me263 – Fluids and Heat Transfer

Assignment 8 – Heat Exchangers

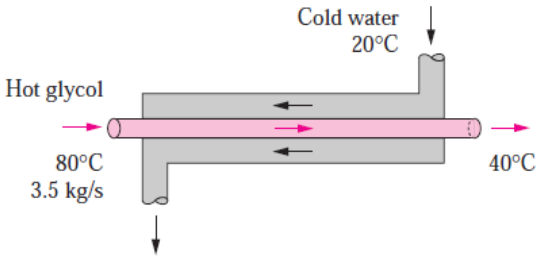
Question 1

Water at an average temperature of 110°C and an average velocity of 3.5 m/s flows through a 5 m long stainless steel tube (k = 14.2 W/m^2·°C) in a boiler. The inner and outer diameters of the tube are D_i = 1.0 cm and D_o = 1.4 cm, respectively. If the convection heat transfer coefficient at the outer surface of the tube where boiling is taking place is h_o = 8400 W/m^2·°C, determine:

a. The inner convective heat transfer coefficient, h_i (you know, using Nu and all that.)
b. The overall heat transfer coefficient U_i of this boiler based on the inner surface area of the tube.
c. The overall heat transfer coefficient U_i of this boiler based on the inner surface area of the tube with a fouling factor $R_{f,I}$ = 0.0005 m^2·°C/W on the inner surface of the tube.

Question 2

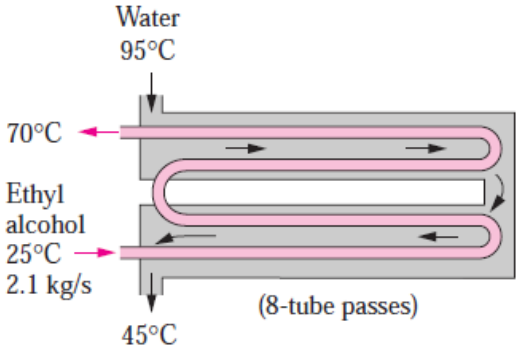
A double-pipe counter-flow heat exchanger is to cool ethylene glycol (Cp = 2560 J/kg·°C) flowing at a rate of 3.5kg/s from 80°C to 40°C by water (Cp = 4180 J/kg·°C) that enters at 20°C and leaves at 55°C. The overall heat transfer co-efficient based on the inner surface area of the tube is 250W/m^2·°C. Determine:



a. The rate of heat transfer.
b. The mass flow rate of water.
c. The heat transfer surface area on the inner side of the tube.

Question 3

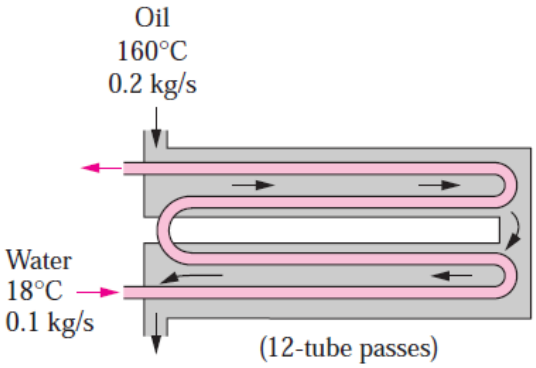
A shell-and-tube heat exchanger with 2-shell passes and 8-tube passes is used to heat ethyl alcohol (Cp = 2670 J/kg·°C) in the tubes from 25°C to 70°C at a rate of 2.1 kg/s. The heating is to be done by water (Cp = 4190 J/kg·°C) that enters the shell side at 95°C and leaves at 45°C. If the overall heat transfer coefficient is 950 W/m^2·°C, based on the inner surface of the tube, determine:



a. The rate of heat transfer.
b. The heat transfer surface area of the heat exchanger.

Question 4

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.



Using the NTU method (note they only give the inlet temperatures and flowrates), 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 5

Redo problem 2 but this time select a BASCO Heat Exchanger to do the job and use their method of selection.