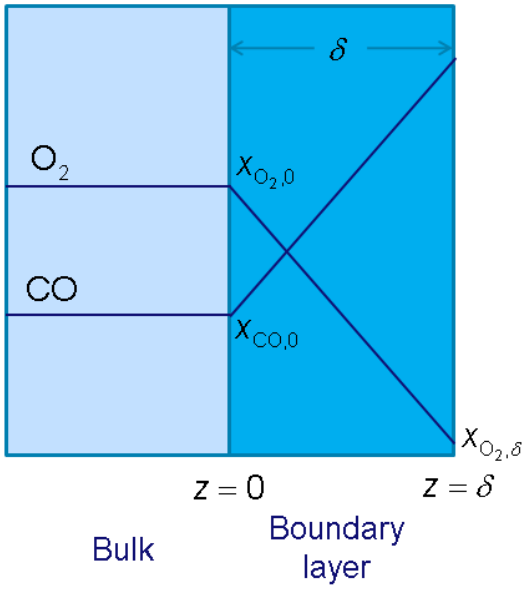
Assignment ODE

Gasification of a carbon particle: 2 C + O2 -> 2 CO



Assume: i) very fast reaction so that $x_{O_2,\delta} \approx 0$; ii) ideal gas; iii) steady state (decrease in particle size goes much slower than establishing of the concentration profiles;

Application of the Maxwell-Stefan equations for multi-component mass transfer yields (using 1 and 2 to denote O_2 and CO respectively:

$$\frac{dx_1}{dz} = -\frac{(1+x_1)}{c_{tot}D_{12}}N_1$$

With the boundary conditions: $x_1(z=0) = x_{1,0} = 0.2$ and $x_1(z=\delta) = 0$ (very fast reaction)

P = 1 atm; T = 873 K; D_{12} = $1.6 \cdot 10^{-3}$ m^2/s, δ = $1.0 \cdot 10^{-3}$ m

a) Solve this boundary value problem and calculate the O_2 mole flux using the Maxwell-Stefan approach
b) Compare with the analytical solution by integrating the equation analytically
c) Compare the O_2 mole flux with the Fickian approach and explain your result.