Lesson 16 Homework Problem 1 (Janna 7.40 with extra help)

Janna 7.40:
Kerosene \[ \rho = 0.73(1000) \text{ kg/m}^3, \ c_p = 2470 \text{ J/(kg·C}^\circ)\], \( \mu = 0.40 \text{ cp}, \ k_f = 0.132 \text{ W/(m·C}^\circ)\] is to be preheated in a double pipe heat exchanger before being pumped to a distillation facility. The kerosene flow rate is 8000 kg/hr and is to be heated from 24 to 35°C. Water is available from the condensed exhaust of the small steam turbine, and its flow rate can be controlled. The water is available at 95°C. Select an appropriate heat exchanger.

Add these pieces of information:
- The outer tube is 2-1/2 std M copper.
- The inner tube is 1-1/4 std M.
- Water flows in the inner tube, whereas the kerosene flows in the annular space.
- The available water flow rate is 5400 kg/hr
- The HXR is in a counter-flow arrangement.

Find these things:

a) Determine the required length of a new heat exchanger. (Easy, if you calculate a value for \( UA \) first)

b) Consider a heat exchanger that has been in use for about one year. How long would this exchanger have to be to accomplish the same task? (Not much tougher than part a. I smell something foul…)

c) Now let’s say you build the exchanger using the considerations of b): i.e., you build a heat exchanger that is physically as big as the one in part b). When the heat exchanger is brand new, however, it won’t require the full 5400 kg/hr of water flow in order to meet the design requirements. (How come?) For a new exchanger of this size, what would the required water flow rate be? (MUCH tougher)