

Problem 1.2-3 (1-2 in text): Conduction through a Wall

Figure P1.2-3 illustrates a plane wall made of a very thin ($th_w = 0.001$ m) and conductive ($k = 100$ W/m-K) material that separates two fluids, A and fluid B. Fluid A is at $T_A = 100^\circ\text{C}$ and the heat transfer coefficient between the fluid and the wall is $\bar{h}_A = 10$ W/m²-K while fluid B is at $T_B = 0^\circ\text{C}$ with $\bar{h}_B = 100$ W/m²-K.

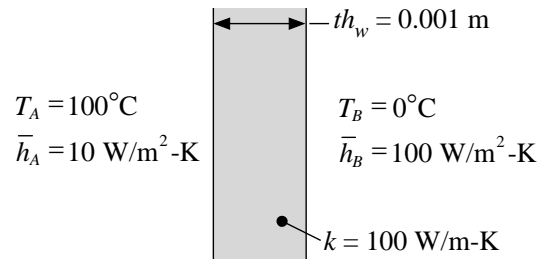


Figure P1.2-3: Plane wall separating two fluids

- a.) Draw a resistance network that represents this situation and calculate the value of each resistor (assuming a unit area for the wall, $A = 1$ m²).

Heat flowing from fluid A to fluid B must pass through a fluid A-to-wall convective resistance ($R_{conv,A}$), a resistance to conduction through the wall (R_{cond}), and a wall-to-fluid B convective resistance ($R_{conv,B}$). These resistors are in series. The network and values of the resistors are shown in Figure 2.

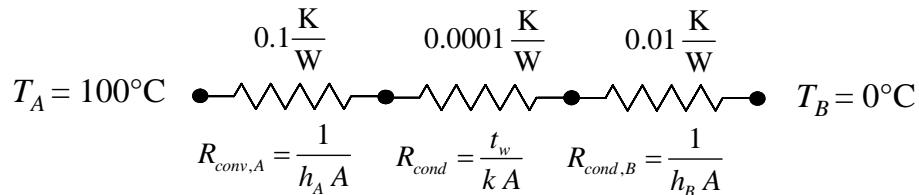


Figure 2: Thermal resistance network representing the wall.

- b.) If you wanted to predict the heat transfer rate from fluid A to B very accurately, then which parameter (e.g., th_w , k , etc.) would you try to understand/measure very carefully and which parameters are not very important? Justify your answer.

The largest resistance in a series network will control the heat transfer. For the wall above, the largest resistance is $R_{conv,A}$. Therefore, I would focus on predicting this resistance accurately. This would suggest that \bar{h}_A is the most important parameter and the others do not matter much.