

Water Supply & Sanitary Engineering (DI05006021)

Unit 8: Sewage Treatment and Disposal

Lecture 30: Characteristics of Sewage and Sampling Techniques

GTU Diploma Engineering

Agenda

- Introduction to Sewage
- Physical Characteristics
- Chemical Characteristics
- Biological Characteristics
- Importance of Sampling
- Types of Sampling Techniques

Introduction to Sewage

- Sewage is primarily water (approx. 99.9%) and about 0.1% solid matter.
- The solid matter exists in suspended, dissolved, and colloidal states.
- It contains organic matter, inorganic salts, and numerous microorganisms.
- Characteristics vary based on water usage, industrial discharge, and seasonal changes.

Physical Characteristics: Colour and Odour

- Fresh domestic sewage is slightly grey or light brown.
- Stale or septic sewage becomes dark grey or black due to anaerobic decomposition.
- Fresh sewage has a mildly soapy or oily odour.
- Septic sewage emits offensive odours, primarily Hydrogen Sulphide (H_2S), due to the breakdown of organic matter containing sulfur.

Physical Characteristics: Temperature and Turbidity

- Temperature of sewage is generally slightly higher than the local water supply.
- Higher temperatures accelerate biological activity and decrease gas solubility (e.g., oxygen).
- Turbidity indicates the presence of suspended matter, including faecal matter, paper, and soap.
- Turbidity is measured using a turbidimeter in NTU (Nephelometric Turbidity Units).

Chemical Characteristics: Solids

- Total Solids (TS) = Suspended Solids (SS) + Dissolved Solids (DS).
- Volatile Solids (organic) evaporate at 550°C and represent the organic load.
- Fixed Solids (inorganic) remain as ash after heating to 550°C.
- Settleable solids are those that settle out in an Imhoff cone within one hour.

Chemical Characteristics: Organic Matter

- Organic matter in sewage consists of proteins (approx. 65%), carbohydrates (approx. 25%), and fats/oils (approx. 10%).
- Proteins contain nitrogen and sulfur, which lead to foul odors during anaerobic breakdown.
- Fats and oils can cause blockages in sewers and inhibit oxygen transfer in treatment plants.
- Organic strength is primarily measured by BOD and COD tests (covered in next lecture).

Chemical Characteristics: Nitrogen and Phosphorus

- Nitrogen exists in four forms: Free ammonia, Albuminoid ammonia, Nitrites, and Nitrates.
- Free ammonia indicates recent pollution. Nitrates indicate stable, fully oxidized organic matter.
- Phosphorus comes from synthetic detergents and human waste.
- Excessive Nitrogen and Phosphorus in receiving waters cause eutrophication (algal blooms).

Chemical Characteristics: pH and Chloride

- Fresh sewage is generally alkaline (pH $\geq$ 7.0), ideal for biological treatment.
- Septic sewage turns acidic (pH $\leq$ 7.0) due to the formation of organic acids.
- Chlorides (NaCl) in sewage come from human urine and industrial discharges.
- Abnormally high chloride levels can indicate seawater infiltration or industrial waste.

Biological Characteristics

- Sewage contains millions of microorganisms per milliliter, primarily bacteria, viruses, fungi, and protozoa.
- Bacteria are classified as Aerobic (require oxygen), Anaerobic (function without oxygen), and Facultative (can adapt to both).
- Pathogenic organisms are disease-causing microbes (e.g., Salmonella, Vibrio cholerae) excreted by infected individuals.
- Indicator organisms like E. coli are tested to determine the likelihood of pathogen presence.

Importance of Sewage Sampling

- Sampling ensures the correct characterization of sewage for plant design.
- Sewage flow and strength vary diurnally (hourly), daily, and seasonally.
- A single isolated sample rarely represents the true average characteristics.
- Proper sampling locations, equipment, and preservation techniques are critical for accurate results.

Types of Sampling: Grab Samples

Concept 1

Grab Sample: A single sample taken at a specific time and location.

Represents the composition of sewage only at that specific moment.

Useful for testing parameters that change rapidly, such as pH, dissolved oxygen, and residual chlorine.

Not suitable for determining the average organic load (BOD) over a day.

Concept 2

Types of Sampling: Composite Samples

- Composite Sample: A mixture of multiple grab samples collected over a specific period (usually 24 hours).
- Time-proportional composite: Samples of equal volume collected at regular time intervals.
- Flow-proportional composite: Sample volumes collected are proportional to the flow rate at the time of sampling.
- Flow-proportional composite samples provide the most accurate representation of the average sewage characteristics.

Summary

- Sewage characteristics are physical, chemical, and biological.
- Temperature, color, and odor provide preliminary physical indicators.
- Solids, organic matter (N, P), pH, and chlorides define chemical strength.
- Pathogens and beneficial treatment bacteria constitute biological characteristics.
- Proper sampling (especially composite sampling) is essential for accurate representation.

Next Lecture: BOD and COD Tests

- In the next lecture, we will dive deeper into measuring the organic strength of sewage.
- We will cover the principles of Biochemical Oxygen Demand (BOD).
- We will understand Chemical Oxygen Demand (COD).
- We will learn how to interpret BOD/COD ratios for treatability.