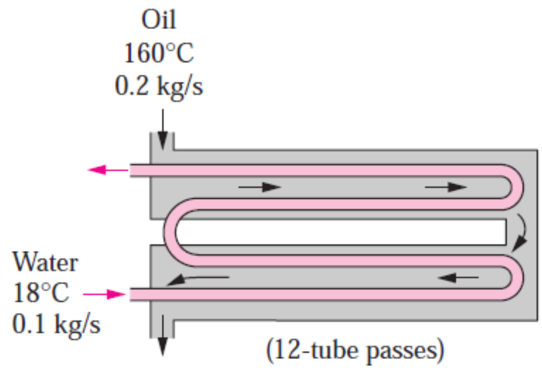
Mech 262- Thermodynamics 2

Assignment 7

Question 1

Hot oil (Cp = 2200 J/kg ·°C) is to be cooled by water (Cp = 4180 J/kg ·°C) in a 2-shell-passes and 12-tube-passes heat exchanger. The tubes are thin-walled and are made of copper with a diameter of 1.8 cm. The length of each tube pass in the heat exchanger is 3 m, and the overall heat transfer coefficient is 340 W/m^2 ·°C. Water flows through the tubes at a total rate of 0.1 kg/s, and the oil through the shell at a rate of 0.2 kg/s. The water and the oil enter at temperatures 18°C and 160°C, respectively.



Determine the rate of heat transfer in the heat exchanger and the outlet temperatures of the water and the oil. (Answers: 36.2 kW, 104.6°C, 77.7°C)

Question 2

Consider an aluminum cold drink can that is initially at a uniform temperature of 3°C. The can is 12.5 cm high and has a diameter or 6 cm. If the convection heat transfer coefficient between the can and the surrounding air at 25°C is 10 W/(m^2·°C), determine how long it will take for the average temperature of the drink to rise to 10°C.

In an effort to slow down the warming of the cold drink a person puts the can in a perfectly fitting 1 cm thick cylindrical rubber insulation [k = 0.13 W/(m·°C)]. Now how long will it take for the average temperature of the drink to rise to 10°C? Assume the top of the can is not covered.

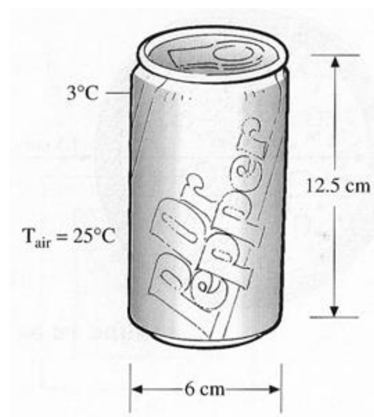


FIGURE P8-98

Question 3

In a manufacturing facility, 2 in diameter brass balls (k = 64.1 Btu/h · ft · °F, r = 532 lbm/ft^3, and Cp = 0.092 Btu/lbm · °F) initially at 250 °F are quenched in a water bath at 120 °F for a period of 2 min at a rate of 120 balls per minute.

If the convection heat transfer coefficient is 42 Btu/h · ft^2 · °F, do the following:

a. Convert this problem to SI units.
b. Determine the temperature of the balls after quenching.
c. Determine the rate at which heat needs to be removed from the water in order to keep its temperature constant at 120 °F.