

ME 1065 – HW #3

Due 10/1/08

- 1) In the shell of a shell-and-tube heat exchanger with two shell passes and eight tube passes, 100,000 lb_m/hr of water is heated from 180°F to 300°F. Hot exhaust gases having roughly the same physical properties as air enter the tubes at 650°F and leave at 350°F. The total surface area, based on the outer tube surface, is 10,000 ft². Determine:
 - a. the LMTD as if the heat exchanger were a simple counterflow exchanger,
 - b. the correction factor F for the actual arrangement (you will need a heat transfer textbook to find this),
 - c. the effectiveness of the heat exchanger, and
 - d. the average overall heat transfer coefficient for the outer tube surface.

- 2) During one phase of the separation of crude oil into its components, the oil is to be heated by water in a 1-4 shell and tube heat exchanger. The oil flows through the tubes at a rate of 110,000 lb_m/hr, an entrance temperature of 100°F, a density of 740 kg/m³, a specific heat of 2.05 kJ/kg·K, a thermal conductivity of 0.132 W/m·K, a Prandtl number of 4400, and a viscosity of 3.4 cp (note the units here!). Water enters the heat exchanger at 66,000 lb_m/hr and a temperature of 200°F. It is proposed to use an exchanger that has a shell with an inside diameter of 23¼ inches, and containing copper tubes of 1 inch outer diameter, 13 BWG, laid out on a 1¼ inch square pitch. The 192 tubes are 12 feet long, and the exchanger contains 6 baffles. Determine the rate of heat transfer and the oil and water outlet temperatures.

Note: For transition flow, the following correlation is valid for Pr > 0.7

$$Nu_0 = \frac{\frac{\xi}{8} (Re - 1000) Pr}{1 + 12.7 \sqrt{\frac{\xi}{8}} (Pr^{2/3} - 1)} \left[1 + \left(\frac{D}{L} \right)^{2/3} \right], \text{ where } \xi = \frac{1}{(1.82 \log Re - 1.64)^2}$$

Nu \cong Nu₀, and “log” is the base-10 log