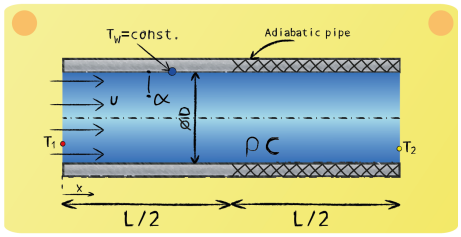
Energy Balance - Convection - Body 4

Water flows through a pipe an average velocity u and inlet temperature T_1. Provide the energy balance to determine the water temperature T_2.
Hint: $T_w < T_2 < T_1$



Energy balance:

$$\dot{H}_1 - \dot{H}_2 - \dot{Q}_{\text{loss}} = 0$$

Energy fluxes:

$$\dot{H}_1 = \dot{m} \cdot c \cdot T_1$$

$$\dot{H}_2 = \dot{m} \cdot c \cdot T_2$$

$$\dot{Q}_{\text{loss}} = \frac{1}{2} \cdot \alpha \cdot \pi D \cdot L \cdot \Delta T$$

Logarithmic mean temperature difference:

$$\Delta T = \frac{2 \cdot \dot{m} \cdot c}{\alpha \cdot \pi D \cdot L} (T_1 - T_2) = \frac{T_1 - T_2}{\ln\left(\frac{T_1 - T_{\text{w}}}{T_2 - T_{\text{w}}}\right)}$$

Mass flow rate:

$$\dot{m} = u \cdot \frac{\pi \cdot D^2}{4} \cdot \rho$$