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8 .Heat transfer in transition region between Laminer and turbulent flow:

Example:

$T_{ca} = 16\ ℃$ $D_{io} = D_i = 0.02\ m$

$T_{cb} = 28\ ℃$ $D_{oi} = D_o = 0.04\ m$

$T_w = 30\ ℃$ $\vartheta = 0.2\ m/s$

$$\overline{T_c} = \frac{16 + 28}{2} = 22\ ℃$$

Properties of water at 22 ℃ by interpolation:

$\mu = 9.6\ x\ 10^{-4}\ kg/ms$
$\rho = 997.14\ kg/m^3$
$C_p = 4.179\ kj/kg℃$
$k = 0.606\ W/m℃$
$\mu_w = 8.03\ x\ 10^{-4}\ kg/ms$ (at 30 ℃)

$$D_e = 4\ r_H$$

$$r_H = \frac{\pi\ (D_o^2 - D_i^2)}{4(\pi D_o + \pi D_i)}$$

$$r_H = \frac{(D_o^2 - D_i^2)}{4(D_o + D_i)} = \frac{D_o - D_i}{4}$$

$$D_e = D_0 - D_i = 0.04 - 0.02 = 0.02\ m$$

$$Re = \frac{D_e \vartheta \rho}{\mu} = \frac{0.02\ x\ 0.2\ x\ 997.14}{9.6\ x\ 10^{-4}}$$

$Re = 4154.75$ Transition region

$$\frac{L}{D} = \frac{1\ m}{0.02\ m} = 50$$

From Figure 13 J_H=0.004 (for L/D=50)

$$J_H = \left(\frac{h}{C_p G}\right)\left(\frac{C_p \mu}{k}\right)^{2/3}\left(\frac{\mu_w}{\mu}\right)^{0.14}$$

$$G = \vartheta \text{ x } \rho = 0.2 \text{ x } 997.14 = 199.43 \ \frac{kg}{m^2 s}$$

$$0.004 = \left(\frac{h}{4179 \text{ x } 199.43}\right)\left(\frac{4179 \text{ x } 9.6 \text{ x } 10^{-4}}{0.606}\right)^{2/3}\left(\frac{8.03 \text{ x } 10^{-4}}{9.6 \text{ x } 10^{-4}}\right)^{0.14}$$

$$h = 969.46 \ W/m^2{}^\circ C$$