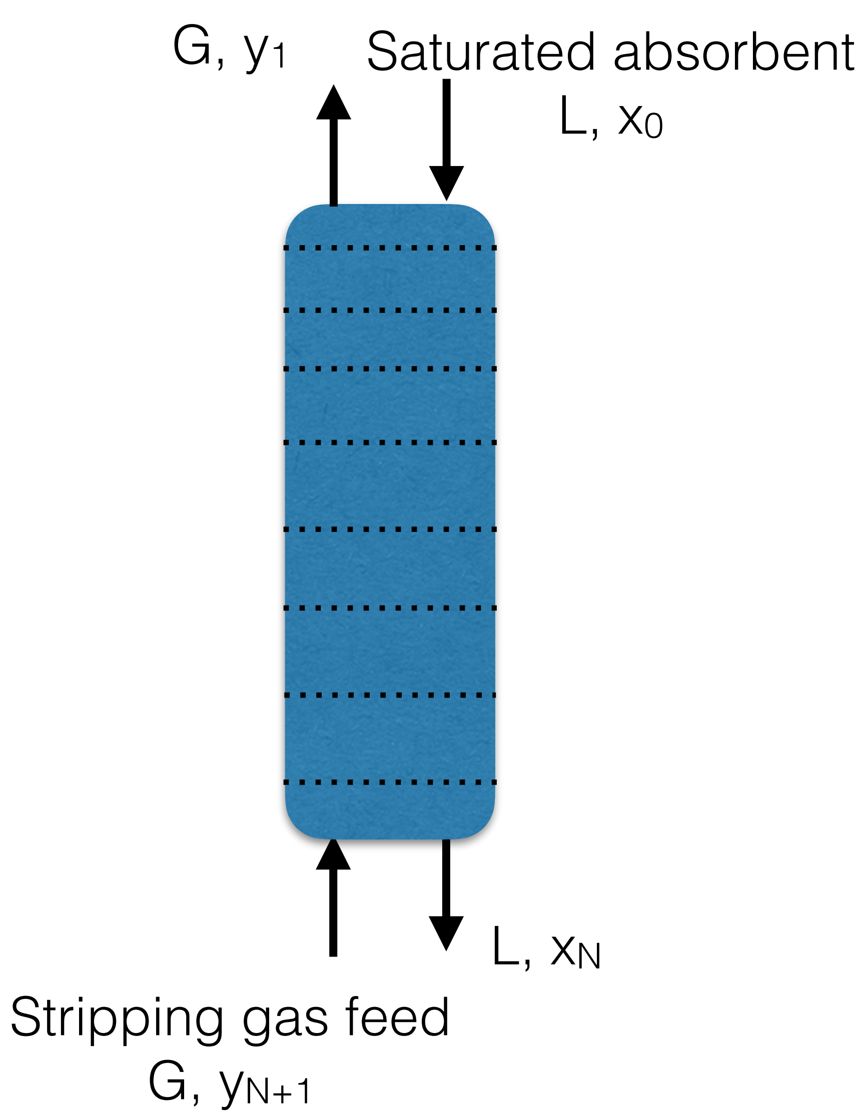
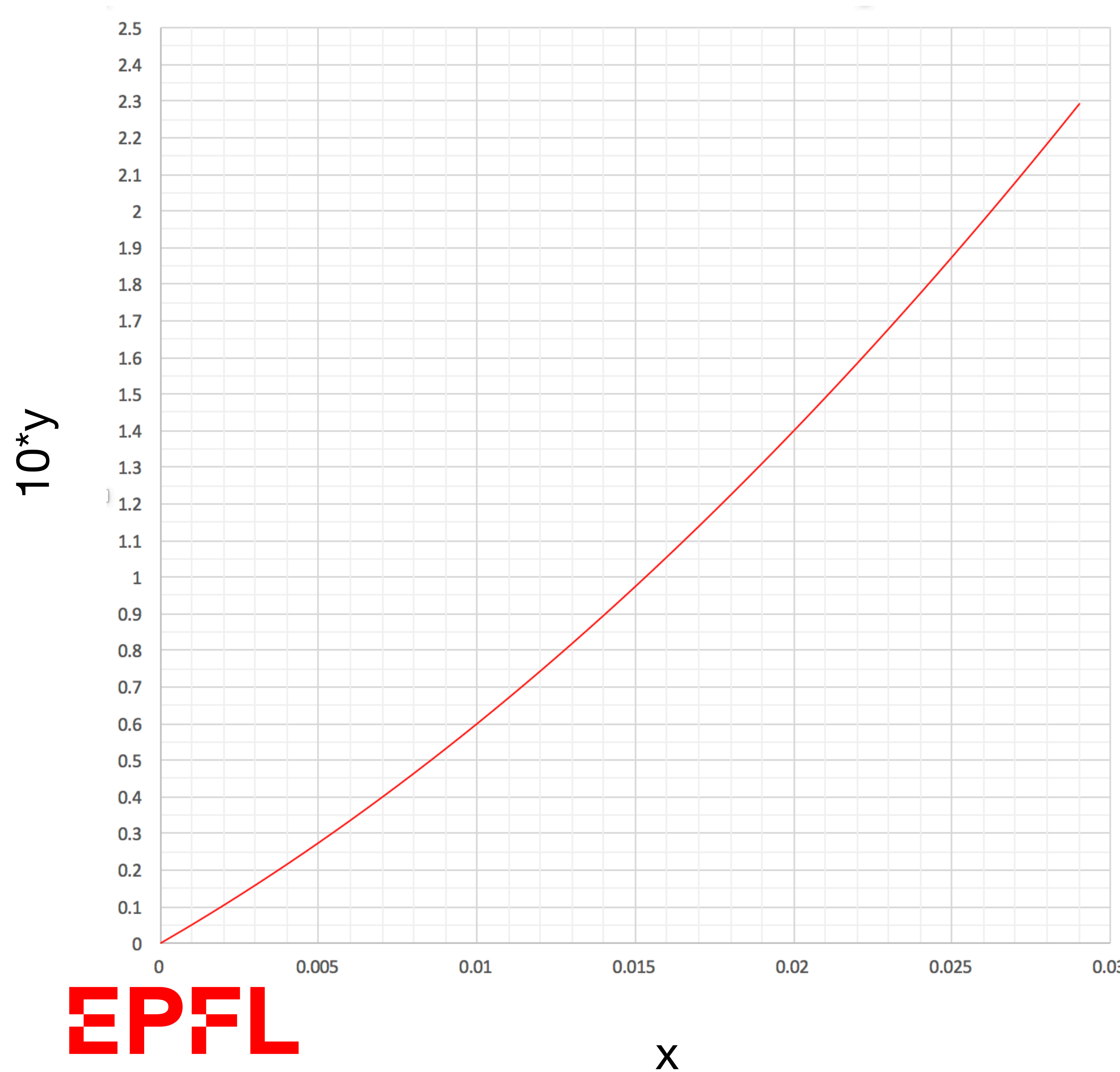
Exercise problem 1: Stripping

100 mol/hr of amine containing 2.9% CO_2 at 1 bar is to be regenerated with steam such that concentration of CO_2 reduces to 1%. Pure steam is being used as the stripping gas. Calculate number of stages if $L/G = 0.5\ L/G_{min}$. Calculate exit concentration of steam.

$$y = \frac{L}{G}x + \left(y_1 - \frac{L}{G}x_0\right)$$



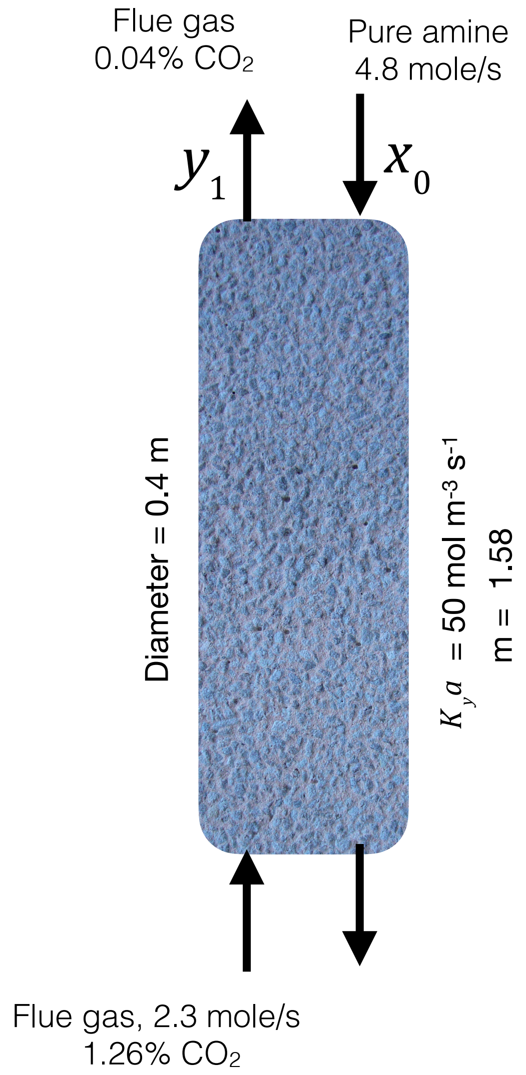


EPFL

Exercise problem 2: CO_2 absorption in a packed bed.

Calculate HTU, NTU, and h for the following problem. How would you decrease HTU?

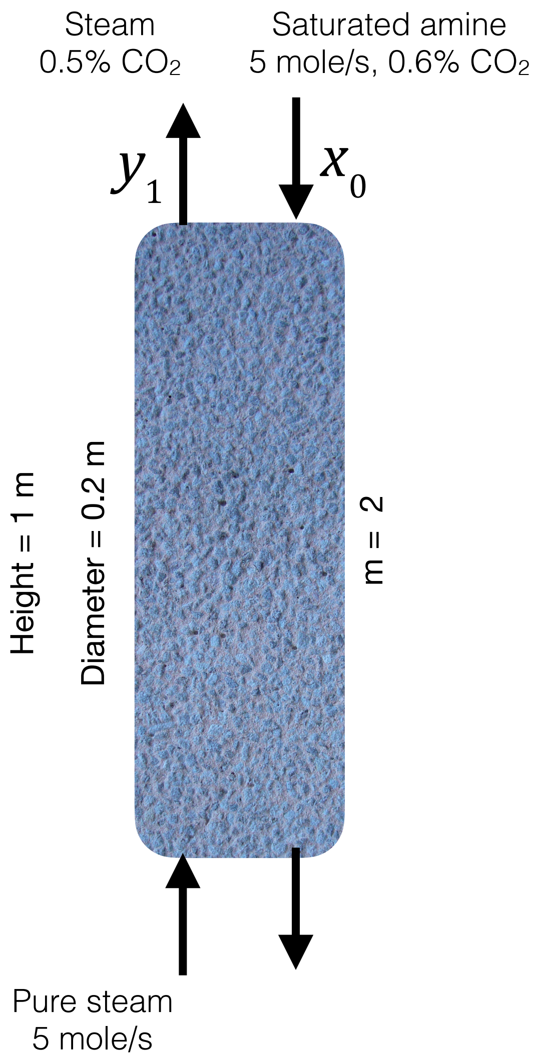
$$h = \frac{G}{K_y a A}\left[\left(\frac{1}{1-\frac{mG}{L}}\right)\ln\left(\frac{y_{N+1}-mx_N}{y_1-mx_0}\right)\right]$$



Exercise problem 3: CO_2 stripping in a packed bed.

Calculate HTU, NTU, and Kya for the following problem.

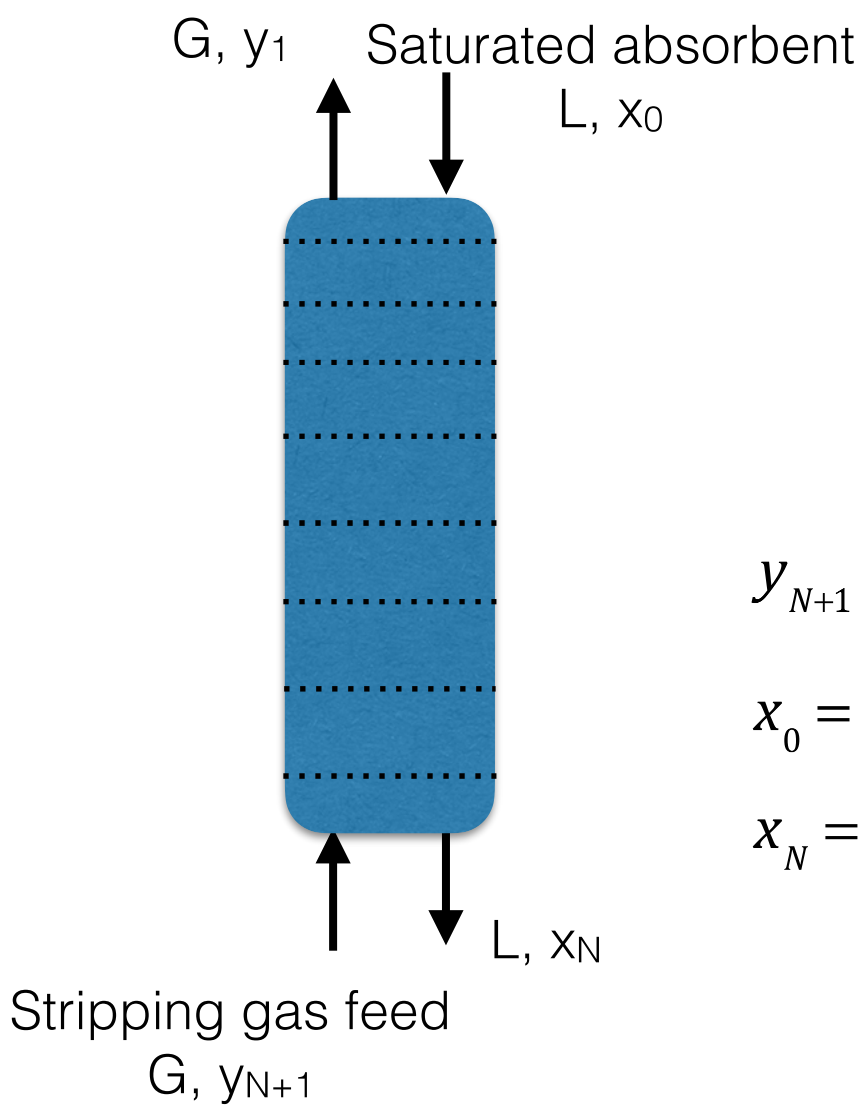
$$h = \frac{G}{K_y a A}\left[\left(\frac{1}{1-\frac{mG}{L}}\right)\ln\left(\frac{y_{N+1}-mx_N}{y_1-mx_0}\right)\right]$$



Solution to exercise problem 1

100 mol/hr of amine containing 2.9% CO_2 at 1 bar is to be regenerated with steam such that concentration of CO_2 reduces to 1%. Pure steam is being used as the stripping gas. Calculate number of stages if L/G = 0.5 L/G_{min}. Calculate exit concentration of steam.

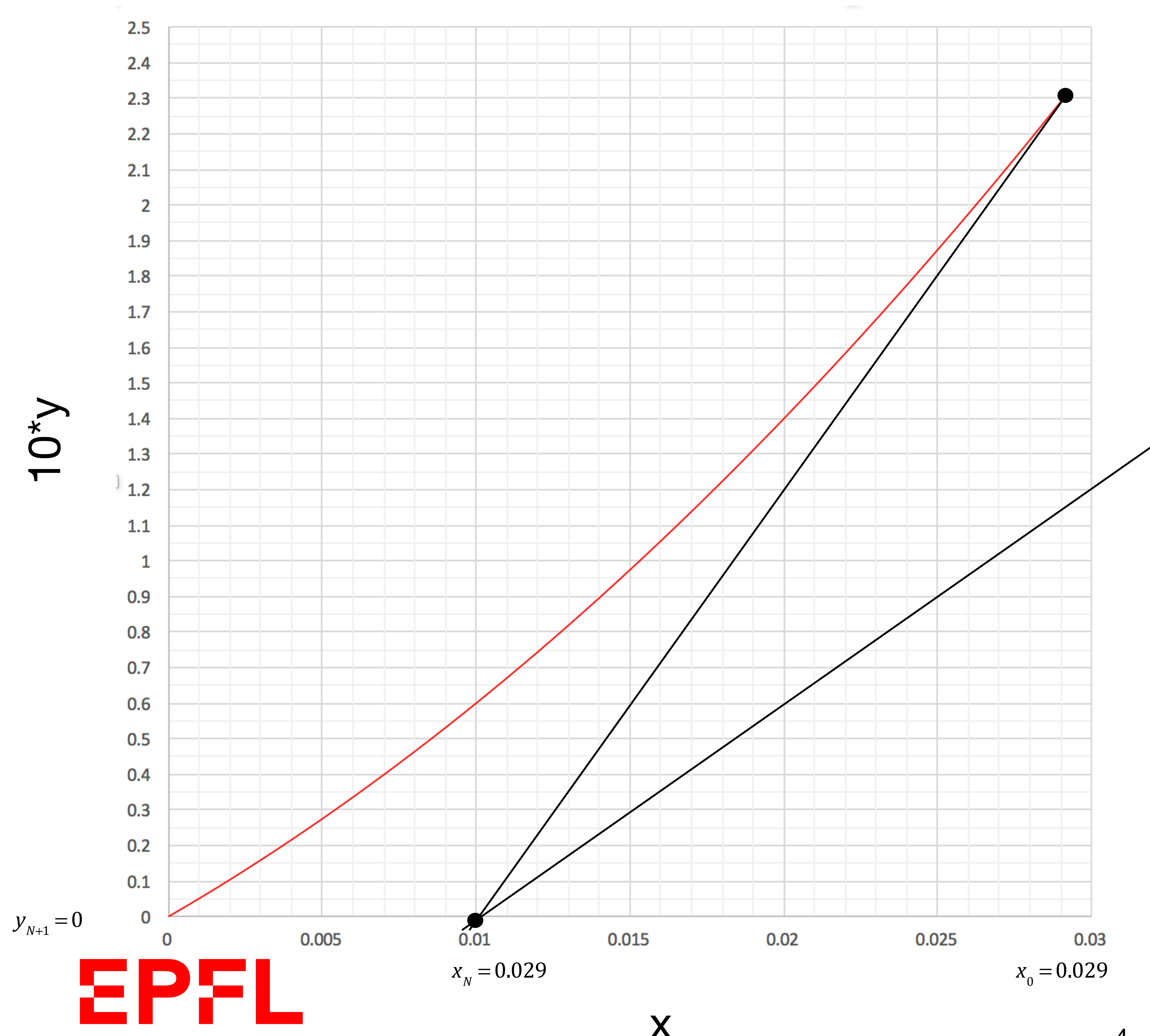
$$y=\frac{L}{G}x+(y_1-\frac{L}{G}x_0)$$



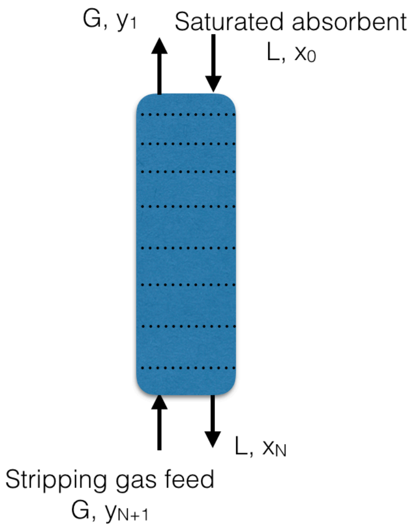
$$y_{N+1}=0$$

$$x_0=0.029$$

$$x_N=0.01$$



Solution to exercise problem 1

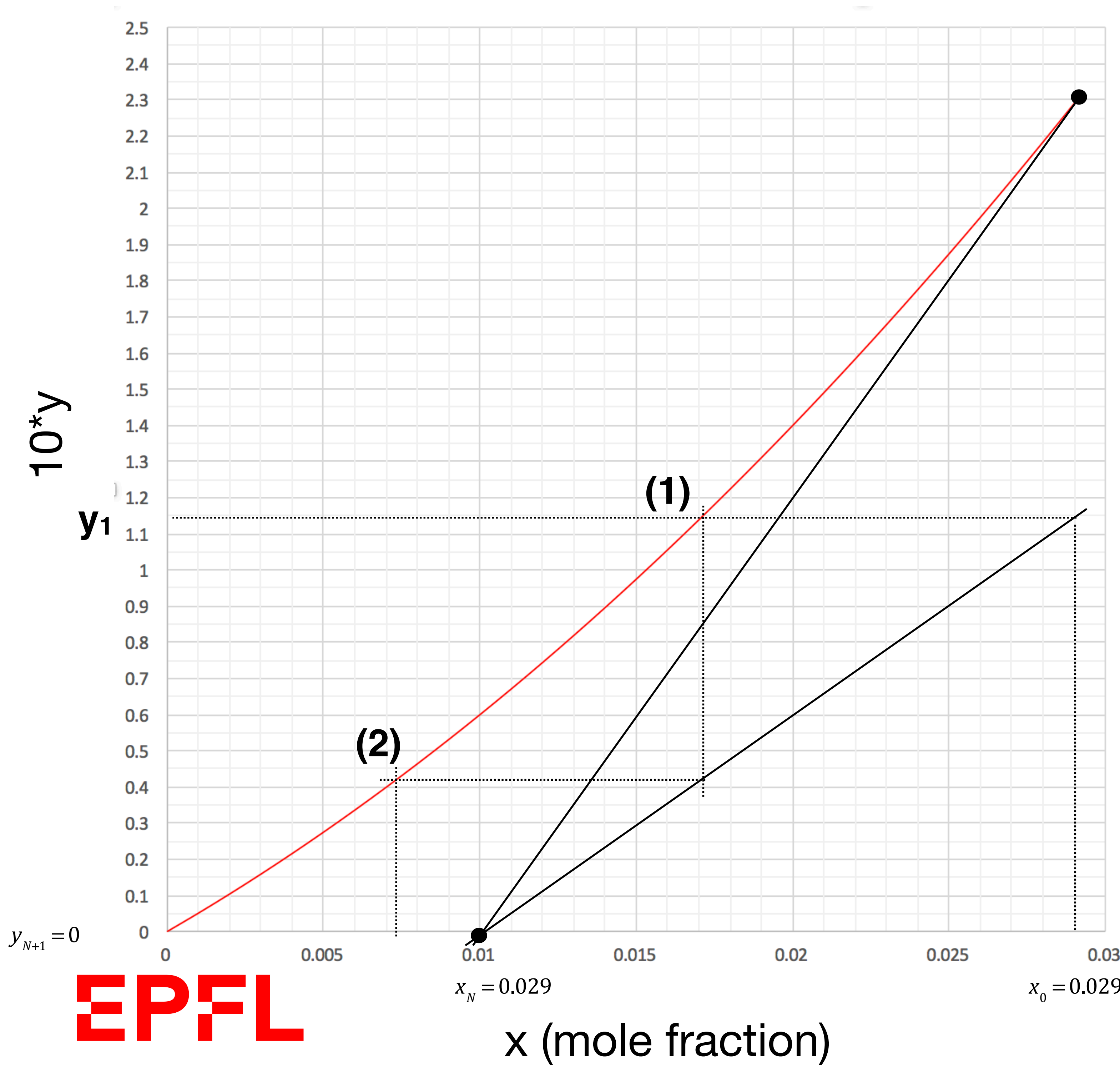


$$\frac{L}{G_{\min}} = \frac{2.3-0}{0.029-0.01} = \frac{2.3}{0.019} = 121$$

$$\frac{L}{G} = 0.5 * \frac{L}{G_{\min}} = 60.5$$

$$y_1 = \frac{1.15}{10} = 0.115$$

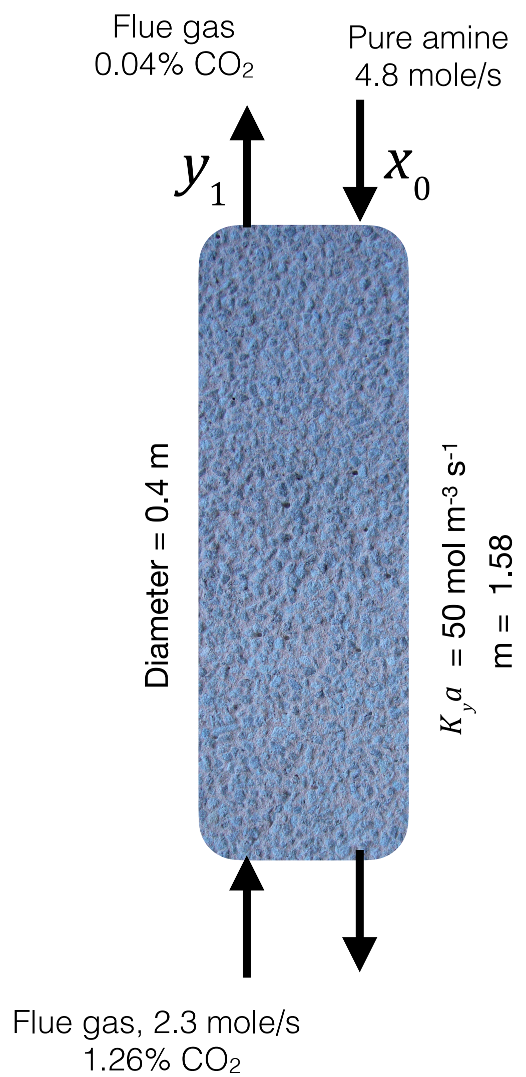
$$y_1 = 11.5\%$$



Solution to Exercise problem 2

Calculate HTU, NTU, and h for the following problem. How would you decrease HTU?

$$h = \frac{G}{K_y aA}\left[\left(\frac{1}{1-\frac{mG}{L}}\right)\ln\left(\frac{y_{N+1}-mx_N}{y_1-mx_0}\right)\right]$$



$$y_{N+1} = 0.0126 \qquad y_1 = 0.0004 \qquad x_0 = 0$$

$$L(x_N - x_0) = G(y_{N+1} - y_1) \qquad x_N = x_0 + \frac{G}{L}(y_{N+1} - y_1) = 0.0058$$

$$HTU = \frac{G}{K_y aA} = \frac{2.3}{50*\pi*0.2^2} = 0.37 \quad meters$$

$$NTU = \left(\frac{1}{1-\frac{mG}{L}}\right)\ln\left(\frac{y_{N+1}-mx_N}{y_1-mx_0}\right) = \left(\frac{1}{1-\frac{1.58*2.3}{4.8}}\right)\ln\left(\frac{0.0126-1.58*0.0058}{0.0004-1.58*0}\right) = 8.85$$

$$h = HTU*NTU = 0.37*8.85 = 3.2 \quad meters$$

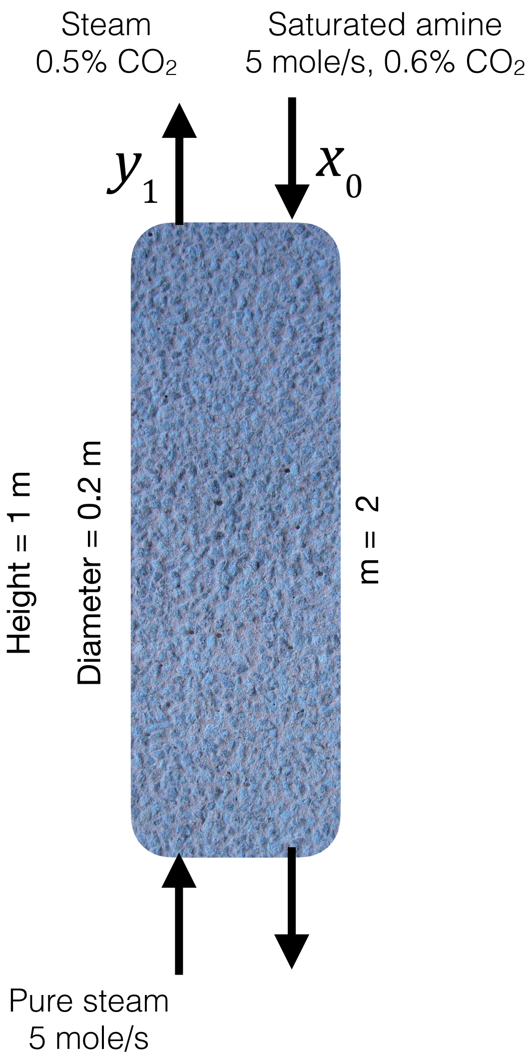
Bigger diameter column (larger A) will decrease HTU

Decreasing gas flow rate will decrease HTU

Solution to exercise problem 3

Calculate HTU, NTU, and Kya for the following problem.

$$h = \frac{G}{K_y aA}\left[\left(\frac{1}{1-\frac{mG}{L}}\right)\ln\left(\frac{y_{N+1}-mx_N}{y_1-mx_0}\right)\right]$$



$$y_{N+1} = 0 \qquad y_1 = 0.005 \qquad x_0 = 0.006$$

$$L(x_0 - x_N) = G(y_1 - y_{N+1}) \qquad x_N = x_0 - \frac{G}{L}(y_1 - y_{N+1}) = 0.001$$

$$NTU = \left(\frac{1}{1-\frac{mG}{L}}\right)\ln\left(\frac{y_{N+1}-mx_N}{y_1-mx_0}\right) = \left(\frac{1}{1-\frac{2*5}{5}}\right)\ln\left(\frac{0-2*0.001}{0.005-2*0.006}\right) = 1.25$$

$$HTU = \frac{h}{NTU} = \frac{1}{1.25} = 0.8$$

$$K_y a = \frac{5}{0.8*\pi*0.1^2} = 199.2 \quad mole \quad m^{-3} \quad s^{-1}$$