Convection - External Flow Example Values

Flat Plate

Average temperature of 300 K

- c_p = 1007 [J/kg-K]
- mu = 184.6E-7 [N-s/m^2]
- k = 26.3E-3 [W/m-K]
- rho = 1.1614 [kg/m^3]

Case 1:

- Free-stream velocity: 15 m/s
- Length of plate: 1.5 m

Calculated Values

- $L_{critical}$ = 0.53 m → use turbulent flow values
- Reynolds number at end of plate: 1.42 E6
- h_bar = 47.63 W/m^2K

Case 2:

- Free-stream velocity: 5 m/s
- Length of plate: 0.25 m

Calculated Values

- $L_{critical}$ = 1.59 m → use laminar flow values
- Reynolds number at end of plate: 78,643
- h_bar = 17.45 W/m^2K

Case 3:

- Free-stream velocity: 5.5 m/s
- Length of plate: 1.5 m

Calculated Values

- $L_{critical}$ = 1.45 m → Should check both values – too close to tell from equations along
- Reynolds number at end of plate: 519,044
- h_bar_laminar = 7.47 W/m^2K
- h_bar_turbulent = 21.35 W/m^2K

Cylinder in Cross-Flow

Average temperature of 300 K

- c_p = 1007 [J/kg-K]
- mu = 184.6E-7 [N-s/m^2]
- k = 26.3E-3 [W/m-K]
- rho = 1.1614 [kg/m^3]

Case 1:

- Free-stream velocity: 10 m/s
- Diameter of cylinder: 0.0127 m

Calculated Values

- Re_D = 7,990 → Look up values for C and n
- C = 0.193
- n = 0.618
- h_bar = 91.9 W/m^2K

Case 2:

- Free-stream velocity: 10 m/s
- Diameter of cylinder: 0.1 m

Calculated Values

- Re_D = 62,914 → Look up values for C and n
- C = 0.0266
- n = 0.805
- h_bar = 45.46 W/m^2K

Case 3:

- Free-stream velocity: 5 m/s
- Diameter of cylinder: 0.00008 m (approximate human hair diameter)

Calculated Values

- Re_D = 25.17 → Look up values for C and n
- C = 0.911
- n = 0.385
- h_bar = 923.7 W/m^2K