For the second step, recall that

$$D = \mu_g - k_d = \frac{\mu_m S}{K_s + S} - k_d \tag{a}$$

Then

$$\frac{1}{D + k_d} = \frac{1}{\mu_m} + \frac{K_s}{\mu_m}\frac{1}{S} \tag{b}$$

We now plot $1/(D + k_d)$ versus $1/S$. The intercept is 1.25 h or $\mu_m = 0.8\ \text{h}^{-1}$. The slope is 100 h/(mg/l). Thus, $K_s/\mu_m = 100$ or $K_s = 80$ mg/l.

Example 6.5.

The specific growth rate for inhibited growth in a chemostat is given by the following equation:

$$\mu_g = \frac{\mu_m S}{K_s + S + IK_s/K_I} \tag{a}$$

where

$S_0 = 10$ g/l $\quad K_s = 1$ g/l $\quad I = 0.05$ g/l $\quad Y^M_{X/S} = 0.1 \dfrac{\text{g cells}}{\text{g subs}}$

$X_0 = 0 \quad K_I = 0.01$ g/l $\quad \mu_m = 0.5\ \text{h}^{-1} \quad k_d = 0$

a. Determine X and S as a function of D when $I = 0$.
b. With inhibitor added to a chemostat, determine the effluent substrate concentration and X as a function of D.
c. Determine the cell productivity, DX, as a function of dilution rate.

Solution

a)

$$S = \frac{K_s D}{\mu_m - D} = \frac{D}{0.5 - D}$$

$$X = Y^M_{X/S}(S_0 - S) = 0.1\left(10 - \frac{D}{0.5 - D}\right)$$

b) In the presence of inhibitor

$$\mu_g = \frac{\mu_m S}{K_s\left(1 + \frac{I}{K_I}\right) + S} = D$$

$$S = \frac{K_s\left(1 + \frac{I}{K_I}\right)D}{\mu_m - D} = \frac{\text{I}\left(1 + \frac{0.05}{0.01}\right)D}{0.5 - D}$$

$$S = \frac{6D}{0.5 - D}$$

$$X = Y^M_{X/S}(S_0 - S) = 0.1\left(10 - \frac{6D}{0.5 - D}\right)$$