2012 LG생명공학 경시대회 문제 답안지

배양 및 생물반응공학

1. a) $\mu = \frac{\ln(X_2/X_1)}{\Delta t} = \frac{\ln(1.6/1.5)}{1/6} = \boxed{0.39\ hr^{-1}}$

b) $t_d = \frac{\ln 2}{\mu} = \frac{\ln 2}{0.39} = \boxed{1.78\ hr}$

c) Monod eq'n ; $\mu = \frac{\mu_m S}{K_S + S}$

$\frac{1}{\mu} = \frac{K_S}{\mu_m}\frac{1}{S} + \frac{1}{\mu_m}$ ← use this eq'n for the curve fitting

Linear regression of $\frac{1}{S}$ against $\frac{1}{\mu}$ gives

$\frac{K_S}{\mu_m} = 20.93$ and $\frac{1}{\mu_m} = 0.494$.

$\therefore K_S = 42.29\ g/L$ $\mu_m = \boxed{2.02\ hr^{-1}}$

d) Calculate S at $\mu = 0.39\ hr^{-1}$

$0.39 = \frac{2.02\,S}{42.29 + S}$ $\therefore S = \boxed{10.12\ g/L}$

e) glucose consumption $= \frac{6}{0.46} = 13.04\ g/L$

glucose conc. at $[EtOH] = 6\ g/L$

$= 20 - 13.04 = 6.96\ g/L$

$\mu = \frac{2.02 \times 6.96}{42.29 + 6.96} = \boxed{0.29\ hr^{-1}}$

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2. a) $FS_0 - FS = V \cdot r$

F = feed flow rate, S = aspartate concentration

V = reactor volume, r = rxn rate

$$S_0 - S = \frac{V}{F} \times \frac{k_{cat}[E]_t S}{K_M + S}$$

$$0.2 - S = \frac{1}{10} \times \frac{100 \times 60 \times 100 \times 10^{-6} S}{0.01 + S}$$

$$0.2 - S = \frac{0.6S}{0.1 + 10S}$$

$$10S^2 - 1.3S - 0.02 = 0$$

$$S = 0.144\ M$$

$$\therefore \text{conversion} = \frac{0.2 - 0.144}{0.2} = \boxed{0.28 \text{ or } 28\%}$$

b) at 90% conversion, $S = 0.1 S_0 = 0.02\ M$

$$F = \frac{V}{S_0 - S} \times \frac{k_{cat}[E]_t S}{K_M + S}$$

$$= \frac{1}{0.2 - 0.02} \times \frac{100 \times 60 \times 100 \times 10^{-6} \times 0.02}{0.01 + 0.02}$$

$$= \boxed{2.2\ L/hr}$$

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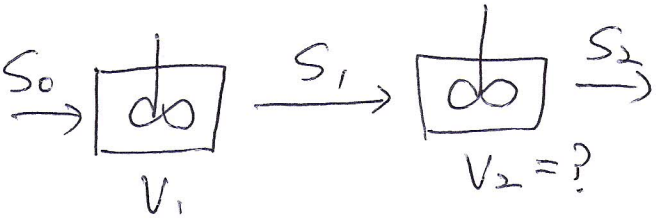
2. c)



from the answer of problem a), $S_1 = 0.144\ M$

at 90% total conversion, $S_2 = 0.1 S_0 = 0.02\ M$

Doing the mass balance of aspartate for reactor 2. gives

$$V = \frac{F(S_1 - S_2)}{r_{S_2}} = 10\,(0.144 - 0.02) \times \frac{0.01 + 0.02}{100 \times 10 \times 100 \times 10^{-6} \times 0.02}$$

$$= \boxed{3.1\ L}$$