CivE 375 — Assignment 3 part 2

⑥ 2100 g/m³ BOD_5 — $BOD_{5,max} = 0.5\ g/m^3$

Min – January: 95 m³/s 6°C

Max – July: 175 m³/s 26°C

wastewater flow 2 m³/s

$k = 0.2\ d^{-1}$ @ 20°C

$\theta = 1.135$ (< 20°C)

1.056 (> 20°C).

$$K_6 = K_{20}\theta^{(6-20)} = 0.034$$

$$K_{26} = K_{20}\theta^{(26-20)} = 0.28$$

i) Find BOD_{ult} allowable

winter $$BOD_u = \frac{BOD_{5,max}}{1-e^{-5k}} = \frac{0.5}{1-e^{-5 \cdot 0.034}} = 3.20\ g/m^3$$

summer $$BOD_u = \frac{BOD_{5,max}}{1-e^{-5K}} = 0.664$$

ii) Find BOD_{ult} from plant. (Assume T = 20°C)

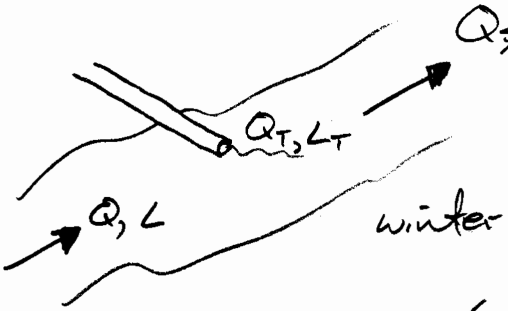
$$BOD_u = \frac{2100}{1-e^{-5(0.2)}} = 3322\ g/m^3$$

iii) Perform mass balance

L_S – BOD_{ult} in the summer allowed = 3.20 g/m³

L_W – BOD_{ult} in the winter allowed = 0.664 g/m³

L_T – BOD_{ult} from treatment plant = ??



– Find allowable L_T.

$\therefore Q_{s,w}L_{s,w} = QL + Q_T L_T$

winter $$L_T = \frac{(97)(3.2) - 95(0)}{2} = 155.2\ g/m^3$$

$\therefore$ (3322 − 155.2) g/m³ must be treated.
≈ 95.3% of wastewater.

summer $$L_T = \frac{(177)(0.664)}{2} = 58.8\ g/m^3$$ → 98.2% require treatment

(7) Solve using least-squared method p. 115 of text.

$$na + b\Sigma y - \Sigma y' = 0$$
$$a\Sigma y + b\Sigma y^2 - \Sigma y'y = 0$$
} rearrange

$$b = \frac{\Sigma y \cdot \Sigma y' - n\Sigma yy'}{(\Sigma y)^2 - n \cdot \Sigma y^2}$$

$$a = \frac{\Sigma y' - b\Sigma y}{n} = \frac{\Sigma yy' - b\Sigma y^2}{\Sigma y}$$

where
$y = BOD_t$
$n = \#$ of data points
$b = -k$
$a = BOD_{ult}$
$y' = (y_{n+1} - y_{n-1}) / 2\Delta t$

→ SEE EXCEL Sheet.

(8) a) Poisson Dist. (eq. 2.90 in text)

$$y = \frac{1}{a}\left[(1-e^{-n_1\lambda})^{P_1}(e^{-n_1\lambda})^{q_1}\right]\left[(1-e^{-n_2\lambda})^{P_2}(e^{-n_2\lambda})^{q_2}\right] \times \left[(1-e^{-n_3\lambda})^{P_3}(e^{-n_3\lambda})^{q_3}\right]$$

b) SEE Appendix G:

Sample	Combination	MPN/100mL
A	2-1-5	1900
B	4-2-2	3200
C	5-4-3	28000

(8) c) Thomas Equation (eq. 2.91 of text)

$$MPN/100mL = \frac{\text{no. of positive tubes} \times 100}{\left(\text{mL of sample in negative tubes} \times \text{mL of sample in all tubes}\right)^{1/2}}$$

SEE EXCEL sheet.