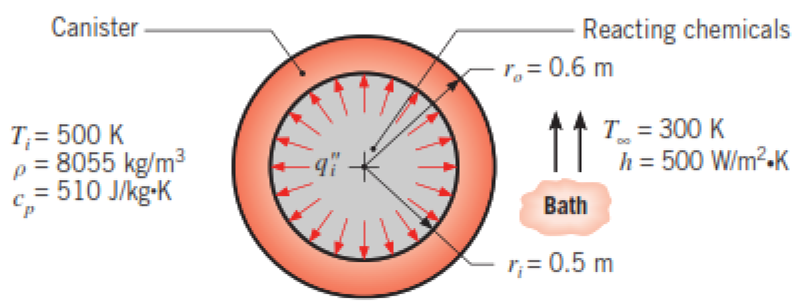
Cankaya University
Faculty of Engineering
Mechanical Engineering Department
ME 611 Advanced Conduction Heat Transfer
HW # 1

1.)

A spherical, stainless steel (AISI 302) canister is used to store reacting chemicals that provide for a uniform heat flux q_i'' to its inner surface. The canister is suddenly submerged in a liquid bath of temperature $T_\infty < T_i$, where T_i is the initial temperature of the canister wall.



(a) Assuming negligible temperature gradients in the canister wall and a constant heat flux q_i'', develop an equation that governs the variation of the wall temperature with time during the transient process. What is the initial rate of change of the wall temperature if $q_i'' = 10^5$ W/m^2?

(b) What is the steady-state temperature of the wall?

(c) The convection coefficient depends on the velocity associated with fluid flow over the canister and whether the wall temperature is large enough to induce boiling in the liquid. Compute and plot the steady-state temperature as a function of h for the range $100 \leq h \leq 10{,}000$ W/m$^2 \cdot$K. Is there a value of h below which operation would be unacceptable?

2.)

A photovoltaic panel of dimension $2\text{ m} \times 4\text{ m}$ is installed on the roof of a home. The panel is irradiated with a solar flux of $G_S = 700\text{ W/m}^2$, oriented normal to the top panel surface. The absorptivity of the panel to the solar irradiation is $\alpha_S = 0.83$, and the efficiency of conversion of the absorbed flux to electrical power is $\eta = P/\alpha_S G_S A = 0.553 - 0.001\text{ K}^{-1}T_p$, where T_p is the panel temperature expressed in kelvins and A is the solar panel area. Determine the electrical power generated for (a) a still summer day, in which $T_{sur} = T_\infty = 35°\text{C}$, $h = 10\text{ W/m}^2\cdot\text{K}$, and (b) a breezy winter day, for which $T_{sur} = T_\infty = -15°\text{C}$, $h = 30\text{ W/m}^2\cdot\text{K}$. The panel emissivity is $\varepsilon = 0.90$.