

Water Pollution

By:

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- Water is the essential element that makes life on earth possible.
- **Precious resource** –
 - Water 71% & Land 29%
 - Salt water – 97%
 - Freshwater – 3% (Ice Caps & Glaciers 2% and Surface & Ground water 1%)
- **Water Scarcity** – Future wars

“When the quality or composition of water changes directly or indirectly as a result of man’s activities such that it becomes unfit for any purpose it is said to be polluted”

Sources:

- **Point sources:** When a source of pollution can be readily identified because it has a definite source and place where it enters the water e.g. Municipal and Industrial discharge pipes.
- **Non-point sources:** When a source of pollution cannot be readily identified, such as agricultural runoff, acid rain, etc.

CAUSES OF WATER POLLUTION

1. **Pathogens**
2. **Oxygen depleting wastes**
3. **Inorganic plant nutrients**
4. **Inorganic chemicals**
5. **Organic chemicals**
6. **Sediment (Suspended matter)**
7. **Radioactive isotopes**
8. **Hot water**
9. **Oil**

1. Pathogens - disease-causing agents

- Domestic sewage, untreated human and animal wastes.
- Bacteria, viruses, protozoa and parasitic worms
- **Coliform bacteria** - Escherichia coli and Streptococcus faecalis
 - Large intestine of humans - food digestion and vitamin K production.
 - Gastrointestinal diseases.

2. Oxygen Depleting Wastes

- **Wastes** that can be decomposed by **aerobic bacteria**. Bacteria use up dissolved oxygen (**DO**) present in water to degrade these wastes.
- **BOD (Biological Oxygen Demand)** - The amount of oxygen required to break down a certain amount of organic matter.
 - It is an **indicator** of level of **pollution**.
 - Too much organic matter lead to depletion of all DO and **death of aquatic life**.
 - **Anaerobic decomposition** - foul odour and unpleasant taste in absence of DO.

3. Inorganic Plant Nutrients (Nitrates and phosphates)

- Domestic sewage and agricultural runoff
- **Eutrophication** - Excessive growth of algae and aquatic plants - clog water intake pipes, bad taste and odour to water, and cause a buildup of organic matter.
- **Blue Baby Syndrome** – Nitrates (Methaemoglobinaemia)

4. Inorganic chemicals

- Salts and compounds of toxic metals i.e. mercury and lead.
- Make water unfit to drink, harm fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment.

5. Organic chemicals

- Oil, gasoline, plastics, pesticides, cleaning solvents, detergent etc.
- Source - Industrial activity - improper handling and illegal disposal of chemical wastes.
- **Pesticides – Bio-accumulate** and **Bio-magnify**

6. Sediment (Suspended Matter)

- Insoluble **particles of soil** and other solids - suspended in water (**Soil erosion**).
- Reduce **photosynthetic activity** (aquatic plants and algae) by preventing penetration of sunlight (Disrupt **ecological balance**).
- Settle down at the bottom of water body as sediments and destroys **feeding and spawning grounds** of fish, clogs and fills lakes etc.

7. Radioactive isotopes

- **Bio-accumulate** and **bio-magnify**
- **Ionizing radiation** - birth defects, cancer and genetic damage.

8. Hot water (Power plants and Industries)

- **Thermal pollution** - Rise in temperature of the local water bodies.
- Power plants use water as coolant from a water body to absorb the heat.
- Heated water (**15°C**) is discharged back into the water body. It decreases **solubility of oxygen** and changes **breeding cycles** of aquatic organisms.

9. Oil

- **Runoff** from roads and parking lots
- **Leakage** from underground tanks
- **Oil spills** – accidental release
- Regular leakage from oil **carrier ships**
- **Service** of ships

Groundwater Pollution

A much greater threat to human life comes from our groundwater being polluted which is used for **drinking** and **irrigation**:

- **Urban run-off** - waste water and garbage
- **Industrial waste storage** located above aquifers
- **Agriculture** - fertilizers and pesticides
- **Leakage** - underground storage tanks (gasoline/ hazardous substances)
- **Landfill leachate**
- **Septic tanks** - Poorly designed and inadequately maintained
- **Tailings** - Mining wastes

GW flows are **slow and not turbulent** hence the contaminants are not effectively **diluted** and **dispersed** as compared to surface water.

Water Pollution Control

1. Primary (physical) treatment:

- **Screening** - remove big sized / floating objects (stones, sticks, and rags etc. clog pipes).
- **Sedimentation** – remove pollutants which can settle by gravity.
 - ▢ **Comminuter** - grinds coarse material into small pieces
 - ▢ **Grit chamber** - The detention time is chosen to be long enough to allow lighter, organic material to settle.
 - ▢ **Primary clarifier** (sedimentation tank) where the flow speed is reduced sufficiently to allow most of the suspended solids to settle out by gravity.
- **Efficiency:** BOD (35%) and suspended solids (60%)

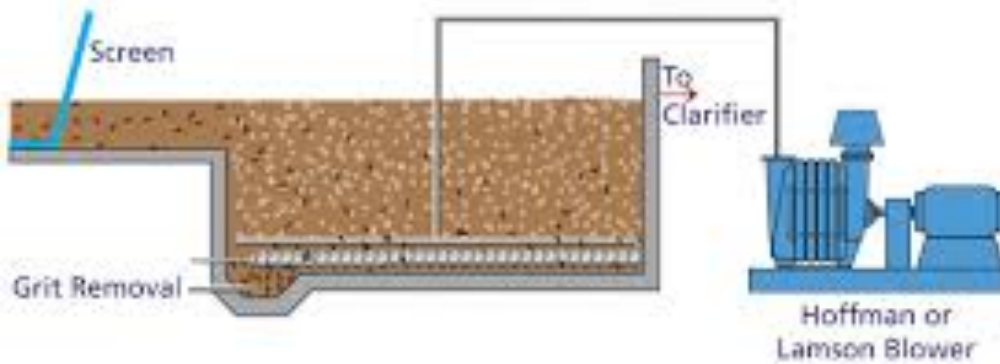




Screening



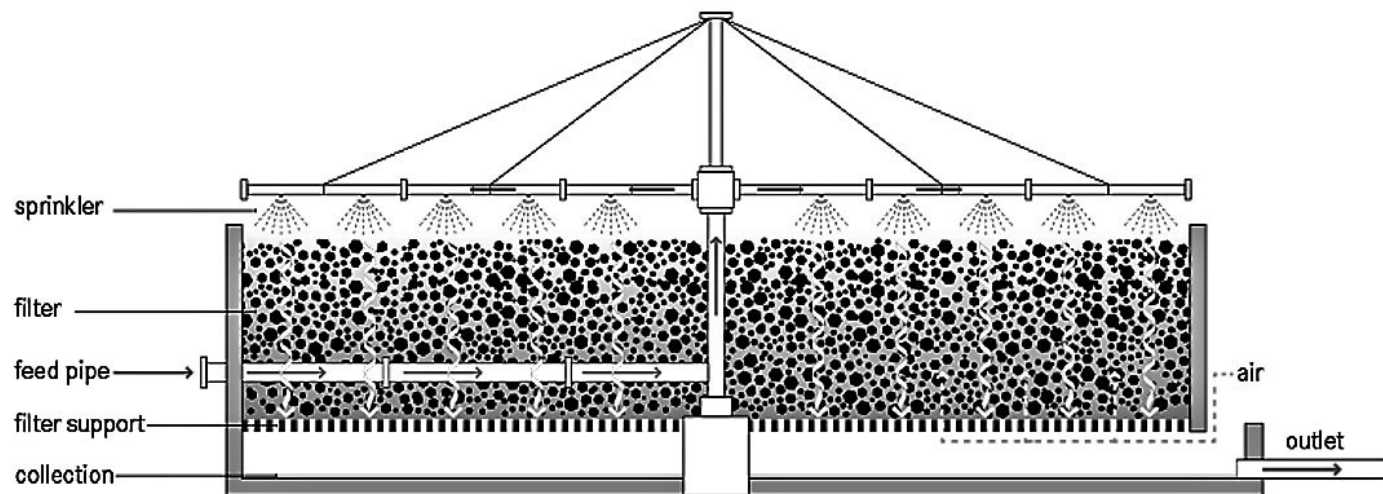
Primary Clarifier



2. Secondary (Biological) treatment – BOD removal (85%)

(a) Trickling filter

- Consists of a rotating **distribution arm** that **sprays** liquid wastewater over a circular bed of ‘fist size’ rocks.
- The spaces between the rocks allow **air to circulate** easily so that aerobic conditions can be maintained.
- The individual rocks in the bed are covered with a layer of **slime**, which consists of bacteria, fungi, algae, etc. which degrade the waste trickling through the bed.



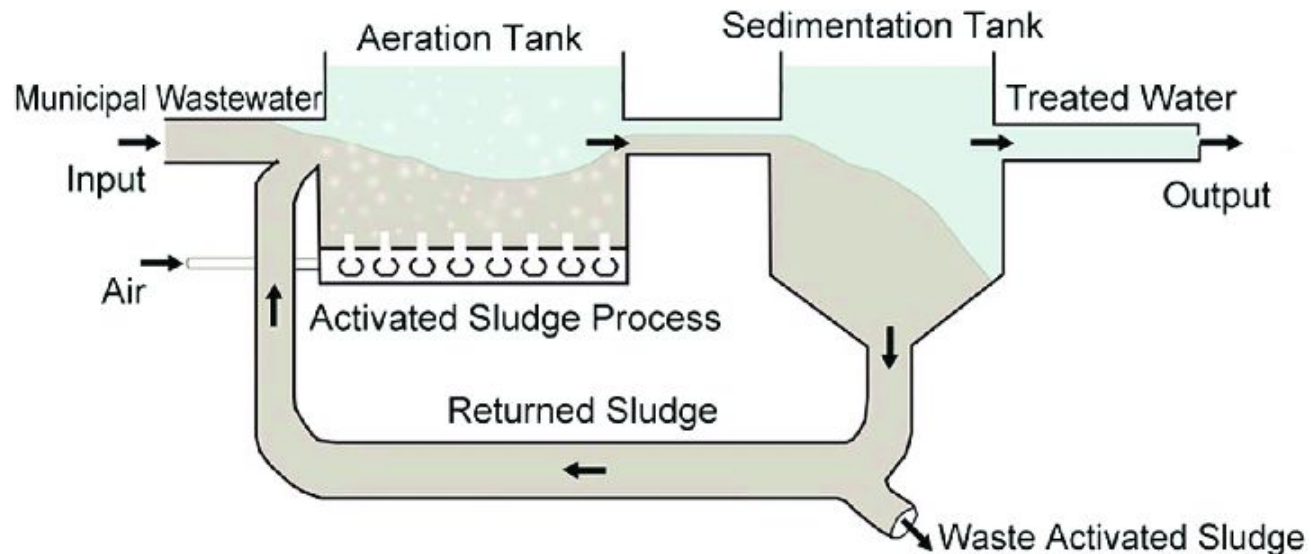
(b) Activated Sludge Process (ASP):

- Sewage is mixed for several hours with bacteria rich **sludge** and **air bubbles** to facilitate degradation by **micro-organisms**. The water then goes into a sedimentation tank where most of the microorganisms settle out as sludge.
- Sludge is **anaerobically digested** to convert organic matter into CO_2 , CH_4 (60%) and other stable end products. Dried digested sludge is a good source of **manure**.

ASP vs TF

- Use less land area for equivalent performance
- Less expensive to construct
- Have fewer problems with flies and odour
- Has higher rate of BOD removal

Hence, ASP is preferred over trickling filters.



(c) Oxidation Pond

- ❑ Large **shallow** ponds approximately **1 to 2 meters** deep.
- ❑ Raw or partially treated sewage is decomposed by **microorganisms**.
- ❑ **Easy to build** and manage and accommodate large fluctuations in flow.
- ❑ **Treatment** at a much **lower cost**.
- ❑ Require a large land **area**.



3. Tertiary (Advanced) Treatment:

It comprise of series of physical and chemical processes to remove specific pollutants left in the water after primary and secondary treatment:

- Nitrates and phosphates – eutrophication
 - Colour
 - Odour &
 - Biorecalcitrant pollutants
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- Ozonation
 - Photocatalysis
 - Electrocoagulation
 - Membrane filtration etc.

Further Readings

- Causes and effects of water pollution - Sustainability | ACCIONA,
https://www.youtube.com/watch?v=71IBbTy-_n4



Thank you for attention!!!

1. Which is a non-point source of water pollution:

- a) Sewage discharge pipe
- b) Acid rain
- c) Agricultural runoff
- d) Solid waste
- e) b & d
- f) b & c

2. BOD represent:

- a) Non-biodegradable pollution load
- b) Biodegradable pollution load
- c) Total pollution load
- d) Load of pathogens

3. Bioaccumulation means:

- a) Increase in concentration of pollutant through food chain.
- b) Storage of pollutants in tissue of living organisms.
- c) a & b both
- d) None

4. Leachate originate from:

- a) Mining sites
- b) Landfills
- c) Sewage sludge
- d) Agriculture

5. How much BOD is removed in secondary treatment?

- a) 95%
- b) 85%
- c) 75%
- d) 50%