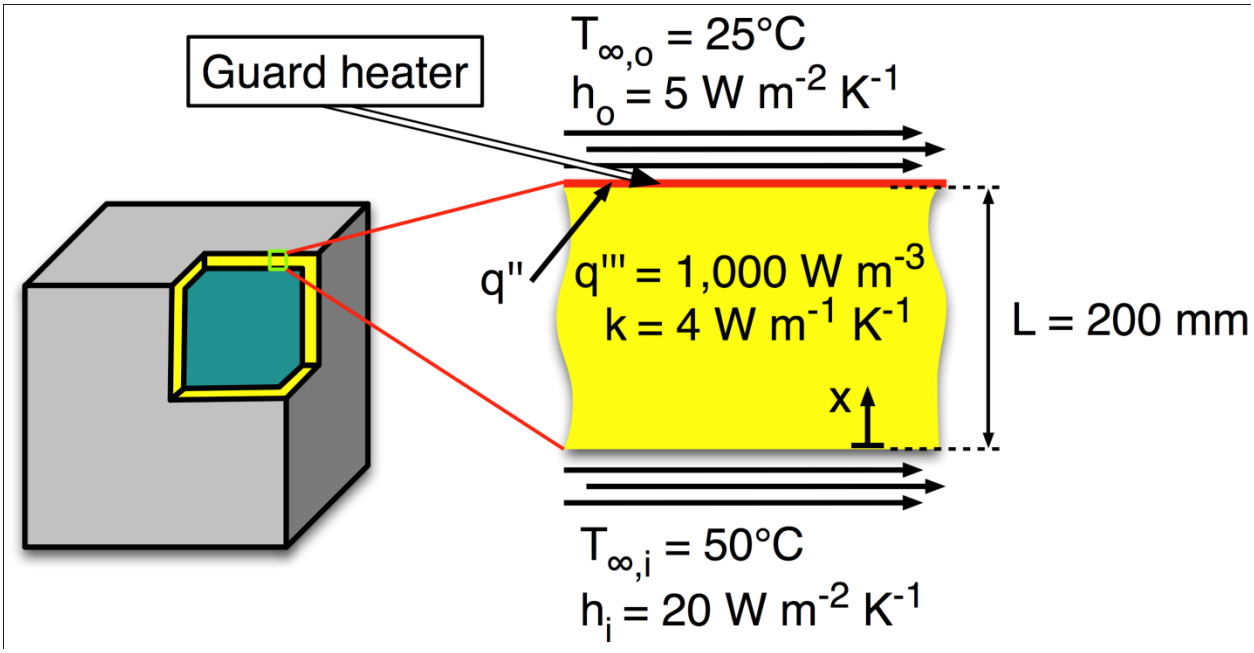
The walls of an experimental warming chamber are constructed from sheets of reactive material. In order to accurately simulate a well insulated system while permitting access during testing, the outside of the chamber is covered in very thin guard heater film so that all of the heat generated in the walls is transferred to the inside of the chamber. The air inside the chamber is maintained at $T_{\infty,i}$ = 50°C and flows over the chamber walls with h_i = 20 W m^{-2} K^{-1}. The air outside the chamber is maintained at $T_{\infty,o}$ = 25°C and flows over the chamber with h_o = 5 W m^{-2} K^{-1}. The reactive material is known to have a thermal conductivity of k = 4 W m^{-1} K^{-1}, and uniformly generates q''' = 1,000 W m^{-3} of heat during operation.



A. Assume that the guard heater film on the outside of the chamber ensures that all heat generated in the walls is transferred to the interior of the chamber. Sketch the temperature distribution from the bulk air inside the chamber to the bulk air flowing outside of the chamber on T-x coordinates.

B. Following the assumption of part A, what are the temperatures at the wall-to-interior ($T_{x=0}$) and wall-to-exterior ($T_{x=L}$) interfaces?

C. What heat flux q'' must be maintained in the guard heater film to ensure that all of the heat generated in the chamber walls is transferred to the interior of the chamber?

D. What will the steady-state wall-to-surroundings interface temperature be if the guard heater film continues to generate heat at the same rate as in part C after the wall reaction ceases.

E. In the commercialized warming chamber, the guard heaters will be replaced with sheets of polystyrene insulation (k_i = 0.03 W m^{-1} K^{-1}). How thick must the insulation be to ensure that 95% of the heat generated in the walls is transferred to the interior of the chamber? Assume the same convection coefficients and air temperatures as in the experimental system.