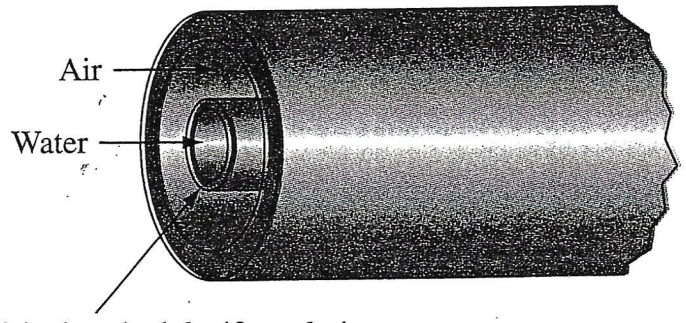
ASSIGNMENT #8

Convective Heat Transfer with Flow in Tubes

8–1 In a heat exchanger, as shown in the accompanying figure, air flows over brass tubes of 1.8-cm 1D and 2.1-cm OD containing steam. The convection heat transfer coefficients on the air and steam sides of the tubes are 70 W/m^2 K and 210 W/m^2 K, respectively. Calculate the overall heat transfer coefficient for the heat exchanger (a) based on the inner tube area and (b) based on the outer tube area.

8–2 Hot water is used to heat air in a double-pipe heat exchanger as shown in the following sketch. If the heat transfer coefficients on the water side and on the air side are 100 Btu/h ft^2 °F and 10 Btu/h ft^2 °F, respectively, calculate the overall heat transfer coefficient based on the outer diameter. The heat exchanger pipe is 2-in., schedule 40 steel (k = 54 W/m K) with water inside. Express your answer in Btu/h ft^2 °F and W/m^2 °C.



8–3 In a shell-and-tube heat exchanger with $\bar{h}_i = \bar{h}_o$ = 5600 W/m^2 K and negligible wall resistance, by what percent would the overall heat transfer coefficient (based on the outside area) change if the number of tubes were doubled? The tubes have an outside diameter of 2.5 cm and a tube wall thickness of 2 mm. Assume that the flow rates of the fluids are constant, the effect of temperature on fluid properties is negligible, and the total cross-sectional area of the tubes is small compared with the flow area of the shell.

8–4 In a single-pass counterflow heat exchanger, 10,000 lb/h of water enters at 60°F and cools 20,000 lb/h of an oil having a specific heat of 0.50 Btu/lb °F from 200°F to 150°F. If the overall heat transfer coefficient is 50 Btu/h ft^2 °F, determine the surface area required.

8–5 Water flowing through a pipe is heated by steam condensing on the outside of the pipe. (a) Assuming a uniform overall heat transfer coefficient along the pipe, derive an expression for the water temperature as a function of distance from the entrance. (b) For an overall heat transfer coefficient of 570 W/m^2 K based on the inside diameter of 5 cm, a steam temperature of 104°C, and a water flow rate of 0.063 kg/s, calculate the length required to raise the water temperature from 15.5°C to 65.5°C.