3506

CIVE 375 Assignment 3 part 1

① From page 3-40 of notes.

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

$V_s = 3mL$
$V_t = 300mL$
$V_{sb} = 300mL$
$V_b = 300mL$
$V_{ss} = 300 - 3 = 297mL$

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

$$f = \frac{V_{ss}/V_t}{V_{sb}/V_b} = \frac{297/300}{300/300} = 0.99$$

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

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

From page 3-42 $BOD_{UH} = L$

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

$$BOD_5 = 470.6 = L(1 - e^{-5k})$$
$$BOD_8 = 660.8 = L(1 - e^{-8k})$$

} 2 equations, 2 unknowns

$\rightsquigarrow k = 0.0972\ d^{-1}$ solved by trial + error see Excel sheet.

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

$$= 1222.6\ mg/L$$

(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.

$L = 10.75\ g/m^3$
$k = 0.1407\ d^{-1}$

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

$= 5.43\ g/m^3$

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

(3) Solution contains $50\ g/m^3$ of $CH_3(CH_2)_8COOH$
and $42\ g/m^3$ of NH_3-N

Page 3-44 in Notes.

Note: NH_3-N is not a compound, it just means that NH_3 is measured as nitrogen. Similar to NO_3-N measured in Lab 1. In other word there is 1 mole of N for every mole of NH_3.

$$CH_3(CH_2)_8COOH + 14O_2 \longrightarrow 10CO_2 + 10H_2O$$

$\therefore$ 14 moles of O_2 is required to convert 1 mole of $CH_3(CH_2)_8COOH$

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

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example of p 3-46 notes

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

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

ii) NBOD $\quad GMW(NH_3) = 17\ g/mol$

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

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

④ Find CBOD + NBOD for:

$250\ g/m^3$ CH_3COOH $MW = 60\ g/mol$

$200\ g/m^3$ CH_2NH_3COOH $MW = 76\ g/mol$

$$CH_3COOH + 2O_2 \longrightarrow 2CO_2 + 2H_2O$$

$$CH_2NH_3COOH + \tfrac{7}{4}O_2 \longrightarrow 2CO_2 + NH_3 + \tfrac{3}{2}H_2O$$

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)

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

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

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$NBOD_{28} = 0$ (no nitrogen involved)

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

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

$NBOD = 168.4\ g/m^3$

⑤ Water sample contains $300\ g/m^3$ of $C_8H_{12}O_3N_2$

Find COD, BOD_{UH} and BOD_5 @ 20°C + 25°C

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

$\theta = 1.056$ For $T > 20°C$ (p. 3-43 of notes)

$GMW_c = 184\ g/mol$

$$K_{25c} = K_{20c}\,\theta^{(25-20)} = 0.276\ d^{-1}$$ Page 3-43 of notes

$$C_8H_{12}O_3N_2 + 8O_2 \longrightarrow 8CO_2 + 2NH_3 + 3H_2O$$

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

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

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

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

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