

Water Supply & Sanitary Engineering (DI05006021)

Unit 8: Sewage Treatment and Disposal
Lecture 32: Preliminary Sewage Treatment

GTU Diploma Engineering

Agenda

- Overview of Treatment Stages
- Purpose of Preliminary Treatment
- Screening Devices
- Comminutors and Macerators
- Grit Chambers
- Skimming Tanks

Stages of Sewage Treatment

- 1. Preliminary Treatment: Removal of large debris, grit, and oil.
- 2. Primary Treatment: Removal of settleable suspended organic solids (Primary Clarification).
- 3. Secondary Treatment: Biological removal of dissolved and colloidal organics (Aeration, Trickling Filters).
- 4. Tertiary/Advanced Treatment: Removal of nutrients, pathogens, and specific chemicals.

Purpose of Preliminary Treatment

- Primary goal: Protect downstream mechanical equipment (pumps, aerators) from damage.
- Prevent blockages in pipes and valves.
- Remove heavy inorganic material (sand, gravel) that would occupy valuable space in digesters.
- It does NOT significantly reduce the BOD of the sewage; it is purely a physical conditioning step.

Screening: The First Barrier

- Screens consist of parallel steel bars placed across the flow channel.
- They capture large floating and suspended matter: rags, wood, plastics, and sanitary products.
- Types based on clear spacing: Coarse screens ($\geq 50\text{mm}$), Medium screens (20-50mm), Fine screens ($\leq 20\text{mm}$).
- Screens are placed at an angle (usually 30 to 60 degrees) to the flow to increase screening area and ease cleaning.

Manual vs. Mechanical Screens

Concept 1

Concept 2

Manual Screens: Cleaned by operators using hand rakes. Used in very small plants or as a bypass/backup.

Drawbacks: Labor-intensive, risk of sudden clogging during peak flows causing backwater effects.

Mechanical Screens: Cleaned automatically by motorized rakes. Used in medium to large plants.

Advantages: Continuous cleaning, prevents severe head loss, reduces operator contact with raw sewage.

Comminutors (Shredders)

- Instead of removing the debris via screens, comminutors grind and shred the coarse solids while they remain in the wastewater stream.
- The shredded particles (typically 6mm) pass through and settle out later in the primary clarifiers.
- Advantage: Eliminates the messy, odorous job of handling and disposing of screenings.
- Disadvantage: Can result in shredded plastics binding together and causing issues downstream.

Grit Chambers: Principles

- Grit consists of heavy inorganic matter: sand, gravel, eggshells, coffee grounds.
- Specific gravity of grit is around 2.65, much heavier than organic matter (approx. 1.02).
- Grit chambers are designed as enlarged channel sections to reduce the flow velocity of sewage.
- Velocity is controlled to approx. 0.3 m/s. This allows heavy grit to settle while keeping lighter organic matter suspended.

Types of Grit Chambers

- 1. Horizontal Flow Grit Chamber: Long, narrow channels. Velocity is controlled by a proportional weir or Parshall flume at the exit.
- 2. Aerated Grit Chamber: Air is injected near the bottom, creating a spiral flow pattern. The rolling action keeps organics suspended while heavy grit falls into a hopper.
- Aerated chambers also freshen the raw sewage and strip out odorous gases.

Proportional Weirs

- In horizontal grit chambers, maintaining a constant velocity of 0.3 m/s despite varying flow rates is critical.
- A proportional weir (Sutro weir) is installed at the outlet.
- The weir is shaped such that discharge is directly proportional to the head (height of water).
- This ensures that as flow increases, water depth increases proportionally, maintaining a constant horizontal velocity ($V = Q/A$).

Skimming Tanks

- Used to remove lighter-than-water substances: fats, oils, greases (FOG), and soaps.
- Air is introduced from the bottom to create bubbles. The FOG coagulates and attaches to the air bubbles, rising to the surface.
- The floating scum layer is then mechanically skimmed off the top.
- Essential for industrial wastes or where large amounts of grease are expected, as FOG interferes with biological treatment.

Flow Equalization (Optional but important)

- Sewage flow is highly variable throughout the day.
- Equalization basins are large holding tanks that temporarily store excess flow during peak hours.
- They release the wastewater at a constant, steady rate into the downstream treatment units.
- Benefits: Improves clarifier efficiency, dilutes sudden toxic industrial shocks, and stabilizes biological processes.

Summary

- Preliminary treatment prepares sewage for further processing and protects equipment.
- Screens remove large floating and suspended debris.
- Comminutors shred debris directly within the flow.
- Grit chambers use controlled velocity (0.3 m/s) to settle heavy inorganic sand.
- Skimming tanks utilize aeration to float and remove oils and greases.

Next Lecture: Primary Sewage Treatment

- In the next lecture, we transition to Primary Treatment.
- We will discuss the removal of settleable organic solids.
- We will learn about Primary Sedimentation Tanks (Clarifiers).
- We will explore design criteria like Surface Overflow Rate (SOR) and Detention Time.