

Homework Assignment Number Thirteen
Assigned: Wednesday, April 21, 1999
Due: Wednesday, April 28, 1999 BEFORE LECTURE STARTS.

Problem 1. Geankoplis, 4.10-5, page 324, as stated

Natural convection + radiation

Horizontal pipe:

$$N_{Pr} = 0.7022$$

$$N_{Gr} = 2.75 \cdot 10^6$$

$$h_c = 7.32 \frac{W}{m^2 \cdot K}$$

$$h_r = 4.55 \frac{W}{m^2 \cdot K}$$

$$h_c + h_r = 11.87 \frac{W}{m^2 \cdot K}$$

$$q = 615.5W$$

Problem 2. Geankoplis, 4.10-5, page 324, with vertical pipe

Natural convection + radiation

Vertical pipe:

$$N_{Pr} = 0.7022$$

$$N_{Gr} = 1.68 \cdot 10^{11}$$

$$h_c = 5.16 \frac{W}{m^2 \cdot K}$$

$$h_r = 4.55 \frac{W}{m^2 \cdot K}$$

$$h_c + h_r = 19.71 \frac{W}{m^2 \cdot K}$$

$$q = 503.5W$$

For the same situation, the horizontal pipe transfers more heat. Why?

Problem 3. Geankoplis, 4.11-2, page 324

$$\frac{q_{12}}{A_1} = \frac{\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1} = \frac{5.676 \cdot 10^{-8} (283.2^4 - 0^4)}{\frac{1}{0.1} + \frac{1}{1.0} - 1} = 36.51 \frac{W}{m^2}$$