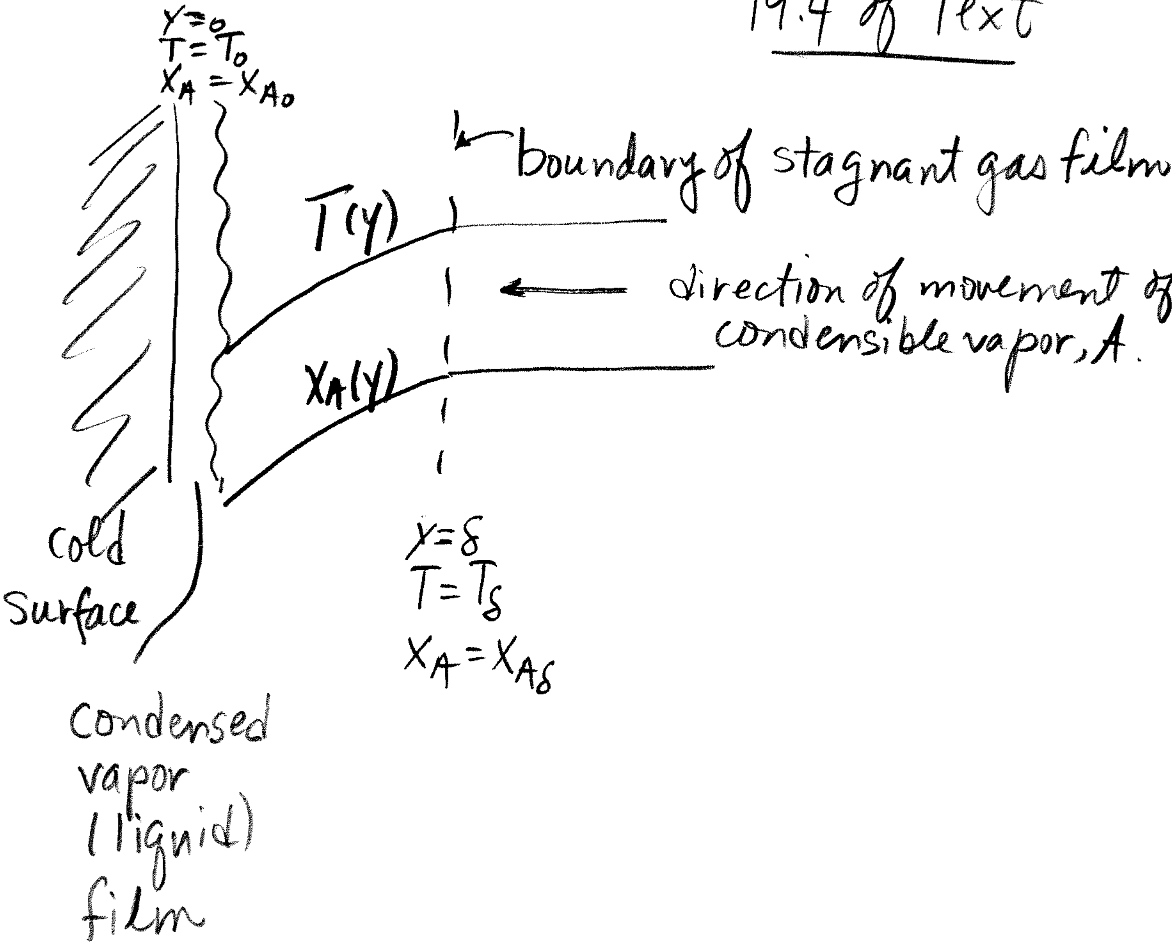
A Note About Simultaneous Mass + Heat Transfer: 19.4 of Text



Continuity of A: $$\frac{dN_{Ay}}{dy} = 0$$

Energy: $$\frac{de_y}{dy} = 0.$$

Flux Expressions: $$N_{Ay} = -\frac{c\mathcal{D}_{AB}}{1-x_A}\frac{dx_A}{dy}.$$

conduction only $\longrightarrow$ $$q = e_y = -k\frac{dT}{dy} + (\tilde{H}_A N_{Ay} + \tilde{H}_B N_{By})$$ (19.3-6) but $N_{By} = 0$

$$\tilde{H}_A = \tilde{C}_{pA} \, (T - T_0) \qquad \left(\text{reference } T \text{ is } T_0 \right)$$

Solution: Section 18.2 shows that for 1-dimensional diffusion through stagnant B.

$$\frac{(1 - x_A)}{(1 - x_{A0})} = \left(\frac{1 - x_{A\delta}}{1 - x_{A0}} \right)^{y/\delta}$$

and $$N_{Ay} = \frac{c \mathcal{D}_{AB}}{\delta} \ln \left(\frac{1 - x_{A\delta}}{1 - x_{A0}} \right)$$

Energy Transport.

$$\frac{de_y}{dy} = 0 \quad \longrightarrow \quad e_y = C_1$$

$$-k \frac{dT}{dy} + N_{Ay} \tilde{C}_{pA} \, (T - T_0) = C_1$$

BC1 $\quad y = 0 \quad T = T_0$

BC2 $\quad y = \delta \quad T = T_\delta$

$$\frac{T-T_0}{T_\delta - T_0} = \frac{1-\exp\left(\frac{N_{Ay}\tilde{C}_{pA}}{k}\cdot y\right)}{1-\exp\left(\frac{N_{Ay}\tilde{C}_{pA}}{k}\cdot \delta\right)}$$

$$\begin{array}{ll} \text{with } N_{Ay} \rightarrow & -k\,(dT/dy)\big|_{y=0} \\ \hline \text{without } N_{Ay} \rightarrow & -k\,(dT/dy)^{\circ}\big|_{y=0} \end{array} = \frac{-\,(N_{Ay}\tilde{C}_{pA}/k)\cdot\delta}{1-\exp\left(\frac{N_{Ay}\tilde{C}_{pA}}{k}\cdot\delta\right)}$$

↑
heat conduction
flux

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