

Water Supply & Sanitary Engineering (DI05006021)

Unit 2: Quantity and Quality of Water
Lecture 7: Water Testing and Quality Standards

GTU Diploma Engineering

Agenda

- Physical Tests: Turbidity, Color, Taste/Odor
- Chemical Tests: pH, Hardness
- Chemical Tests: Chlorides, Nitrogen, Residual Chlorine
- Bacteriological Tests: MPN and E. coli
- Indian Standard BIS 10500 for Drinking Water
- Unit 2 Summary

Physical Tests: Turbidity

- Measures the resistance to the passage of light through water due to suspended matter.
- Measured using Jackson Turbidimeter (historical) or Nephelometer (modern).
- Nephelometric Turbidity Units (NTU) measure scattered light at 90 degrees.
- High turbidity shields bacteria from disinfectants like chlorine.

Physical Tests: Color and Taste/Odor

- Color: Measured on the Platinum-Cobalt scale (Hazen Units) using a Tintometer. True color (dissolved) vs Apparent color (suspended).
- Taste and Odor: Measured by Threshold Odor Number (TON).
- $\text{TON} = (\text{Volume of Sample} + \text{Volume of Odor-free water}) / (\text{Volume of Sample})$.
- Determined subjectively by the human nose (Osmoscope).

Chemical Tests: pH Value

- Indicates the intensity of acidity or alkalinity.
- $\text{pH} = -\log[\text{H}^+]$. Scale ranges from 0 to 14.
- $\text{pH} < 7$ is acidic (corrosive to pipes).
- $\text{pH} > 7$ is alkaline (can cause scaling).
- Measured using a Potentiometer (pH meter) or indicators like methyl orange/phenolphthalein.

Chemical Tests: Total Hardness

- Caused mainly by Calcium (Ca^{++}) and Magnesium (Mg^{++}) ions.
- Temporary Hardness: Carbonates and Bicarbonates (removed by boiling).
- Permanent Hardness: Sulfates, Chlorides, Nitrates (requires special treatment).
- Tested via EDTA Titration using Eriochrome Black T indicator.

Chemical Tests: Chlorides and Residual Chlorine

- Chlorides: Indicates sewage pollution or seawater intrusion. Tested via Mohr's method (Silver Nitrate titration).
- Residual Chlorine: The amount of chlorine remaining after the chlorine demand is satisfied.
- Crucial for preventing recontamination in the distribution system.
- Tested using DPD method or Chloroscope.

Chemical Tests: Nitrogen Content

- Indicates organic pollution (sewage). Exists in four forms:
- 1. Free Ammonia: Recent, fresh pollution.
- 2. Organic/Albuminoid Nitrogen: Undecomposed organics.
- 3. Nitrites: Partially decomposed (Highly dangerous).
- 4. Nitrates: Fully oxidized (Old pollution; Causes 'Blue Baby Syndrome').

Bacteriological Tests: Indicator Organisms

- Testing for every specific pathogen is impossible.
- Instead, we test for 'Indicator Organisms' like the Coliform group (*E. coli*).
- Coliforms live in human intestines. Their presence proves fecal contamination.
- If *E. coli* is present, pathogens like Typhoid or Cholera might also be present.

Bacteriological Tests: MPN Method

- Most Probable Number (MPN) / Multiple Tube Fermentation.
- Inoculate water into tubes with MacConkey broth.
- Incubate at 37°C for 48 hours.
- Positive result: Production of acid and gas (bubbles).
- Use statistical tables to determine the MPN index per 100 ml.

Drinking Water Quality Standards

- In India, water quality is governed by IS 10500:2012.
- Provides an 'Acceptable Limit' (ideal) and a 'Permissible Limit in Absence of Alternate Source'.
- Ensures water is safe for lifetime consumption without adverse health effects.

IS 10500: Physical & Chemical Parameters

- Turbidity: Acceptable = 1 NTU, Permissible = 5 NTU
- pH Value: Acceptable = 6.5 to 8.5, No relaxation
- Total Hardness (as CaCO_3): Acc = 200 mg/L, Perm = 600 mg/L
- Chlorides: Acc = 250 mg/L, Perm = 1000 mg/L
- Residual Chlorine: 0.2 mg/L minimum at consumer end.

IS 10500: Toxic & Biological Limits

- Nitrate (as NO_3): Max 45 mg/L (No relaxation).
- Fluoride: Acceptable = 1.0 mg/L, Permissible = 1.5 mg/L.
- Bacteriological standard: E. coli or Thermotolerant coliform bacteria must not be detectable in any 100 ml sample.
- Zero tolerance for fecal contamination.

Unit 2 Summary

- We determined total quantity (Population * Per capita demand).
- We accounted for fluctuations (Max daily and hourly demands).
- We learned to collect and test water samples.
- We compared quality against IS 10500 standards.
- Next Unit: We will design the treatment processes to fix these impurities!