Homework. 4.

4-2. $C_6H_{12}O_6$: $12\times6+1\times12+16\times6 = 180$ g/mol

3.5 g/L, 21 m³/d. Biological contactor.

$C_5H_7O_2N$: $12\times5+1\times7+16\times2+14 = 113$ g/mol.

$Y = 0.375$ g biomass / g sugar. $A = 2000\ m^2$.

$B_A = 8\text{-}12$ g BOD$_5$/m²/d.

$1.674\ C_6H_{12}O_6 + 3.10\ O_2 + 1\ NH_3 \rightarrow 1\ C_5H_7O_2N + 3.10\ O_2 + 8.0\ H_2O$

$\frac{113}{0.375\times180} = 1.674$

$\therefore \frac{3.10\times32}{1.674\times180} = 0.536$ g$_{O_2}$/g sugar.

$\therefore$ BOD $= 0.536\times3.5 = 1.875$ g$_{O_2}$/L.

$A_{BC} = \frac{Q_0 \cdot C_{0,BOD}}{B_A} = \frac{21\times1000\times1.875}{B_A} = \frac{39375\ g/d}{B_A}$

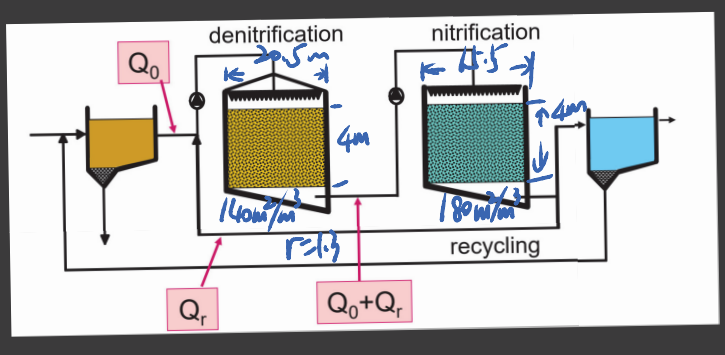
$= 3281.25\ m^2 \sim 4$ p $21.875\ m^2$.

each is 2000 m². so require 2.

4-3 biotrickling filter. + pre-nitrification.

$Q_0 = 5000\ m^3/d$ $C_{0,BOD} = 170$ g$_{O_2}$/m³. $N_{TKN,inf} = 45$ g$_N$/m³

$N_{NO_3,eff} = 15$ g$_N$/m³ $N_{NH_4,eff} = 2$ g$_N$/m³



$\phi'_{DE} = 20.5$m. $H_{DE} = 4$m, $a_{s,DE} = 140$m²/m³

$\phi'_N = 4.5$ m, $H_N = 4$m. $a_{s,N} = 180$m²/m³

$$C_{den} = C_{o,TKN} + C_{o,NO_3} - 0.045 \cdot C_{o,BOD_5} - C_{e,TKN} - C_{e,NO_3}$$

$$= 45 \times 80\% + 0 - 0.045 \times 170 \times 75\% - 2 - 15$$

$$= 17.76 \times 5 \ g_N/m^3$$

$$r_{den} = \frac{C_{den}}{C_{o,BOD_5}} = \frac{17.26 \times 5}{170 \times 75\%} = 0.13 \ g_N/g_{BOD_5}$$

$$B_{A,BOD_5} = e^{(0.182 - r_{den})/0.05} = e^{1.05} = 2.83 \ g_{BOD_5}/m^2/d$$

$$A_{den} = \frac{Q_0 \cdot C_{o,BOD_5}}{B_{A,BOD_5}} = \frac{5000 \times 170 \times 75\%}{2.83} = 21557 \ m^2$$

$$V_{TF} = \frac{A_{den}}{Q_{s,de}} = \frac{21557}{140} = 1554 \ m^3$$

$$V'_{TF} = 2 \times 4 \times \left(\frac{29.5}{2}\right)^2 \cdot \pi = 2640 \ m^3 >> 1554 \ m^3$$

$$\phi_{De} = \sqrt{\frac{V_{TF}}{8\pi}} \times 2 = 15.73 \ m.$$

$$\Delta C_{NH_4} = 45 \times 0.8 - 0.045 \times 170 \times 0.75 - 2 = 32.76 \times 5 \ g_N/m^3$$

$$0.61 \ C_8H_{17}O_3N + 4.54 \ NO_3^- + 0.38 \ NH_4^+ + 4.54 \ H^+ \longrightarrow$$

$$C_5H_7NO_2 + 2.27 \ N_2 + 5.08 \ CO_2 + 5.45 \ H_2O$$

$$\Delta OM = \frac{17.76 \times 5}{14 \times 40.5\%} \times 0.61 \times 3.83 = 67 \ g/m^3$$

$$\therefore \Delta BOD_5 = 67 \times 0.72 = 48.24 \ g_{O_2}/m^3.$$

$$\therefore C'_{o,BOD_5} = 170 \times 0.75 - 48.24 = 78.3 \ g_{BOD_5}/m^3$$

$$\therefore A_{tot} = A_{BOD_5} + A_{nit} = \frac{Q_0 \cdot C_{o,BOD_5}}{J_{BOD_5}} + \frac{Q_0 (C_{o,NH_4} - C_{e,NH_4})}{J_{NH_4}}$$

$j_{BOD5} = 4\sim7\ g_{BOD5}/m^2/d$. $j_{NH4} = 0.9\ g_{NH4}/m^2/d$.

$$\therefore A_{tot} = \frac{5000 \times 79.3}{j_{BOD5}} + \frac{5000 \times 32.76\times5}{0.9}$$

$$= 28865\ m^2 \sim 28116\ m^2$$

$$V_{TF} = \frac{A_{tot}}{a_6} = 1326\ m^3 \sim 1562\ m^3.$$

$$V_{TF}' = 2\times4\times\left(\frac{15.5}{2}\right)^2 \cdot \pi = 1506\ m^3 \approx V_{TF}$$

$$r = \frac{C_{den+1}}{C_{e,NH3}+1} = \frac{17.76\times5+1}{15-1} = 1.34 > 1.30$$

4-4 AT => MBBR. 15000 + 10000 capita.

0.35 m^3/capita. nitrification.

Y → [1000] 1100 m^3 ×2. $C_{0,TSS} = 185\ g_{TSS}/m^3$

$Q_0 = 5500\ m^3/d$ $C_{0,BOD} = 160\ g_{BOD}\cdot m^3$ $N_{TKN,inf} = 35\ gN/m^3$

a). $\theta_x = 10d$. $F_T = 1.072^{(10-15)} = 0.706$

$$SP_c = 0.75 + 0.6\times\frac{185\times0.5}{160\times0.25} - \frac{0.102\times10\times0.706}{1+0.17\times10\times0.706}$$

$$= 0.885$$

$$\therefore V_{AT} = \frac{Q_0 \cdot C_{0,BOD} \cdot SP_c \cdot \theta_x}{X_{AT}}$$

$$= \frac{5500\times160\times0.75\times0.885\times10}{1000\times3} = 1947\ m^3 < 2200\ m^3$$

enough.

b) $V_{BOD_5,\,reactor} = \dfrac{160 \times 0.25 \times 5500 \times (15+10)}{15 \times 1.3 \times 1000} = 846\ m^3$

$\Delta C_{NH_4\text{-}N} = 25 \times 0.9 - 0.045 \times 160 \times 0.75 - 2$

$= 24.1\ g/m^3$ 27.6 g/m^3

$\therefore V_{NH_4\text{-}N,\,reactor} = \dfrac{24.1 \times 5500 \times (15+10)}{15 \times 0.183 \times 1000}$

$= 1145\ m^3$ 1311 m^3

$V_{tot} = V_{BOD_5,\,reactor} + V_{NH_4\text{-}N,\,reactor}$

$= 846 + 1145 = 1991\ m^3 < 2200 m^3$ enough.

2156 m^3