CIVE 3331 Pg 254 Pr. 1

Why is BOD bottle stoppered? - To prevent reaeration from atmosphere.

Why is test done in dark? To prevent algae from producing O_2 by photosynthesis

Why is sample diluted? To keep from using all oxygen initially in bottle - otherwise test cannot measure required O_2.

Why is sample sometimes seeded? Because necessary microorganisms to exert O_2 demand may be absent

Why isn't ultimate BOD measured? Takes too long; esp at low DO portion (late time) of degradation

~~Process~~

~~Please grade.~~

- ~~Still my original soln was wrong.~~
  ~~Students got full credit for attempt.~~
- ~~Need by Monday PM~~

CIVE 3331 P 254 PR 5.2

Wastewater $BOD_5 = 200 mg/L$ treated in a plant that removes 90% of BOD.

You will conduct a BOD_5 test with a 300mL bottle using treated sewage and dilution water. $DO_0 = 9.2 mg/L$.

a) What is maximum amount of wastewater to add if you want $DO = 2.0 mg/L$ at end of test?

$$DO_0 - DO_5 \left(\frac{\forall_{waste} + \forall_{dilution}}{\forall_{waste}} \right)$$

Treated sewage = 20mg/L (expected)

$$(9.2 mg/L - 2.0 mg/L)\left(\frac{\forall_w + \forall_d}{\forall_w}\right) = 20 mg/L$$

$$7.2 mg/L \left(\frac{\forall_w + \forall_d}{\forall_w}\right) = 20 mg/L$$

$$\left(\frac{\forall_w + \forall_d}{\forall_w}\right) = \frac{20 mg/L}{7.2 mg/L} = 2.78$$

$$\frac{300mL}{2.78} = \forall_w = \underline{\underline{108mL}} \longleftarrow$$

b) What DO do you expect if 1/2 wastewater & 1/2 dilution are mixed

$$9.2 mg/L - 20 mg/L \underbrace{\left(\frac{\forall_w}{\forall_w + \forall_d}\right)}_{\frac{150mL}{300mL}} = DO_5$$

$9.2 mg/L - 10 mg/L = 0$ (Expect all O_2 to be gone; DO = 0)

CIVE 3331 PE 5-5

	DO_0	DO_f	Waste (ml)	Vol dilute
Raw	6.0	2.0	5	295
Treat	9.0	4.0	15	285

What is %-removal of BOD in this plant?

Raw $(6.0 - 2.0\ mg/L)\left(\frac{300\ ml}{5\ ml}\right) = 240\ mg/L - BOD_5$

Treated $(9.0 - 4.0\ mg/L)\left(\frac{300\ ml}{15\ ml}\right) = 100\ mg/L - BOD_5$

∴ Plant removes $140\ mg/L$

$$\%\ removal = \frac{140\ mg/L}{240\ mg/L} \times 100\% = 58.3\%\ removal$$

Plant is not operating properly because it is supposed to remove 85% of BOD.

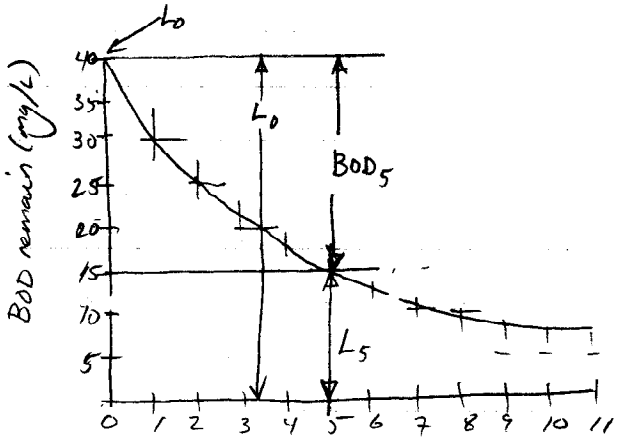
CIVE 3331 Pr. 5.6

From plot find

a) Ultimate BOD

b) BOD_5

c) L_5



$L_0 = BOD_t - L_t$

L_0: Ultimate BOD

BOD_t: Amount used in time t

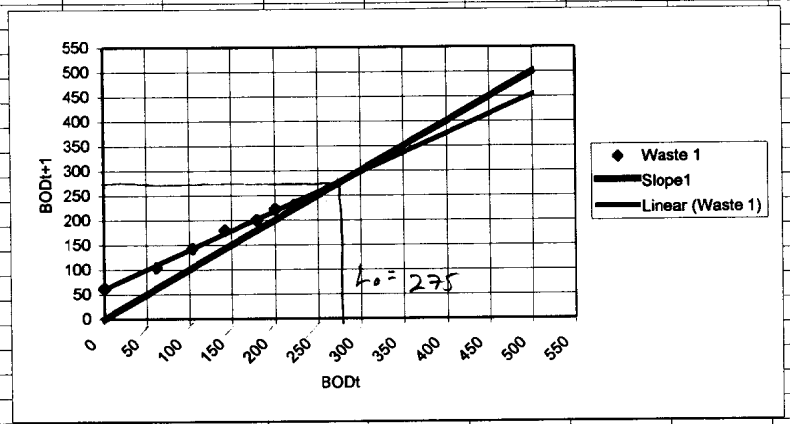
L_t: amount remain in time t

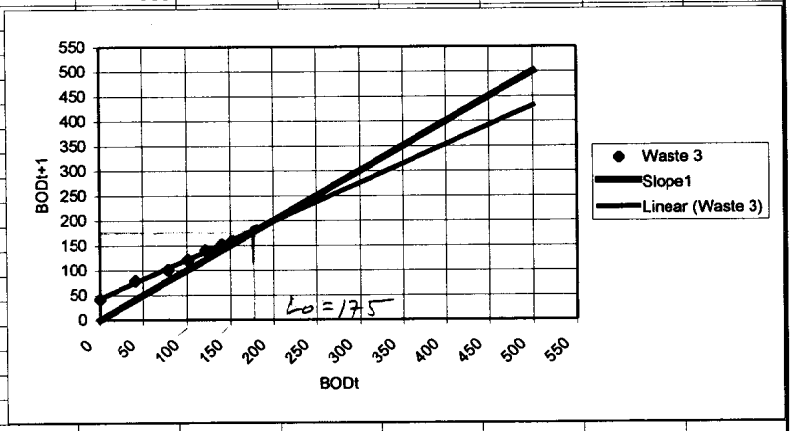
a) $L_0 = 40\ mg/L$

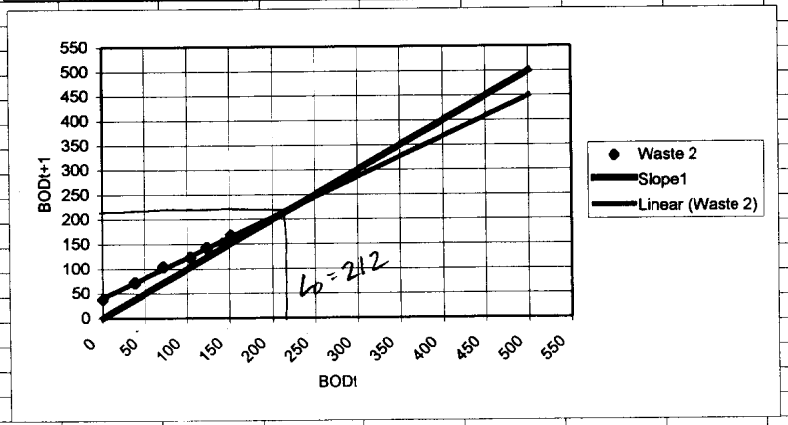
b) $BOD_5 = 25\ mg/L$

c) $L_5 = 15\ mg/L$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	CIVE 3331 Problem 5.14															
2		Example			Waste 1			Waste 2			Waste 3					
3	time (day)	BODt	BOD t+1	Slope1	BODt	BOD t+1	Slope1	BODt	BOD t+1	Slope1	BODt	BOD t+1	Slope1			
4	0	0	57	0	0	62	0	0	38	0	0	41	0			
5	1	57	102	57	62	104	62	38	72	38	41	79	41			
6	2	102	134	102	104	142	104	72	104	72	79	101	79			
7	3	134	160	134	142	179	142	104	123	104	101	121	101			
8	4	160	184	160	179	200	179	123	142	123	121	140	121			
9	5	184	199	184	200	222	200	142	151	142	140	152	140			
10	6	199	207	199	222	230	222	151	167	151	152	159	152			
11	7	207		207	230		230	167		167	159		159			
12		300		300	300		300	300		300	300		300			
13		400		400	400		400	400		400	400		400			
14		500		500	500		500	500		500	500		500			







Waste #1 $L_o \approx 275$ mg/L

Waste #2 $L_o \approx 212$ mg/L

Waste #3 $L_o \approx$ 175 mg/L

CIVE 3331 Problem 5-16

Wastewater with $BOD_5 = 180\ mg/L$ and $k = 0.22/day$ and $TKN = 30\ mg/L$

a) Find $CBOD_u$
b) Find $NBOD_u$
c) Find BOD remaining after 5 days (L_5)

a) $L_o = \frac{BOD_5}{(1-e^{-kt})} = \frac{180\ mg/L}{(1-e^{-0.22*5})} = 269.81 = 270\ mg/L$

$\therefore CBOD_u = 270\ mg/L$

b) $NBOD_u = 30\ mg/L \cdot \frac{17g\ NH_3}{14g\ N} \cdot \frac{64g\ O_2}{17g\ NH_3} = 137\ mg/L$

c) $L_5 = L_o - BOD_5 = 270\ mg/L - 180\ mg/L = 90\ mg/L$
$+137$
$227\ mg/L$

$BOD = CBOD + NBOD$

$= CBOD_u + NBOD_u - BOD_5 = 270 + 137 - 180 = 227$

Check- Solution wrong

CIVE 3331 Problem 5.20

Approximate chemical formula for bacteria is $C_5H_7O_2N$. What is the total carbonaceous & nitrogeneous oxygen demand for 1 g of bacteria cells?

$$C_5H_7O_2N + 5O_2 \rightarrow 5CO_2 + 2H_2O + NH_3 \quad (CBOD)$$

60 + 32 = 92 g

14 + 3 = 17 g

$$NH_3 + 2O_2 \rightarrow NO_3^- + H^+ + H_2O \quad (NBOD)$$

Carbon

$$1g\ C_5H_7O_2N \cdot \frac{1\text{mol } C_5H_7O_2N}{113g\ C_5H_7O_2N} \cdot \frac{5\text{mol } O_2}{1\text{mol } C_5H_7O_2N} \cdot \frac{32g\ O_2}{1\text{mol } O_2} = 1.42\ g\ O_2/g\ ce \quad (1.42)$$

Nitrogen

$$1g\ C_5H_7O_2N \cdot \frac{1\text{mol } C_5H_7O_2N}{113g\ C_5H_7O_2N} \cdot \frac{1\text{mol } NH_3}{1\text{mol } C_5H_7O_2N} \cdot \frac{17g\ NH_3}{1\text{mol } NH_3} = 0.150\ g\ NH_3$$

$$0.150g\ NH_3 \cdot \frac{1\text{mol } NH_3}{17g\ NH_3} \cdot \frac{2\text{mol } O_2}{1\text{mol } NH_3} \cdot \frac{32g\ O_2}{1\text{mol } O_2} = 0.566\ g\ O_2/g\ cells$$

∴ Carbonaceous oxidization uses 1.42 g O_2/g cells

Nitrogeneous oxidization uses 0.566 g O_2/g cells

Overall "process" is

$$C_5H_7O_2N + 8O_2 \rightarrow 5CO_2 + 3H_2O + H^+ + NO_3^-$$