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°C and the heat transfer coefficient between the fluid and the wall is $\overline{h}_A$ = 10 W/m²-K while fluid B is at T_B = 0°C with $\overline{h}_B$ = 100 W/m²-K.

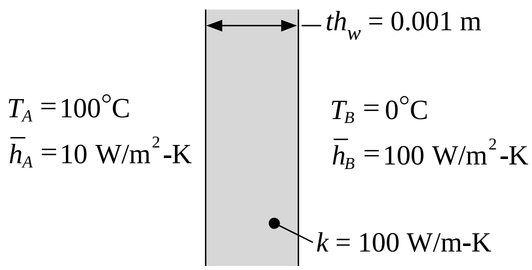

Figure P1.2-3: Plane wall separating two fluids

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 m^2).

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.

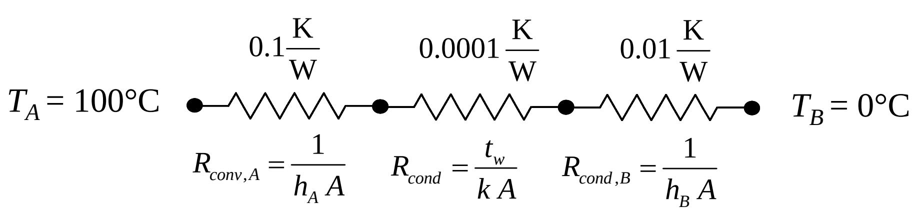

Figure 2: Thermal resistance network representing the wall.

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 $\overline{h}_A$ is the most important parameter and the others do not matter much.