Calculating h

$$Nu_x = f(x^*, Re_x, Pr)$$

$$\overline{Nu_x} = f(Re_x, Pr)$$

Empenical Method

$$\overline{Nu_L} = C Re_L^m Pr^n$$

Fig 7.2

$$T_f = \frac{T_s + T_\infty}{2}$$

Flat Plate in parallel flow

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = \nu\frac{\partial^2 u}{\partial y^2}$$

$$u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = \alpha\frac{\partial^2 T}{\partial y^2}$$

Stream function $\psi(x,y)$

where $u = \frac{\partial \psi}{\partial y}$ $\quad v = \frac{-\partial \psi}{\partial x}$

satisfies

$$f(\eta) = \frac{\psi}{u_\infty\sqrt{\nu x/u_\infty}} \qquad \eta = y\sqrt{\frac{u_\infty}{\nu x}}$$

$$\frac{u}{u_\infty} = \phi\left(\frac{y}{\delta}\right) = \phi(\eta)$$

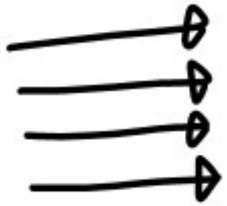
$$u = \frac{\partial \psi}{\partial y} = \frac{\partial \psi}{\partial \eta}\frac{\partial \eta}{\partial y} = u_\infty \sqrt{\frac{\nu x}{u_\infty}}\frac{df}{d\eta}\sqrt{\frac{u_\infty}{\nu x}} = u_\infty \frac{df}{d\eta}$$

$$v = \frac{-\partial \psi}{\partial x} = \frac{1}{2}\sqrt{\frac{\nu u_\infty}{x}}\left(\eta \frac{df}{d\eta} - f\right)$$

$$\frac{\partial u}{\partial x} = \frac{-u_\infty}{2x}\eta \frac{d^2 f}{d\eta^2} \qquad \frac{\partial u}{\partial y} = u_\infty \sqrt{\frac{u_\infty}{\nu x}}\frac{d^2 f}{d\eta^2} \qquad \frac{\partial^2 u}{\partial y^2} = \frac{u_\infty^2}{\nu x}\frac{d^3 f}{d\eta^3}$$

$$2\frac{d^3 f}{d\eta^3} + f\frac{d^2 f}{d\eta^2} = 0$$

$$\delta = \frac{5}{\sqrt{u_\infty / \nu x}} = \frac{5x}{\sqrt{Re_x}}$$



Plate

$$C_{fx} = \frac{\tau_{sx}}{\rho u_\infty^2 / 2} = 0.664 \; Re_x^{-1/2}$$

$$Nu_x = \frac{h_x x}{k} = 0.332 \; Re_x^{1/2} \; Pr^{1/3} \qquad Pr > 0.6$$

Average h

$$\overline{C}_{fx} = 1.328\ Re_x^{-1/2}$$

$$\overline{Nu_x} = \frac{\overline{h}_x x}{k} = 0.664\ Re_x^{1/2}\ Pr^{1/3} \qquad Pr > 0.6$$

$$Nu_x = \frac{0.3387\ Re_x^{1/2}\ Pr^{1/3}}{\left(1+\left(\frac{0.0468}{Pr}\right)^{2/3}\right)^{1/4}} \qquad Pe_x > 100$$

Peclet Number

$$Pe = Re_L\ Pr$$

$$\overline{Nu_x} = 2\ Nu_x$$