

# Water Quality Parameters

## Examination of Water: Biochemical Oxygen Demand (BOD)

- What ?
- Why ?
- How ?



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## Water Quality Parameters - Dissolved Oxygen and BOD

### Biochemical Oxygen Demand (BOD) Determination

- The five day biochemical oxygen demand ( $BOD_5$ ) at  $20^\circ\text{C}$  is the most widely used parameter for quantifying biodegradable organic pollution, applied to both wastewater and surface waters.
- This determination involves the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter.
- Biochemical oxidation is a slow process and theoretically takes an infinite time to go to completion. Within a 20-day period, the oxidation is about 95-99 percent complete, and in the 5-day period used for the BOD test, oxidation is 60-70 percent complete.
- A sample having biodegradable organic matter, i.e., domestic wastewaters and surface water bodies polluted with wastewaters would have substantial  $BOD_5$ . Also, a sample having more organic pollution should exhibit a higher  $BOD_5$  value.

## Water Quality Parameters - Dissolved Oxygen and BOD

### Procedure for BOD Determination

- Saturate tap water with oxygen by bubbling air through it by using a compressor. Measure dissolved oxygen (DO) concentration in this water. It should be at least 8 mg/L. This is known as **dilution water**.
- Prepare a blank sample (using 300 mL of dilution water only) in a BOD bottle. Incubate for 5 days at 20°C. The DO of the dilution water should not be much different from the initial value.
- Prepare three samples by adding 5 mL of the wastewater in the BOD bottle, and making up to 300 mL with dilution water. Incubate for 5 days at 20°C. Measure DO in each sample after 5 days.
- Derive the expression for  $BOD_5$  based on these DO values and extent of dilution of the wastewater sample.

## Biochemical Oxygen Demand [BOD]

The Quantity of Oxygen Used in the Biochemical Oxidation of Organic Material.

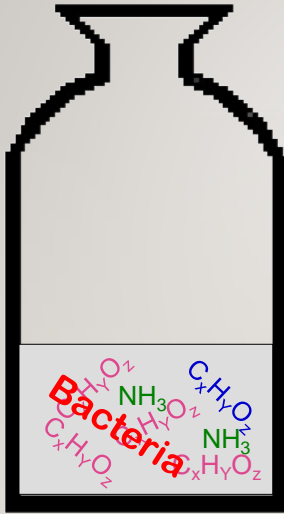
Under:

Specified Time: 5 Days or 3 Days

Specified Temperature: 20<sup>0</sup> C or 27<sup>0</sup> C

Specified Conditions: In the Dark; In the Presence of Bacteria

## Measured Volume of Wastewater is Added to BOD Bottle



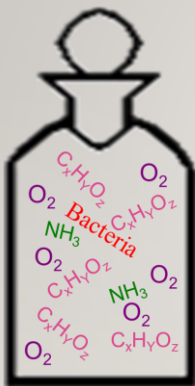
Contains:

Organics

Ammonia

Bacteria

## Dilution Water Added



Dilution Water Contain:

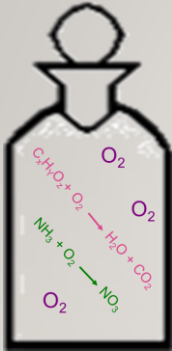
Nutrients

Oxygen

Measure  
DO Concentration

## Incubate 5 Days

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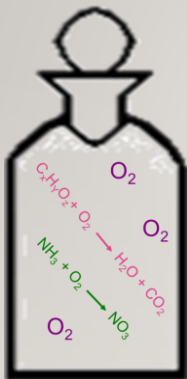
### Some Oxygen Used

- Respiration
- Nitrification

**Measure  
DO Concentration**

## Measure Oxygen Loss (Demand)

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**DO Day 1 - DO Day 5**

**= Oxygen Demand**

**(Of What Is In The Bottle)**

## BOD

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### Reagents

- ✓ High Quality
- ✓ Free of Toxic Material
- ✓ Free of Oxygen Demanding Substances

### Distilled Water

- ✓ Phosphate Buffer
- ✓ Magnesium Sulfate
- ✓ Calcium Chloride
- ✓ Ferric Chloride

Provide Essential Nutrients; Buffer pH

### Other Reagents

- ✓ Dechlorinating Agent Sodium Sulfite -  $\text{Na}_2\text{SO}_3$
- ✓ Nitrification Inhibitor CBOD
- ✓ Quality Control Check Accuracy
- ✓ Glucose - Glutamic Acid Solution

## BOD

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### Sample Pretreatment

- Temperature: Near  $20^{\circ}\text{C}$
- pH: Between 6.5 and 7.5 (Adjust if  $> 8.5$  or  $< 6.0$  and seed)
- Supersaturated DO Agitate
- Dechlorinate Proper Amount of Sodium Sulfite



## BOD

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### Dilution Water

<b>Distilled Water</b>	+	<b>Buffer</b>	+	<b>Nutrients</b>
High Quality No Toxics No Organics		pH 7.2		(Phosphorus & Ammonia) Magnesium, Calcium, Iron

### BOD Procedure

#### Dilute Sample

- ✓ Minimum Residual, 1.0 mg/L
- ✓ Minimum Depletion, 2.0 mg/L
- ✓ At Least Two Dilutions
- ✓ Thoroughly Mix Sample

#### Add Nitrification Inhibitor

if required for CBOD

TCMP  
0.10 gram/bottle  
Two "shots"

#### Add SEED (Bacteria)

If Required

- ✓ Disinfected Samples
- ✓ Industrial Samples
- ✓ Reference Samples

## BOD

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### BOD Calculation

**DO Initial - DO Final = DEPLETION**

= Oxygen Demand of Diluted Sample

$$\text{BOD mg/L} = \frac{\text{DO Depletion (mg/L)}}{\text{Sample Volume (ml)}} \times 300 \text{ mL}$$

## BOD

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### BOD Calculation

$$C_1 \times V_1 = C_2 \times V_2$$

$$\text{Sample BOD} \times \text{Sample Volume} = \text{BOD Diluted} \times \text{Diluted Volume}$$

$$\text{BOD Sample} = \frac{\text{BOD Diluted}}{\text{Sample Volume}} \times \text{Volume Diluted}$$

$$\text{BOD Sample} = \frac{\text{Depletion}}{\text{Sample Volume}} \times 300 \text{ mL}$$

## BOD

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### BOD Calculation

$$\text{DO Depletion} = \text{DO Initial} - \begin{matrix} \text{DO 5-Day} \\ \text{Or} \\ \text{DO 3 Day} \end{matrix}$$

Minimum Depletion - 2.0 mg/L

Minimum Residual - 1.0 mg/L

Sample Volume to be Added ?

## BOD PROCEDURE: Summary

### Dilute Sample

- ✓ Minimum Residual, 1.0 mg/L
- ✓ Minimum Depletion, 2.0 mg/L
- ✓ At Least Two Dilutions
- ✓ Thoroughly Mix Sample

### Add Nitrification Inhibitor

If Required for CBOD

### Add SEED (Bacteria)

#### If Required

- ✓ De-chlorinate Samples
- ✓ Industrial Samples
- ✓ Reference Samples

$$\text{Bod}_{(\text{seeded})} = \frac{D_1 - D_2}{\text{Sample Volume}} \times 300 \text{ ml}$$

$D_1$  = Depletion Due To Sample And Seed

(Total Depletion In Bottle With Seed And Sample)

$D_2$  = DO Depletion due to Just Seed  
(Seed Depletion in Bottle with seed and Sample)

## Water Quality Parameters - Dissolved Oxygen and BOD

### DO Depletion – Mostly BOD, But NOT Always

- Substances that can be oxidized by Oxygen in water.
- Sulphide, Iron ( $\text{Fe}^{+2}$ ), etc.
- Instantaneous Oxygen Demand (IOD).