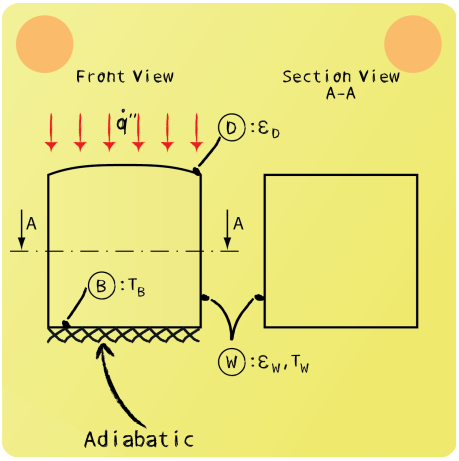
Exam Preparation Radiation 06

A hollow cube with an outwardly-curved top surface (dome) is located in an evacuated space. Radiation from a distant source falls on the top dome. The bottom is adiabatically insulated from the outside and has the temperature T_B. The wall temperature T_W is also known. Determine the temperature of the top dome T_D independently from the view factors.



Energy balance around the entire cube:

$$-\epsilon_\mathrm{D}\sigma A_\mathrm{D}T_\mathrm{D}^4 - \epsilon_\mathrm{W}\sigma A_\mathrm{W}T_\mathrm{W}^4 + \alpha_\mathrm{D}\dot{q}''A'_\mathrm{D} = 0$$

Rewriting yields (Note that the area A'_D that $\dot{q}''$ is projected on $A'_\mathrm{D} = A_\mathrm{B}$ and $\epsilon_\mathrm{D} = \alpha_\mathrm{D}$):

$$T_\mathrm{D} = \sqrt[4]{\frac{\epsilon_\mathrm{D}\dot{q}''A_\mathrm{B} - \epsilon_\mathrm{W}\sigma A_\mathrm{W}T_\mathrm{W}^4}{\epsilon_\mathrm{D}\sigma A_\mathrm{D}}}$$