil, grease and toxic chemicals from urban runoff</p> <p>Sediments from improperly managed construction sites ,crop and forestlands and eroding streambanks</p> <p>Salts from irrigation practices and acid drainage from abandoned mines</p> <p>Bacteria and nutrients from livestock, and faulty septic systems</p>

Wastewater sources: Point vs. Non-Point

Differences between point and nonpoint sources of pollution

S.No.	Point Sources (PS)	Non-Point Sources NPS
1.	Discharge is usually controlled by permits.	Discharge cannot be controlled by permits as many small diffuse sources from many different locations
2.	Relatively easy to monitor and control as one knows the type of contaminants and location of discharge and elusion rates can be measured.	Difficult to control and monitor as individual contributions are small (but cumulative effects can be significant) and many stations are needed.
3.	Industry can be fined if they do not comply with permit regulations	Punishing is difficult as it is difficult to determine dispersion rates

Examples of Point Source pollution and Non-point Source pollution

Examples of Point Source Pollution include discharges from a sewage treatment plant, factory, city storm drain, municipals storm sewer systems, industrial plant, storm water such as from construction sites.

Examples of Non-Point Pollution include soil erosion, chemical run-off, animal waste pollution

- leaching out of fertilizers or nutrients agricultural lands
- nutrient runoff in stormwater agriculture field or forest
- contaminated storm water washed off off parking lots roads and highways called urban runoff
- they can't be dragged to a single point or source

Water Pollution - Specific Sources

- Septic systems: Use a large tank buried in the ground to contain and breakdown household sewage; fats, oils and grease as well as large waste particles are stored and later pumped out of the holding tank; source of concern for groundwater pollution and surface water pollution
- Lagoons: Shallow holding pits in which wastes are pumped and treated. Water quality problems: Poorly constructed lagoons (leakage). Lagoons build on high water table; Nitrates most often found as contaminant
- Waste Disposal: Underground or above ground disposal practice of domestic municipal or industrial liquid waste.

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- Industrial liquid waste treated or untreated
- Solid waste: Land disposal of municipal and industrial solid waste - leaching
- Storage and transport of commercial materials: Storage tanks and spills
- Mining operations: Mines, oil and gas-acid mine drainage, Leaching of toxic metals, Wastewater generated
- Agricultural operations: Fertilizers, pesticides
- Saline water intrusion

Effluent Treatment Plants

Water has the capability to **self purify** itself during the course of hydrologic cycle.

During crystallization, water gets rids of its dissolved impurities.

Coarse particles present in water are separated under the influence of gravity. Suspended matter is also separated.

Water gets rid of algae and weeds when it seeps underground and is filtered through the porous rocks.

Effluent water treatment plants are established so as to speed up the natural processes by which water is purified. There are basic three stages involved in the treatment of waste-water:

- Primary treatment
- Secondary treatment
- Tertiary treatment

Primary treatment of waste water

Primary treatment of waste-water is done to remove large objects, grit, suspended solids and colloids. It involves the following main processes:

- **Screening:** Waste-water is allowed to pass through iron bar screens spaced 1-2 inches apart and removes large impurities like rags, polythene, wood pieces etc.
- **Skimming:**
 1. Mechanicals skimming removes oil, grease and other impurities that are lighter than water.
 2. The impurities which are heavier than water are removed by blowing compressed air into the polluted water when the air bubbles get attached to the grit particles, become light in weight and rise to the surface for skimming.
 3. Collecting and activating agents like potassium xanthates and foaming agents like oil or glue are added for efficient skimming.

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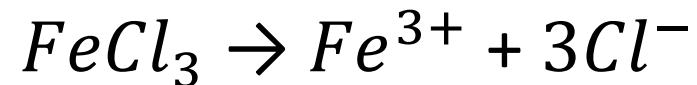
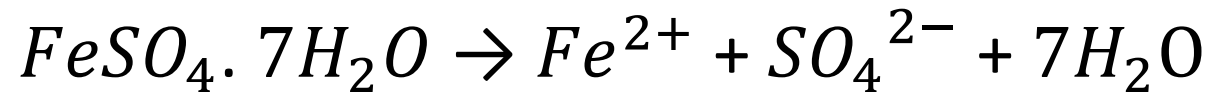
Sedimentation

The waste-water is allowed to stand undisturbed in the sedimentation tank for 1-3 hours. The suspended particles gradually sink to the bottom and form a mass of solids called raw primary biosolids (formerly known as sludge). It is removed from tanks by pumping and may be for the treated to be used as fertiliser or disposed off in a landfill or incinerated.

Flocculation

The suspended particles are either positively charged or negatively charged. Being likely charged, remain suspended on the surface of waste-water for a longer time. So, flocculating agents are added when positively charged suspended particles come in contact with sulphate or chloride ions and negatively charged particulates come in contact with positively charged aluminium or iron ions; thus increasing their weight and settling them at the bottom of the tank.

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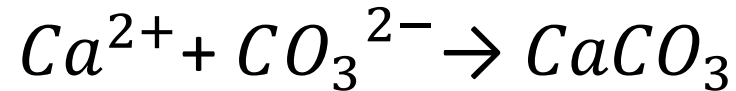
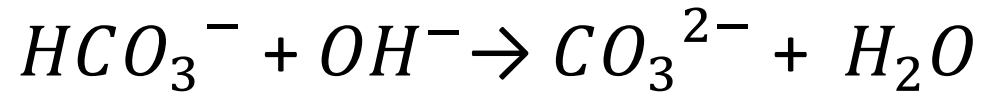
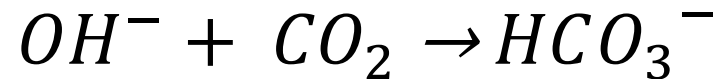
The residual matter ions are converted into their hydrated oxides



The hydrated aluminium oxides and iron oxides are insoluble and adsorb the uncharged suspended particles and carry them to the bottom of the tank.

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- The reactions (1) and (2) on the previous slide, takes place under alkaline conditions only. If the waste water is acidic, lime is added to make it alkaline. Extra lime changes into insoluble carbonate as depicted below:



Calcium carbonate also removes the suspended particles in the same way as the hydrated aluminium and iron oxides

Secondary Treatment of Waste-Water

Secondary treatment of waste-water involves the microbial oxidation of dissolved or colloidal complex organic compounds into simple non-hazardous inorganic compounds.

C \rightarrow CO_2 \rightarrow Carbonates + Bicarbonates

H \rightarrow H_2O

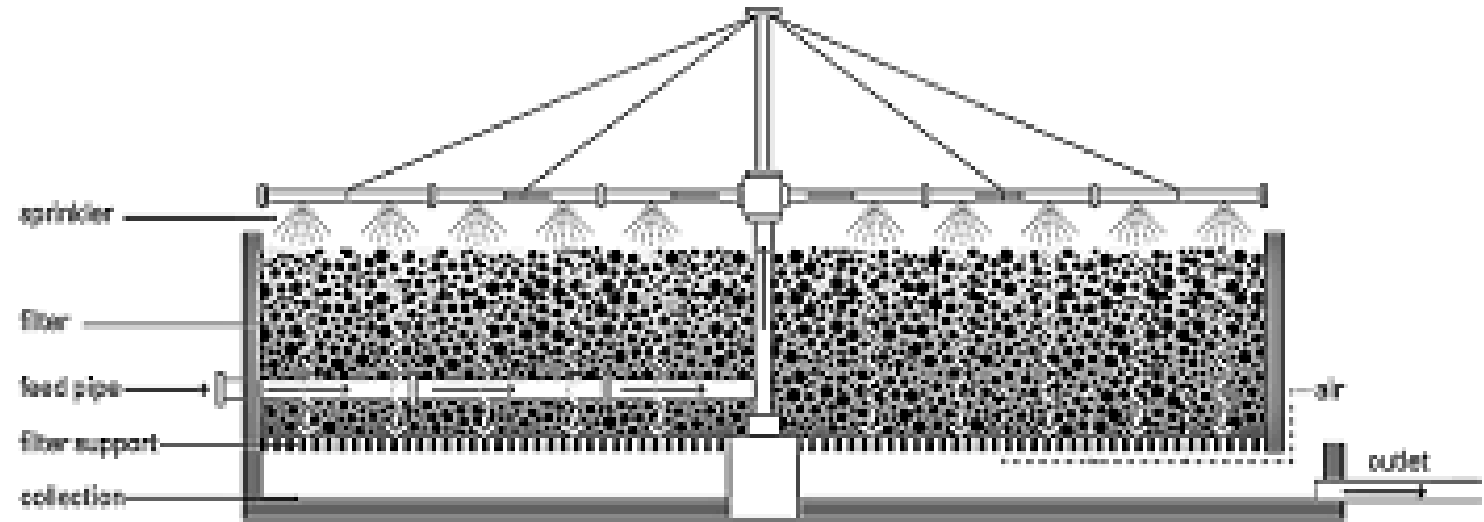
N \rightarrow NH_3

S \rightarrow Sulphates

P \rightarrow Phosphates

Adequate amount of oxygen required for oxidation is accomplished by the use of trickling filters or activated sludge tanks or oxidation ponds (in warmer areas)

Trickling
Filters/Percolating
Filters/Sprinkling
Filters



- Trickling Filter is an attached growth process in which different micro-organisms (bacteria, fungi, protozoa etc.) community; accountable for this treatment is established in an inert packing consisting of clinker, rocks, gravel, stones, slag, coal etc. Modern filters employ a wide range of synthetic materials (such as plastic) as packing material.

Trickling Filters (TF)

PROCESS

- TFs allow organic matter in the wastewater to be adsorbed by microorganisms (aerobic, anaerobic, and facultative bacteria; fungi; algae; and protozoa) attached to the medium as a biological film or slime layer (approximately 0.1 to 0.2 mm thick). As the wastewater flows over the medium, microorganisms in the water slowly attach themselves to the rock, slag, or plastic surface and form a film. The organic matter is then degraded by the aerobic microorganisms in the outer part of the slime layer.
- As the layer thickens through microbial growth, oxygen cannot penetrate the medium face, and anaerobic organisms develop. As the biological film continues to grow, the microorganisms near the surface lose their ability to cling to the medium, and a portion of the slime layer falls off the filter. This process is known as sloughing. The sloughed solids are picked up by the underdrain system and transported to a clarifier for removal from the wastewater.

Advantages of trickling Filters

- Simple and reliable biological process
- Appropriate for places, where land is not available for land intensive treatment systems.
- May qualify for equivalent secondary discharge standards.
- High efficiency to treat high levels of organic matter (medium dependent)
- Suitable for small and medium sized communities.
- Fastly lower the soluble BOD's in waste-water.
- Efficient nitrification units, durable process elements and low power requirements
- No skill and technical expertise required

Disadvantages of Trickling

Filters

- Additional treatment may be needed to match the reference discharge standards.
- Accumulation of excess of bio-mass, that is not able to maintain aerobic conditions.
- Clogging rate may be high.
- Needs regular attention of the operator.
- Less loading of waste-water required for efficiency.
- Less flexibility and control.
- Vector and odour problems
- Snail problems

Activated Sludge Method

After primary treatment, waste-water containing organic pollutants, is pumped into an aeration tank, where it is mixed with air, when some sludge settles down, in which microorganisms flourish. When more of waste-water is further aerated over this sludge, it gets purified more efficiently than the earlier one as more of microorganisms grow as more of sludge piles up. Thus, with each purification, sludge becomes more and more activated. As purification is attained in short time, aeration is speeded up. Water remains unpurified if sterile sludge i.e; without microorganisms, is used.

To speed up this process, it is necessary to bring air and sludge loaded with bacteria in close contact with the waste-water.

Activated sludge method has the following advantages:

1. It does not suffer inefficiency because of seasonal variations and it is equally efficient in winters as well as summers
2. No odour from an activated sludge plant
3. No incorporation of microorganisms have to be inducted in an Activated sludge method.
4. No problem regarding the flies is observed.

One major drawback is that when a large amount of sludge accumulates, it needs to be removed mechanically.