

BIOCHEMICAL OXYGEN DEMAND

OBJECTIVE

Determine the biochemical oxygen demand of wastewater by describing its polluttional strength.

BACKGROUND

Dissolved oxygen is the critical parameter of natural water systems. It determines the quality of a river and the variety of biota that live in it. To maintain higher life forms, a minimum of 2 mg/L of dissolved oxygen is required and 4 mg/L or more is required for some game fish. When organic waste is discharged into a stream, either from indirect sources or as discharge from a wastewater treatment plant, bacteria and other microorganisms will decompose organic matter until it is stabilized. This biodegradation of organic matter under aerobic conditions requires a certain amount of oxygen, and the BOD measures the amount of oxygen needed by the organisms. The BOD can determine the amount of oxygen a stream will need in order to maintain aerobic conditions under polluttional discharge.

Biochemical oxygen demand is the measure of oxygen consumed by microorganisms during aerobic biodegradation of organic matter in water. The test depends on controlled conditions, available nutrients, and time. BOD is measured by placing a sample (diluted) in an airtight BOD bottle, and incubating it at 20°C for 5 days. The dissolved oxygen is measured with a DO meter before and after incubation, and the BOD is calculated from the difference between the initial DO and final DO times the dilution factor.

APPARATUS

6 BOD bottles (300 mL) with glass stoppers and plastic caps to provide a water seal
Incubator or water bath at 20°C
YSI Dissolved Oxygen meter with stirring probe
Siphon apparatus
pH meter
Syringes

Reagents

Aerated Buffer dilution water containing:

Phosphate buffer

(8.5g $\text{KH}_2\text{PO}_4 \cdot 7\text{H}_2\text{O}$ + 21.75g K_2HPO_4 + 33.4g $\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$ + 1.7g NH_4Cl dissolved in 500 mL and diluted to 1 Liter)

Magnesium sulfate solution – 22.5g $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}/\text{L}$

Calcium Chloride solution – 27.5g CaCl_2/L

Ferric Chloride solution – 0.25g $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}/\text{L}$

Laboratory Safety

Use designated waste containers for all chemicals in this experiment, **do not pour chemicals down drains**. WEAR EYE AND HAND PROTECTION DURING THIS LABORATORY!! Laboratory coats are strongly recommended.

PROCEDURE

1. Select a sample such as Primary Clarifier Effluent, Secondary Clarifier Effluent, or Aggie Pond water. (Each group will use a different sample).
2. The DO Probe method will be used to determine dissolved oxygen.
3. Generally, a domestic wastewater sample will require dilution before incubation to bring the oxygen demand and supply into appropriate balance. For appropriate dilutions, consult the laboratory analyst at the treatment plant and/or use the following guidelines:

0.5-1.0% for strong industrial waste
1.0-5.0% for raw and settled wastewater
5.0-25% for biologically treated effluent
25-100% for polluted river water

We will use the following dilutions for this laboratory:

| <u>Sample</u> | <u>Dilutions (%)</u> | <u>Sample Size (mL)</u> |
|--------------------|----------------------|-------------------------|
| Primary Effluent | 2, 3, 4, 5 | 6, 9, 12, 15 |
| Secondary Effluent | 5, 10, 15, 20 | 15, 30, 45, 60 |
| Aggie Pond Water | 25, 50, 75, 100 | 75, 150, 225, 300 |

Each group will also have a blank sample, in which the BOD bottle is filled only with dilution water.

4. Label or otherwise identify each BOD bottle with the corresponding dilution.
5. Using a syringe, add the desired volume of carefully mixed sample to a 300 mL BOD bottle.
6. Slowly siphon or add aerated dilution water into each bottle, filling each so that the stopper will displace all of the air and leave no bubbles.
7. Determine initial DO of each dilution immediately. Determine initial DO using the probe, stopper the same bottle to avoid air entrapment, seal the stopper with a small amount of distilled water, and incubate for 5 days (or 7).
8. Check the dilution water by preparing and incubating a test blank. There will be no dilution made on the blank. The entire bottle will be filled with the dilution water.
9. After 5 days (or 7) determine the DO of each incubated bottle. For a reliable result, the following criteria must be met:
 - a. A residual DO of at least 1 mg/L
 - b. A DO depletion of at least 2 mg/L

10. Calculation:

$$5 \text{ (or 7) day BOD in mg/L} = (DO_{\text{initial}} - DO_{\text{final}})(DF)$$

Where:

DO_{initial} = DO at day 1

DO_{final} = DO at end of test, normally 5 days (but in our case 7)

DF = dilution factor = 300mL/mL of sample

| Primary Effluent (mg/L) | | | | | |
|-------------------------|----|----|----|----|-------|
| Dilutions | 2% | 3% | 4% | 5% | Blank |
| Initial (mg/L) | | | | | |
| Final (mg/L) | | | | | |

| Secondary Effluent (mg/L) | | | | | |
|---------------------------|----|-----|-----|-----|-------|
| Dilutions | 5% | 10% | 15% | 20% | Blank |
| Initial (mg/L) | | | | | |
| Final (mg/L) | | | | | |

| Aggie Pond Water (mg/L) | | | | | |
|-------------------------|-----|-----|-----|------|-------|
| Dilutions | 25% | 50% | 75% | 100% | Blank |
| Initial (mg/L) | | | | | |
| Final (mg/L) | | | | | |

WRITE-UP

RESULTS

1. Report final results in a table. The table should include initial and final DO values, for each group.
2. All equations and variables.

DISCUSSION

3. What is BOD? How does it occur? (5 Pts)
4. What method is used to measure BOD? (6 Pts)
5. What are the critical parameters which determine the quality of a river and the variety of biota that live in it? (7 Pts)
6. What is the real world relevance of Biochemical Oxygen Demand? (6 Pts)
7. Discuss the importance of dissolved oxygen in fresh water systems. (6 Pts)