

CIVE 375 Assignment 3 part 1

① From page 3-40 of notes.

$$BOD_t = \frac{(D_1 - D_2) - (B_1 - B_2)F}{F}$$

dilution Factor $P = \frac{V_b}{V_t} = \frac{3}{300} = 0.01$

$$F = \frac{\frac{V_{s2}/V_t}{V_{t2}/V_b}}{\frac{V_{s1}/V_t}{V_{t1}/V_b}} = \frac{297/300}{300/300} = 0.99$$

$$V_s = 3 \text{ mL}$$

$$V_t = 300 \text{ mL}$$

$$V_{s2} = 300 \text{ mL}$$

$$V_b = 300 \text{ mL}$$

$$V_{s1} = 300 - 3 = 297 \text{ mL}$$

$$\therefore BOD_5 = \frac{(8.6 - 3.3) - (8.8 - 8.2)(0.99)}{0.01} = 470.6 \text{ mL}$$

$$BOD_8 = \frac{(8.6 - 1.2) - (8.8 - 8.0)(0.99)}{0.01} = 660.8 \text{ mL}$$

From page 3-42

$$BOD_{ult} = L$$

$$BOD_t = L(1 - e^{-kt})$$

$$BOD_5 = 470.6 = L(1 - e^{-5k})$$

$$BOD_8 = 660.8 = L(1 - e^{-8k})$$

$\leadsto k = 0.0972 \text{ d}^{-1}$ solved by trial + error
SEE EXCEL sheet.

$$\therefore BOD_{ult} = L = \frac{470.6}{1 - e^{-5(0.0972)}}$$

$$= 1222.6 \text{ mg/L}$$

- ② in order to estimate BOD_5 , we must solve for 'L' and 'k' in the equation:

$$BOD_5 = L(1 - e^{-5k})$$

Using excel we can linearize BOD with respect to k. by rearranging equation to:

$$\ln\left(1 - \frac{BOD_t}{L}\right) = -kt$$

SEE EXCEL SHEET.

$$L = 10.75 \text{ g/m}^3$$

$$k = 0.1407 \text{ d}^{-1}$$

$$\therefore BOD_5 = 10.75(1 - e^{-5(0.1407)})$$

$$= 5.43 \text{ g/m}^3$$

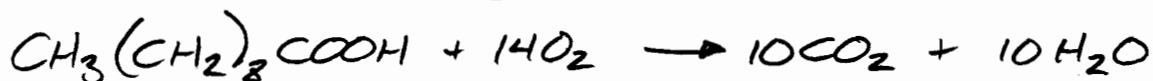
NOTE:

There is another method to solve this problem illustrated in the text on page 115 called the least squares formula. This method may yield an answer different to answer shown above, but it still should be relatively close.

- ③ solution contains 50 g/m^3 of $\text{CH}_3(\text{CH}_2)_8\text{COOH}$
and 42 g/m^3 of $\text{NH}_3\text{-N}$

Page 3-44
in notes.

Note: $\text{NH}_3\text{-N}$ is not a compound, it just means that NH_3 is measured as nitrogen. Similar to $\text{NO}_3\text{-N}$ measured in Lab 1. In other word there is 1 mole of N for every mole of NH_3 .



$\therefore$ 14 moles of O_2 is required to convert 1 mole of $\text{CH}_3(\text{CH}_2)_8\text{COOH}$

From p 3-46 of notes, 1 mol NH_3 requires 2 moles of O_2

cont'd

③ cont'd

example
p 3-46 of
notes

i) CBOD $GMW[CH_3(CH_2)_8COOH] = 172 \text{ g/mol}$

$$\frac{14 \text{ mol } O_2}{1 \text{ mol } CH_3(CH_2)_8COOH} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{\text{mol } CH_3 \dots}{172 \text{ g}} \left| \frac{50 \text{ g } CH_3 \dots}{\text{m}^3} \right| = 130.2 \text{ g/m}^3$$

ii) NBOD $GMW(NH_3) = 17 \text{ g/mol}$

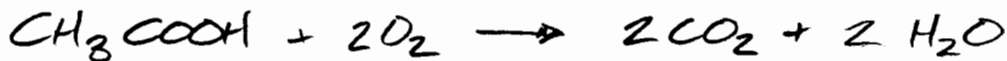
$$\frac{2 \text{ mol } O_2}{\text{mol } NH_3} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{\text{mol}}{17 \text{ g } NH_3} \left| \frac{42 \text{ g}}{\text{m}^3} \right| = 158.1 \text{ g/m}^3$$

iii) $ThOD = CBOD + NBOD = 288.3 \text{ g/m}^3$

④ Find CBOD + NBOD for:

$250 \text{ g/m}^3 \text{ } CH_3COOH \quad MW = 60 \text{ g/mol}$

$200 \text{ g/m}^3 \text{ } CH_2NH_3COOH \quad MW = 76 \text{ g/mol}$



2 mole O_2 converts 1 mole CH_3COOH

$\frac{7}{4}$ mole O_2 converts 1 mole CH_2NH_3COOH

2 mole O_2 converts 1 mole NH_3 (p. 3-46 of notes)

$$CBOD_{aa} = \frac{2 \text{ mol } O_2}{\text{mol } aa} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{\text{mol } aa}{60 \text{ g}} \left| \frac{250 \text{ g } aa}{\text{m}^3} \right| = 266.7 \text{ g/m}^3$$

$$CBOD_{gly} = \frac{\frac{7}{4} \text{ mol } O_2}{\text{mol } gly} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{\text{mol } gly}{76 \text{ g}} \left| \frac{200 \text{ g}}{\text{m}^3} \right| = 147.4 \text{ g/m}^3$$

cont'd



④ cont'd

$$NBOD_{23} = 0 \quad (\text{no nitrogen evolved})$$

$$NBOD_{gly} = \frac{2 \text{ mol } O_2}{\text{mol } NH_3} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{\text{mol gly}}{76 \text{ g}} \left| \frac{200 \text{ g}}{\text{m}^3} \right| = 168.4 \text{ g/m}^3$$

$$\therefore CBOD = 266.7 + 147.4 = 414.1 \text{ g/m}^3$$

$$NBOD = 168.4 \text{ g/m}^3$$

⑤ Water sample contains 300 g/m^3 of $C_8H_{12}O_3N_2$
Find COD, BOD_{ult} and BOD_5 @ $20^\circ\text{C} + 25^\circ\text{C}$

$$K = 0.21 \text{ d}^{-1} \text{ @ } 20^\circ\text{C} \quad \text{let } C_8H_{12}O_3N_2 = c$$

$$\theta = 1.056 \text{ For } T > 20^\circ\text{C} \text{ (p. 3-43 of notes)}$$

$$GMW_c = 184 \text{ g/mol}$$

$$K_{25^\circ\text{C}} = K_{20^\circ\text{C}} \theta^{(25-20)} = 0.276 \text{ d}^{-1} \quad \text{Page 3-43 of notes}$$



$$BOD_{ult} = CBOD = \frac{8 \text{ mol } O_2}{\text{mol } c} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{\text{mol } c}{184 \text{ g}} \left| \frac{300 \text{ g}}{\text{m}^3} \right| = 417.4 \text{ g/m}^3$$

$$NBOD = \frac{2 \text{ mol } O_2}{\text{mol } NH_3} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{2 \text{ mol } NH_3}{\text{mol } c} \left| \frac{32 \text{ g}}{\text{mol } O_2} \right| \frac{\text{mol } c}{184 \text{ g}} \left| \frac{300 \text{ g}}{\text{m}^3} \right| = 208.7 \text{ g/m}^3$$

$$COD = CBOD + NBOD = 626.1 \text{ g/m}^3$$

$$BOD_5 \text{ @ } 20^\circ\text{C} = 417.4 (1 - e^{-5(0.21)}) = 271.3 \text{ g/m}^3$$

$$BOD_5 \text{ @ } 25^\circ\text{C} = 417.4 (1 - e^{-5(0.276)}) = 312.4 \text{ g/m}^3$$