Lecture 7
Measurement of D.O

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Organic Matter in Water

- Dissolved form: Organic compounds fully dissolved in water.
- Suspended form: Particles floating in water.
- **Sources of organic matter**:
- Domestic and industrial wastewater.
- Decomposition of plant and animal bodies present in water.

Environmental Impacts & :

- Consumption of dissolved oxygen in the water source due to decomposition, affecting respiration of fish and other aquatic life.
- Water pollution and emission of unpleasant odors due to anaerobic decomposition
- **Removal**:
- Naturally during the self-purification process of water, limited by the biological load
- Artificially through polluted water treatment units.

Methods for Measuring Organic matter

- Organic matter can be measured based on its oxidation by different methods.
- Oxidation includes carbohydrates, fats, proteins, and may involve elements like nitrogen, sulfur, etc.
- The following measurements are used as indicators of organic matter concentration in water.

1: Biochemical Oxygen Demand (BOD)

- This measurement determines the amount of dissolved oxygen consumed by bacteria and fungi in the decomposition of organic matter over a specific time at 20°C.
- It requires a long period, usually 5 days, depending on the type of organic matter.
- It is a measure of oxygen consumption by microorganisms responsible for the biological decomposition of organic matter under specific temperature conditions over a defined period

2: Chemical Oxygen Demand (COD)

- Based on oxidation of organic matter using strong chemical oxidants such as potassium dichromate and concentrated sulfuric acid.
- The remaining oxidizing agent is measured to infer the organic matter concentration.
- This is a rapid method, typically taking about 2 hours.

3: Total Organic Carbon (TOC)

- AnalysisBased on complete combustion of organic matter at high temperature with suitable catalysts.
- Carbon in the organic matter is fully converted to CO_2, which is measured using advanced instruments to determine total organic carbon.
- This method is accurate and rapid for measuring organic matter.

Aim of the Experiment

- To determine concentrations of organic matter in river water and polluted water such as domestic and industrial wastewater.
- The data help assess biological load, evaluate river water quality, design treatment units, and study treatment efficiency.

River Classification by BOD

- Very clean: 1 mg/L
- Clean: 2 mg/L
- Moderately clean: 3 mg/L
- Doubtful cleanliness: 5 mg/L
- Poor quality: more than 10 mg/L

Sample Preservation

- Analysis should be conducted as soon as possible.
- If not possible, preserve the sample at 4°C for a maximum of 24 hours.

BOD Measurement Methods

- 5-Day BOD Test
- Respirometric Method

5-Day BOD Test

- Based on measuring the difference in dissolved oxygen in water before and after incubation at 20°C.
- Proper dilution according to organic matter concentration is required.
- Use glass bottles of 250–300 mL with tightly sealed caps.
- DO measurement can use the Winkler method or electrode method

Required Materials for the Experiment

- Glass bottles (250–300 mL) with tight caps.
- Incubator or water bath at 20°C.
- pH measuring device.
- Chemicals used in the Winkler method.

Required Chemicals

- Chemicals for azide modification.
- Phosphate buffer solution.
- Sulfuric acid (N1) or sodium hydroxide (N1).
- Nutrient supplements: magnesium sulfate, calcium chloride, ferric chloride.
- Note: Organic matter serves as the main food for bacteria and fungi; inorganic compounds are used as nutritional supplements.

BOD Test Procedure

- Prepare dilution water: Saturate 1 L distilled water with oxygen, add 1 mL phosphate buffer and 1 mL each nutrient solution; let settle ≥2 hours.
- Add 0.6 mg/L bacteria to samples without bacteria.
- Dilute sample with dilution water using a 600 mL graduated cylinder and mix thoroughly.
- Transfer diluted sample to two bottles (250–300 mL), seal tightly.One bottle: initial DO measurement.Second bottle: incubate 5 days at 20°C for final DO measurement.Repeat for all required dilutions.

Dilution ratio = sample volume / sample volume + dilution water

BOD Calculations

- Undiluted samples / Rivers
- BOD = initial DO - final DO mg/L
- Diluted samples
- BOD = Initial DO - final DO / dilution ratio mg/l

- dilution ratio = sample volume / sample volume + dilution water

Respirometric Method

- Measures BOD by recording the change in air pressure in a sealed bottle before and after incubation at 20°C.
- Advanced techniques measure pressure change; nitrification inhibitors and CO_2 absorbers are used.

COD Measurement Methods

- Modern method: Commercial devices like WTW (Germany) with a reactor and spectrophotometer.
- Traditional chemical method (detailed below).

- **COD Sample Preparation**
- Prepare solutions: potassium dichromate, sulfuric acid, catalyst.
- Collect samples in sterilized glass bottles.
- Homogenize precipitable material.Preserve samples by adding sulfuric acid to reach pH < 2 and store at 4°C until testing.

COD Equipment and Chemicals

- Thermos reactor (COD digester)
- Burette + holder
- Special vials
- Conical flask
- Pipettes,
- washing bottle
- Chemicals: sulfuric acid, silver sulfate

COD Procedure

- Take 3 COD vials: 2 samples, 1 blank.
- Add 2.5 mL sample to each vial; add 2.5 mL distilled water.
- Add 1.5 mL potassium dichromate solution.
- Add 3.5 mL sulfuric acid carefully.
- Seal vials, digest at 150°C for 2 hours.
- Cool vials to room temperature.
- Titrate blank and samples with ammonium ferrous sulfate (ferroin indicator) to reddish-brown endpoint.
- Record titration volumes: A = blank, B = sample.

COD calculation mg/L = A – B * N*8000 / sample volume