Homework 8

1. a. Select 1.5 m as generally applicable optimal depth.

b. For temperate climate, use areal loading rate of 80 Kg BOD / ha·day

$$\text{Daily loading} = QC_{in} = 3800\ m^3/d \cdot 200\ mg/L \cdot 1000\ L/m^3 \cdot 10^{6}\ kg/mg = 760\ Kg/day$$

$\therefore$ Pond size $= 10$ ha $= 10^5\ m^2$

c. $$\text{Volume} = 1.5\ m \cdot 10^5\ m^2 = 1.5 \times 10^5\ m^3$$

$$t_R = \frac{\forall}{Q} = \frac{1.5 \times 10^5\ m^3}{3.8 \times 10^3\ m^3/d} = 40 \text{ days}$$

d. $$\text{Volumetric load} = \frac{760\ Kg/day}{1.5 \times 10^5\ m^3} = 5\ Kg\ BOD5/(1000\ m^3 \cdot day)$$

e. Assuming fully mixed conditions,

$$\frac{S}{S_{in}} = \frac{1}{1 + t_R K}$$

$$S = \frac{200\ mg/L}{1 + 40\ \text{days} \cdot 0.2\ \text{day}^{-1}} = 22\ mg/L$$

2. $Q = 4500\ m^3/d$

$S_{in} = 150$ mg COD/L

$S = 7$ mg COD/L

SRT = $\theta_c = 10$ days

MLVSS = $X = 1400$ mg VSS/L

$Y = 0.6$ mg VSS/mg COD

$K_e = 0.06\ day^{-1}$

From Lecture 19, Eq. 32

$$\frac{1}{\theta_c} = YU - K_e = \frac{1}{10\ d} = 0.6\ U - 0.06\ d^{-1}$$

$$U = (0.1 + 0.06)d^{-1} \Big/ 0.6 \frac{mg\ VSS}{mg\ COD} = 0.27 \frac{g\ COD}{g\ VSS \cdot d}$$

From Lecture 19, Eq 26

$$U = \frac{S_{in} - S}{t_R X} = \frac{(150 - 7)\ mg\ COD/L}{t_R \cdot 1400\ mg\ VSS/L}$$

$$= 0.27 \frac{mg\ COD}{mg\ VSS \cdot d}$$

$$t_R = \frac{143}{0.27 \cdot 1400} = 0.38\ day = 9\ hours$$

$$\forall = t_R Q = 1700\ m^3$$

b. $$\frac{F}{M} = \frac{S_{in}}{t_R X} = \frac{150\ mg\ COD/L}{1400\ mg\ VSS/L \cdot 0.38\ d}$$

$$= 0.28 \frac{Kg\ COD}{Kg\ VSS \cdot d}$$

c. From Lecture 19, Equation 12

$$P = \frac{QY(S_{in} - S)}{1 + \theta_c k_e}$$

$$= \frac{4500 \frac{m^3}{d} \cdot 0.6 \frac{mg\ VSS}{mg\ COD} \cdot (150-7) \frac{mg\ COD}{L} \cdot 10^3 \frac{L}{m^3} \cdot \frac{kg}{10^6\ mg}}{1 + 10\ d \cdot 0.06\ d^{-1}}$$

$$= 241\ kg\ VSS/d$$

d. $$X_r = \frac{1}{SVI} = \frac{1}{100\ mL/g}$$

$$= 0.01 \frac{g}{mL} = 10{,}000 \frac{mg}{L}$$

From Lecture 19, Eq. 37

$$\theta_c = \frac{t_R}{1 + r - r(X_r/X)}$$

$$10\ d = \frac{0.38\ d}{1 + r - r(10000/1400)} \longrightarrow r = 0.16$$

e. From Lecture 20, pg 11

$$R_{O_2} = Q(S_{in} - S) - 1.42\,P$$

$$= 4500 \frac{m^3}{d} (150-7) \frac{mg\ COD}{L} \cdot 10^3 \frac{L}{m^3} \cdot \frac{kg}{10^6\ mg}$$

$$- 1.42 \frac{kg\ COD}{kg\ VSS} \cdot 241 \frac{kg\ VSS}{d}$$

$$= 300\ kg\ COD/d = 300\ kg\ O_2/d$$