Solutions

2.1

- $Q = \dot{m}_h c_h \Delta T_h = 1.5 \times 2100 \times 30 = \mathbf{94.5}$ kW.
- $T_{c,out} = 20 + Q/(\dot{m}_c c_c) = 20 + 94\,500/8360 = \mathbf{31.3}$ °C.

2.2

- Counterflow ends: $90 - 31.3 = 58.7$ K and $60 - 20 = 40$ K.
- $\Delta T_{lm} = (58.7 - 40)/\ln(58.7/40) = \mathbf{48.75}$ K.
- $A = Q/(U \Delta T_{lm}) = 94\,500/(400 \times 48.75) = \mathbf{4.85}$ m^2.

2.3

- Parallel ends: $90 - 20 = 70$ K and $60 - 31.3 = 28.7$ K; $\Delta T_{lm} = 41.3/\ln(70/28.7) = \mathbf{46.32}$ K.
- $A = 94\,500/(400 \times 46.32) = \mathbf{5.10}$ m^2: counterflow is about 5% smaller.

3.1

- $1/U = 1/U_{clean} + R_f = 1/400 + 0.0005 = 0.003$, so $U = \mathbf{333.3}$ W/(m^2 · K).
- $C_{min} = 1.5 \times 2100 = 3150$ W/K (oil); $C_r = 3150/8360 = \mathbf{0.3768}$.
- $NTU = UA/C_{min} = 333.3 \times 4.85/3150 = \mathbf{0.513}$; counterflow formula gives $\varepsilon = \mathbf{0.377}$.
- $Q = \varepsilon C_{min}(T_{h,in} - T_{c,in}) = 0.377 \times 3150 \times 70 = \mathbf{83.0}$ kW.
- $T_{h,out} = 90 - Q/C_{min} = 90 - 83\,000/3150 = \mathbf{63.6}$ °C.
- Both outlets are unknown, so ΔT_{lm} cannot be found without iterating; ε–NTU needs only the inlets.

exercises.lol exercises.com.cn