FDE 307
Mass Transfer and Unit Operations

MOLECULAR DIFFUSION IN GASES

Equimolar counter diffusion in gases

For a binary mixture of components A and B, when the flux of A is precisely opposite in direction to the flux of B with the same magnitude, the case can be named as equimolar counter diffusion. Commonly, the concept is used in one-dimensional models, where diffusion occurs in the same direction throughout the system. It can be summarized as the following;

$$N_A = -N_B$$

Diffusion in gases

Example

Ammonia gas (A) is diffusing through uniform tube 0.10 m long containing N2 gas (B) at 1 atm pressure and 298 K. At point1pA1=1.013×10^4 Pa, and at point 2 pA2=0.507×10^4 Pa. The diffusivity

$D_{AB} = 0.23\times10^{-4}\ m^2/s$

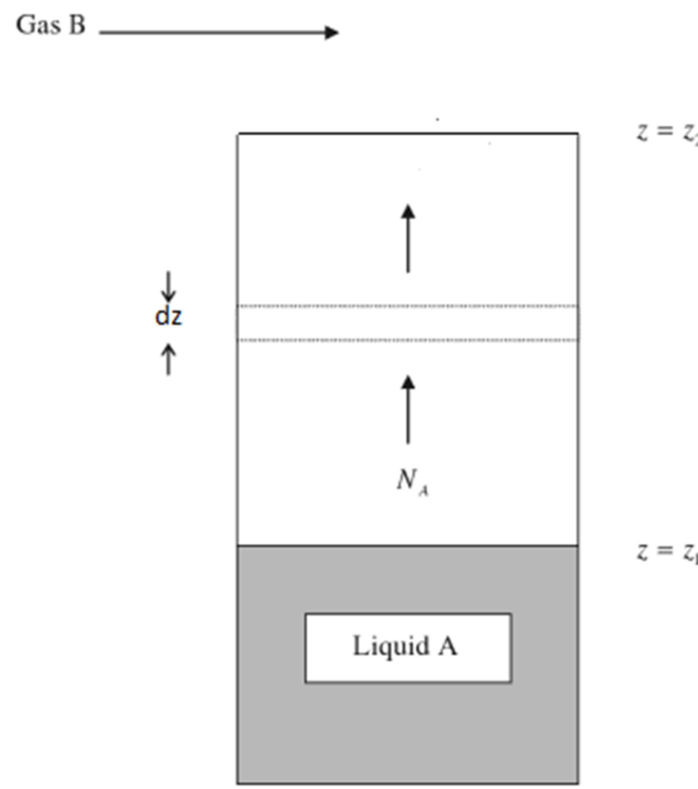
If the diffusion is equimolar, calculate the flux of A and B.

Example

Obtain an expression describing concentration profile for steady-state equimolar counter diffusion.

Molecular diffusion through a stagnant gas

In the case of molecular diffusion through a stagnant gas, there is an impermeable boundary to a component of the mixture at one end of the diffusion path, so it can not pass through. An example shown in Figure represents the case of diffusion of liquid A in Gas B by evaporation. Since gas B is inert in other words nondiffusing in liquid A, it can be considered as stagnant.



Example

Water in the bottom of a narrow metal tube is held at a constant temperature of 293 K. The total pressure of air is 1 atm and the temperature is 293 K. Water evaporates and diffuses through the air in the tube, and the diffusion path is 0.1524 m long. Calculate the rate of evaporation at steady state in kgmol/s.m2. the diffusivity of water vapor at 293 K and 1 atm pressure is $0.25x10^{-4}$ m2/s. Assume that the system is isothermal.