Example 4: Heat flux in a cylindrical shell

Solution for Heat Flux:

\[
q_r = \frac{\left( T_{b1} - T_{b2} \right)}{\left( \frac{1}{h_2R_2} + \frac{1}{k} \ln \left( \frac{R_2}{R_1} \right) + \frac{1}{h_1R_1} \right) r^2}
\]

Calculate Total Heat flow:

\[
Q = \left( q_r \right) \frac{2\pi r L}{2\pi r} = \left( \frac{2\pi L}{\Delta T} \right) \left( T_{b1} - T_{b2} \right)
\]

Overall Heat Transfer Coefficient, U

\[
Q = U A \Delta T = U A \left( T_{b1} - T_{b2} \right)
\]

\( A \) = area of heat transfer (not always unambiguous)
\( \Delta T \) = driving temperature difference

Example: in a pipe

do we use inner or outer area?
overall heat xfer coeffs in pipe

\[ Q = U_1 A_1 \Delta T \]

\[ = \left( \frac{1}{R_0} \right) \left( \frac{1}{h_2 R_2} + \frac{1}{k} \ln \left( \frac{R_2}{R_1} \right) + \frac{1}{h_1 R_1} \right) (2\pi R_1 L) (T_{21} - T_{22}) \]

Area must be specified when \( U \) is reported

\[ Q = U_2 A_2 \Delta T \]

\[ = \left( \frac{1}{R_0} \right) \left( \frac{1}{h_2 R_2} + \frac{1}{k} \ln \left( \frac{R_2}{R_1} \right) + \frac{1}{h_1 R_1} \right) (2\pi R_1 L) (T_{21} - T_{22}) \]

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