

# Chemical Reaction Engineering

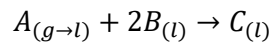
## Practical Session 6

17 December 2021

### Gas/Liquid reactors

#### 1. Overall rate of change through the 2-film theory

Air with gaseous species A bubbles through a vertical tower containing aqueous species B at uniform, constant temperature of 303 K. Reaction occurs as follows:



The reaction rate (per unit of liquid volume) is given by:  $r = k_l C_A C_B^2$ , with a kinetic constant  $k_l = 10^8 \frac{m^6}{mol^2 h}$ .

The diffusion coefficients of species A and B are  $\Gamma_A = 10^{-6} \frac{m^2}{h}$  and  $\Gamma_B = 10^{-6} \frac{m^2}{h}$ . The liquid volume fraction is  $f_L = 0.98$  and the gas/liquid interface area per unit of volume is  $a = 20 \frac{m^2}{m^3}$ . The Henry's constant at the given temperature is equal to  $H_A = 10^5 \frac{Pa \cdot m^3}{mol}$  and the liquid and gas mass transfer coefficients equal to  $K_L a = 2 \frac{1}{h}$  and  $K_G a = 0.01 \frac{mol}{h \cdot m^3 Pa}$ .

- Determine and plot the operating line for a range of partial pressures of A from 100 Pa to 5000 Pa and a fixed concentration of species B equal to  $1 \text{ mol/m}^3$ .
- Estimate and plot the enhancement factor and the overall rate of change in the same conditions reported above.

#### 2. Simulation of a co-current bubble tower

The reaction described in Exercise 1 is carried out in a co-current bubble tower with internal circular section having diameter of 40 cm and height of 5 m. The air stream (containing species A, with partial pressure of 5000 Pa) is fed at total pressure of 1 atm and volumetric flow rate of 0.4 l/s. The liquid stream, containing only species B and water with concentrations equal to  $1 \text{ mol/m}^3$  and  $300 \text{ mol/m}^3$ , respectively, is fed with volumetric flow rate of 10 l/s.

Calculate the profiles of partial pressure of A and concentrations of B and C along the reactor and estimate the conversion of A at the outlet section.

#### 3. Simulation of a counter-current bubble tower

Repeat the previous exercise in case of counter-current configuration.