

Mech 262 – Thermodynamics II

Assignment 6 – Heat Exchangers

Question 1

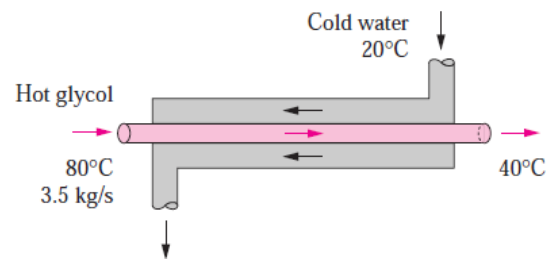
Water at an average temperature of 110°C and an average velocity of 3.5 m/s flows through a 5 m long stainless steel tube ($k = 14.2\text{ W/m}^2\cdot^{\circ}\text{C}$) in a boiler. The inner and outer diameters of the tube are $D_i = 1.0\text{ cm}$ and $D_o = 1.4\text{ cm}$, respectively. If the convection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

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

Question 2

A double-pipe counter-flow heat exchanger is to cool ethylene glycol ($C_p = 2560\text{ J/kg}\cdot^{\circ}\text{C}$) flowing at a rate of 3.5 kg/s from 80°C to 40°C by water ($C_p = 4180\text{ J/kg}\cdot^{\circ}\text{C}$) 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 $250\text{ W/m}^2\cdot^{\circ}\text{C}$. Determine:

- The rate of heat transfer.
- The mass flow rate of water.
- 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 ($C_p = 2670\text{ J/kg}\cdot^{\circ}\text{C}$) 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 ($C_p = 4190\text{ J/kg}\cdot^{\circ}\text{C}$) that enters the shell side at 95°C and leaves at 45°C . If the overall heat transfer coefficient is $950\text{ W/m}^2\cdot^{\circ}\text{C}$, based on the inner surface of the tube, determine:

- The rate of heat transfer.
- The heat transfer surface area of the heat exchanger.

