

BIOCHEMICAL OXYGEN DEMAND (B O D)



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What is BOD?

- ◆ **Biochemical Oxygen Demand** is the amount of oxygen, expressed in mg/L or parts per million (ppm), that bacteria take from the water when they oxidize organic matter.

(Hach, Clifford; R. Klein; C. Gibbs. Introduction to Biochemical Oxygen Demand. Hach Company, 1997.)

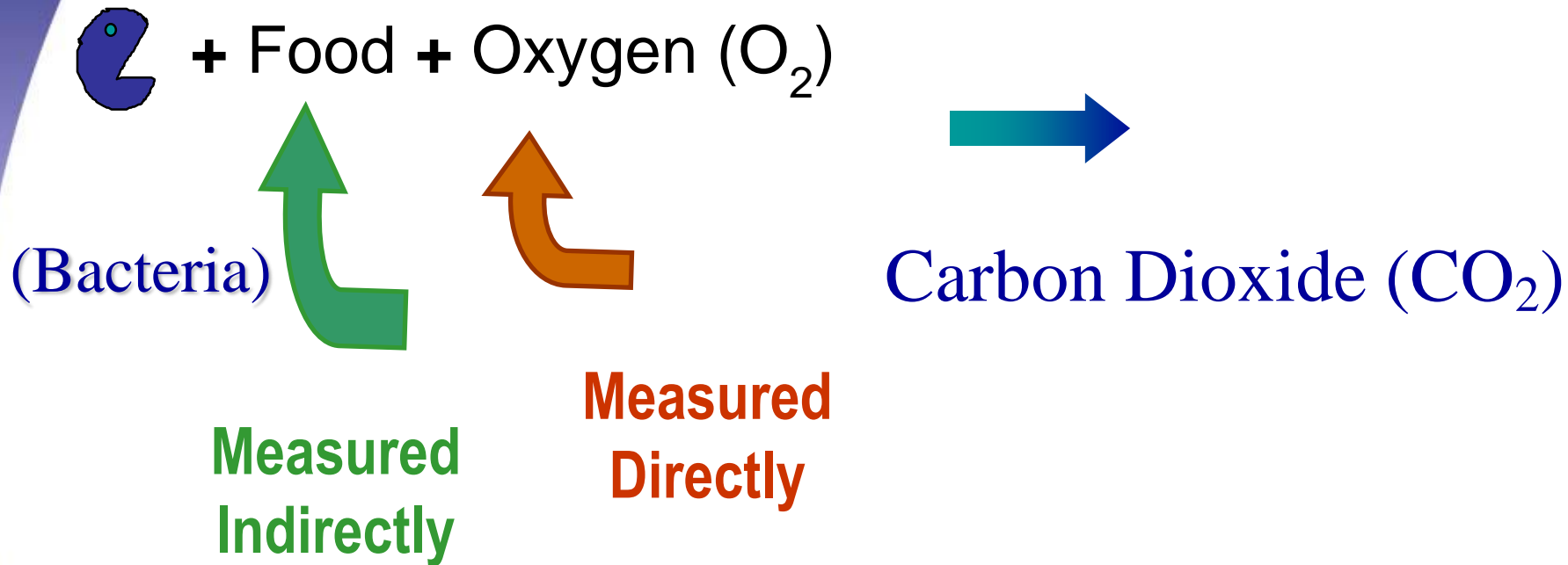


What is BOD?

- ◆ BOD is a measure of organic pollution.
 - Changes in dissolved oxygen concentration are used as an indirect measure of organic content.



What is BOD?





What is BOD?

- ◆ Incubation conditions:
 - Temperature – $20 \pm 1^{\circ}\text{C}$
 - Time – 5 days
 - In the dark





BOD in environmental waters.

- ◆ BOD measurements help in monitoring the effect of effluent on the dissolved oxygen concentration of the receiving water body.





BOD in environmental waters.

- ◆ Initially well aerated, unpolluted stream has low organics material & high DO.
- ◆ Addition of oxidizable organics decreases DO as reaeration can't keep up with oxygen consumption.
- ◆ Decomposition zone creates low DO & high bacterial population.
- ◆ If too much degradable organics in decomposition zone, anaerobic metabolism occurs.
- ◆ In septic zone, this creates foul smell and toxic products i.e. methane & H₂S.



BOD Calculations

- ◆ Using the dilution method, three values must be known in order to calculate BOD:
 - Initial DO
 - Final DO
 - Volume of sample



BOD Calculations

- ◆ Standard Methods calculations:

$$\text{BOD}_5, \text{ mg/L} = \frac{(\text{Initial DO} - \text{Final DO}) 300}{S}$$

S = volume of sample



BOD Dilution Method





Preparing Dilution Water

- ◆ Store distilled water in a BOD incubator until the temperature reaches 20°C.
- ◆ Water is then saturated with oxygen and is ready for use.





Preparing Dilution Water



Add buffer
and nutrients

- ◆ After adding buffer and nutrients, shake the bottle vigorously to ensure saturation.
- ◆ Select proper nutrient buffer pillow.
- ◆ Choose a container that is partially filled
- ◆ Ensure distilled water is 20degC
- ◆ Use immediately!



Determining Range and Sample Volume

Table 2 Determining Minimum Sample Volume

Sample Type	Estimated BOD mg/L	mL of Sample*
Strong Trade Waste	600	1
	300	2
Raw and Settled Sewage	200	3
	150	4
	120	5
	100	6
	75	8
	60	10
	Oxidized Effluents	50
40		15
30		20
20		30
10		60
Polluted River Waters	6	100
	4	200
	2	300

* mL of sample taken and diluted to 300 mL in standard BOD bottle

WAH

**Pg
917**



Determining Range and Sample Volume

- ◆ If our sample is approximately **300mg/L BOD**, what should the minimum and maximum sample volumes be?



Determining Range and Sample Volume

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	120	5
	100	6
	75	8
	60	10
Oxidized Effluents	50	12
	40	15
	30	20
	20	30
	10	60
Polluted River Waters	6	100
	4	200
	2	300

* mL of sample taken and diluted to 300 mL in standard BOD bottle

WAH

Pg
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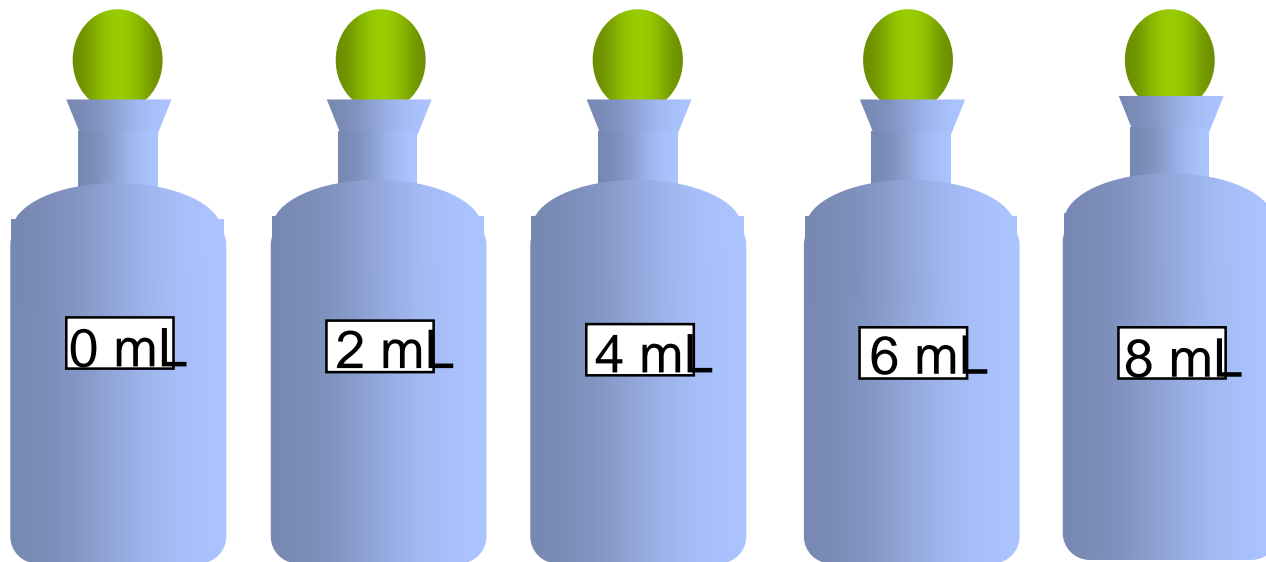
Determining Range and Sample Volume

- ◆ If our sample is approximately **300mg/L BOD**, what should the minimum and maximum sample volumes be?
 - Minimum volume = 2mL
 - Maximum volume = 8mL



Determining Range and Sample Volume

Fill bottles past the neck with dilution
water
and invert to mix (no air bubbles).



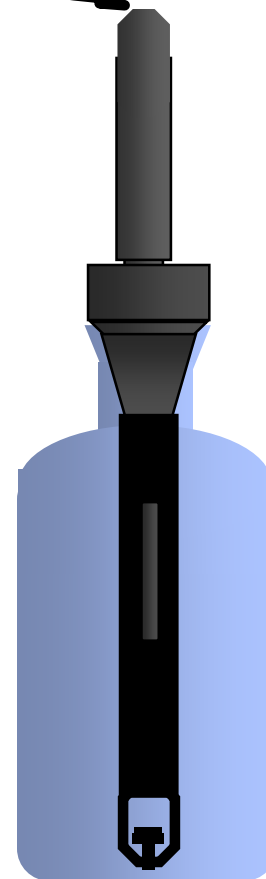


Obtaining Data Points



Initial DO = 7.30 mg/L

Read all 5 bottles





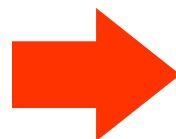
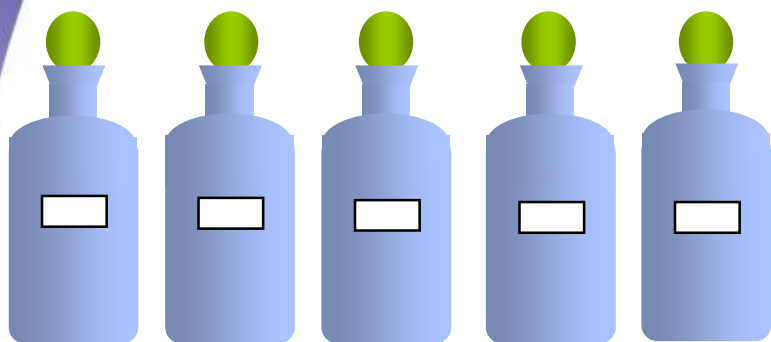
Obtaining Data Points

- ◆ After measuring DO, replace any lost volume in the bottle with dilution water.
- ◆ Replace stopper – watch for air bubbles!
- ◆ Fill area in around stopper with dilution water.
- ◆ Cover with plastic BOD bottle cap.





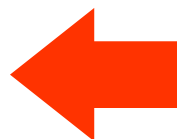
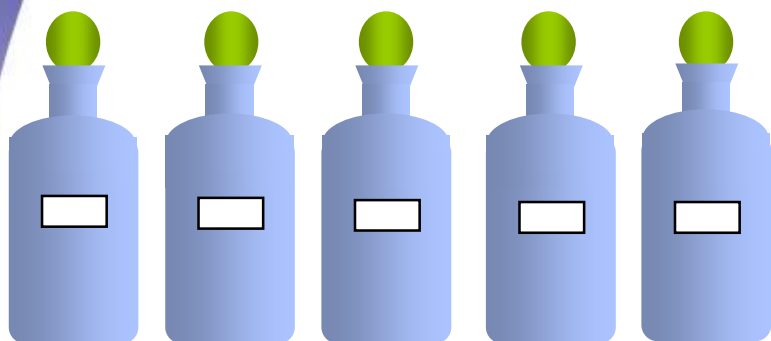
Obtaining Data Points



Transfer samples to 20°C incubator and incubate for 5 days.



Obtaining Data Points



After 5 days, remove samples from incubator and measure final DO.

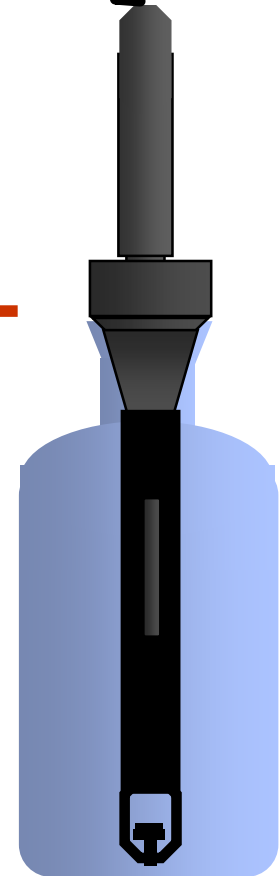


Obtaining Data Points



Final DO = 5.25 mg/L

Read all 5 bottles





Obtaining Data

- ◆ Plug data into equation:

$$\text{BOD}_5, \text{ mg/L} = \frac{(\text{Initial DO} - \text{Final DO}) 300}{S}$$



Obtaining Data

◆ Plug data into equation:

$$\text{BOD}_5, \text{ mg/L} = \frac{(7.30 - 5.25) 300}{2}$$

$$\text{BOD}_5, \text{ mg/L} = 307.5 \text{ mg/L}$$



BOD – Take Home Messages

- ◆ BOD is an indirect measure of organic content.
- ◆ BOD is measured by oxidizing organics using microorganisms (under specific conditions) and directly measuring the amount of oxygen consumed in the process.