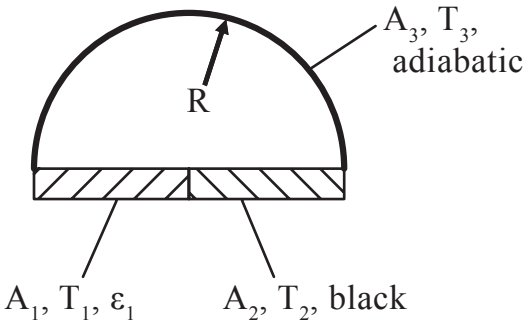
Cupola

Both semi-circular slabs A_1 and A_2 of the geometric configuration depicted below are conditioned to maintain a constant temperature of $T_1 = 150\,°\mathrm{C}$ and $T_2 = 20\,°\mathrm{C}$, respectively. Surface A_1 exhibits an emissivity of $\varepsilon_1 = 0.6$, surface A_2 can be considered a black body and the hemispherical surface A_3, situated above the slabs, of radius $R = 3\,\mathrm{m}$ is adiabatic. Surfaces A_1 and A_3 are grey bodies and emit difuse radiation. The hemispherical volume is submitted to a vacuum. All surfaces are intransparent to radiation.



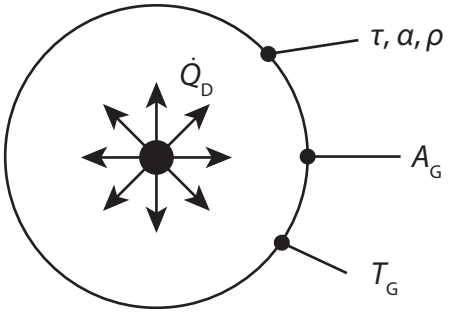
Tasks:

a) Compute the amount of heat transfered through radiation between the surfaces A_1 and A_2 (= net radiative flux through surface A_2).

b) Which temperature T_3 is obtained for surface A_3?

Light bulb

The filament of a light bulb emits diffuse radiation $\dot{Q}_{\mathrm{F}}$. The glass of the bulb is thin, spherical, and acts as a gray body. The surface of the filament is small in comparison to the glass body and the problem is steady in time.
Provide the energy balance for determining the glass temperature T_{G}, while neglecting radiation from the environment.

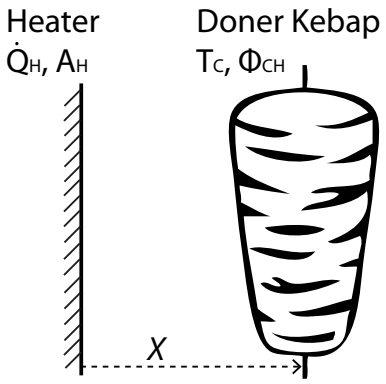


Given properties:

- Power consumption of the filament, $\dot{Q}_{\mathrm{F}}$
- Glass properties, τ, α, ρ
- Surface of the glass sphere, A_{G}

Doner Kebap

A perfectly cylindrical doner kebap is set to be grilled by means of a radiating electric heater. Determine the minimal distance x between the doner kebap and the electric heater so that the critical temperature T_C is not exceeded at the surface.



Given values:

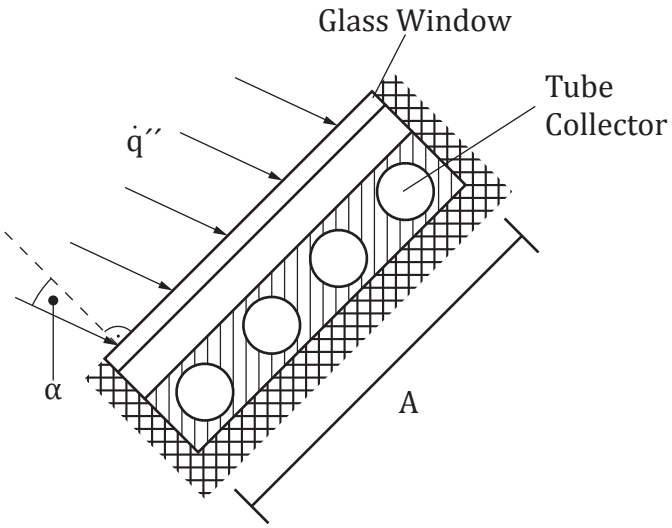
- Thermal radiation from the heater, $\dot{Q}_\mathrm{H}$
- View factor doner kebap, $\rightarrow$ heater $\Phi_\mathrm{DH} = a \exp(-bx)$
- Parameter for Φ_DH, a, b
- Radiating surface of the heater, A_H
- Critical temperature, T_C

Hints:

- Consider stationary conditions.
- Omit convection.
- The doner kebap has an isothermal surface.
- The doner kebap radiates as a grey body.
- Consider the electric heater to be a black body.
- Neglect effects from background/environment radiation.

Solar cell

A solar thermal collector with a lateral surface A, receives a radiation flux $\dot{q}''$ at an angle α. Water flows through the collector tubes with a mass flow rate $\dot{m}$ and it is heated from the inlet temperature T' to the outlet temperature T''. Determine the efficiency η of the thermal collector, and use the given numerical values to calculate the results.



Given values:

- A: 2m^2
- $\dot{q}''$: $1367\,{}^{\text{W}}/_{\text{m}^2}$
- α: $20\,^\circ$
- $\dot{m}$: $0.0145\,{}^{\text{kg}}/_{\text{s}}$
- c_p: $4.18\,{}^{\text{kJ}}/_{\text{kgK}}$
- T': $15\,^\circ\text{C}$
- T'': $55\,^\circ\text{C}$