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 lbm/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 ft^2. 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/m^3, 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 <u>rate of heat transfer</u> and the <u>oil and water outlet temperatures</u>.

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

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

, where $\xi = \frac{1}{(1.82 \log Re - 1.64)^2}$

$Nu \cong Nu_0$, and "log" is the base-10 log