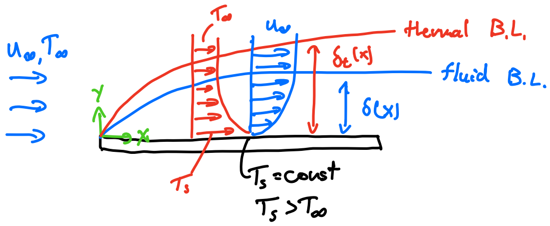
9A - 2ND CLASS

Thermal Boundary Layer

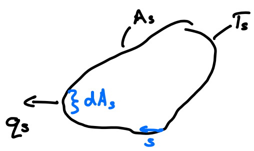


$$\delta_t(x) = y \quad \text{when} \quad \frac{T_s - T(x,y)}{T_s - T_\infty} = 0.99$$

So,
if we know $\vec{u}(x,y)$ and $T(x,y)$
we can find $h(x)$ and $q_s''(x)$

local local

What is the total q from a surface



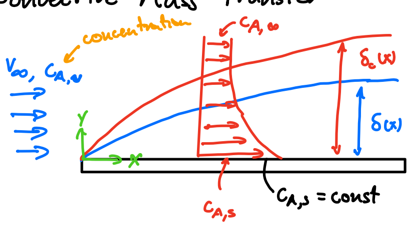
$T_s > T_\infty$

$h = h(s)$
$q_s'' = q_s''(s)$ ← position along surface
surface

$$q = \int_{A_s} q_s''(s)\, dA = \int_{A_s} h(s)(T_s - T_\infty)\, dA_s = (T_s - T_\infty)\int_{A_s} h(s)\, dA$$

$$\bar{h} A_s = \int_{A_s} h(s)\, dA_s \Rightarrow \boxed{\bar{h} = \frac{1}{A_s}\int_{A_s} h(s)\, dA_s}$$

Convective Mass Transfer



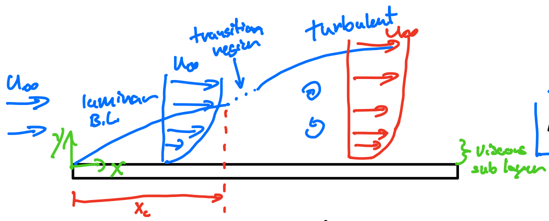
$C_{A,s} > C_{A,\infty}$

$\delta_c(x)$ = concentration B.L. thickness

$$\boxed{h_m(x) = \frac{-D_{AB} \left.\frac{\partial C_A}{\partial y}\right|_{y=0}}{C_{A,s} - C_{A,\infty}}}$$

$$N_{A,s} = h_m(x)\,(C_{A,s} - C_{A,\infty})$$

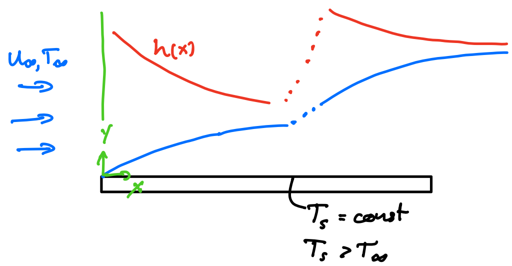
$$\bar{h}_m = \frac{1}{A_s}\int_{A_s} h_m(s)\, dA_s$$



$$Re_x = \frac{\rho u_\infty x}{\mu}$$

$$\boxed{Re_{x_c} = \frac{\rho u_\infty x_c}{\mu} \approx 5\times10^5}$$ ← critical Reynolds number

$$\underbrace{\left.\frac{\partial u}{\partial y}\right|_{y=0}}_{\text{laminar}} < \underbrace{\left.\frac{\partial u}{\partial y}\right|_{y=0}}_{\text{turbulent}}$$



q_s'' would follow same trend