Water Supply & Sanitary Engineering (DI05006021)

Unit 8: Sewage Treatment and Disposal

Lecture 36: Methods of Sewage Disposal and Effluent Standards

GTU Diploma Engineering

Agenda

- Need for Safe Disposal
- Disposal by Dilution (Water Bodies)
- Self-Purification of Streams
- Oxygen Sag Curve
- Disposal on Land (Sewage Farming)
- Sewage Sickness
- Effluent Discharge Standards

Need for Safe Disposal

- Even treated effluent contains some residual organics, nutrients (N, P), and microorganisms.
- Improper disposal can lead to:
- - Contamination of drinking water sources.
- - Fish kills due to oxygen depletion.
- - Eutrophication (algal blooms) in lakes.
- - Outbreaks of waterborne diseases.
- Disposal must be carefully planned to utilize nature's assimilative capacity without overwhelming it.

Method 1: Disposal by Dilution

- The most common method: discharging effluent into large natural bodies of water (rivers, lakes, oceans).
- Conditions favoring disposal by dilution:
- - The receiving water has a very large volume compared to the sewage flow (high dilution ratio).
- - The water body is not a source of drinking water downstream.
- - The receiving water has high dissolved oxygen (DO) levels.
- - Currents are strong enough to rapidly mix and disperse the effluent.

Self-Purification of Streams

- When organic matter is discharged into a river, a natural biological process begins.
- Aerobic bacteria in the river consume the organic matter, utilizing the river's Dissolved Oxygen (DO).
- Simultaneously, the river absorbs fresh oxygen from the atmosphere through the water surface (Reaeration).
- If Reaeration keeps pace with oxygen consumption (Deoxygenation), the river purifies itself without ecological damage.
- This natural recovery process is called 'Self-Purification'.

The Oxygen Sag Curve

- The DO level in a river drops downstream of the discharge point as bacteria consume the waste.
- It reaches a minimum point (critical DO) before gradually recovering as the waste is exhausted and reaeration dominates.
- Plotting this DO level along the length of the river creates the 'Oxygen Sag Curve'.
- Engineers use this curve to ensure the critical DO never drops below 4 mg/L, which is the minimum required for fish survival.

Method 2: Disposal on Land

- Also known as Effluent Irrigation or Sewage Farming.
- Treated sewage is applied to agricultural land.
- Advantages:
- - The soil acts as a massive natural filter.
- - The remaining nutrients (N, P, K) in the effluent act as free fertilizer, increasing crop yields.
- - It provides a reliable source of irrigation water in arid regions.
- - Prevents pollution of surface water bodies.

Conditions for Disposal on Land

- Not all land is suitable for sewage farming. Ideal conditions include:
- - Sandy or loamy soils with high permeability (allows water to drain).
- - Deep water table (prevents rapid contamination of groundwater).
- - Low rainfall region (soil isn't already saturated).
- - The effluent should not contain toxic industrial chemicals or heavy metals, which would accumulate in crops.

Sewage Sickness

- If sewage is applied continuously without allowing the soil to rest, the soil pores become clogged with organic matter.
- Oxygen can no longer penetrate the soil, turning the environment anaerobic.
- The soil turns black, foul odors are produced, and crops die.
- This condition is known as 'Sewage Sickness'.
- Prevention: Apply effluent intermittently, rotate crops, plow the land frequently, and avoid over-irrigation.

Effluent Discharge Standards

- Regulatory bodies (e.g., CPCB in India) mandate strict limits on effluent quality before disposal.
- These standards depend on the disposal destination.
- Why? To protect public health, aquatic life, and soil integrity.
- If a plant fails to meet these standards, it faces legal action, fines, or closure.
- Standard parameters monitored include: pH, BOD, COD, TSS (Total Suspended Solids), and Fecal Coliforms.

Typical Discharge Standards (Inland Surface Water)

- When discharging into a river or lake, the standards are stringent to protect aquatic life.
- General Standards (may vary by region):
- - pH: 5.5 to 9.0
- - Suspended Solids (TSS): ¡ 100 mg/L
- - BOD (3 days at 27°C): ¡ 30 mg/L
- - COD: ¡ 250 mg/L
- - Oil and Grease: ¡ 10 mg/L
- - Fecal Coliform: ¡ 1000 MPN/100ml

Typical Discharge Standards (Land for Irrigation)

- When discharging onto land for irrigation, the standards are slightly more relaxed for organics, as the soil provides further treatment.
- General Standards:
- - pH: 5.5 to 9.0
- - Suspended Solids (TSS): ¡ 200 mg/L
- - BOD: ¡ 100 mg/L
- Note: While BOD limits are relaxed, strict limits apply to heavy metals and toxic chemicals to prevent soil poisoning.

Summary

- Disposal by dilution relies on the natural self-purification capacity of large water bodies.
- The Oxygen Sag Curve models the DO drop and recovery in a river.
- Disposal on land recycles water and nutrients but requires careful management to prevent Sewage Sickness.
- Effluent discharge standards ensure that disposal practices do not harm the environment or public health.

Next Lecture: Low-Cost Sanitation

- Centralized sewerage systems are expensive and not feasible for rural or low-income urban areas.
- Next lecture covers Low-Cost Sanitation Systems.
- We will explore decentralized, on-site treatment options.
- Key topics: Pit latrines, Septic Tanks, and Imhoff Tanks.