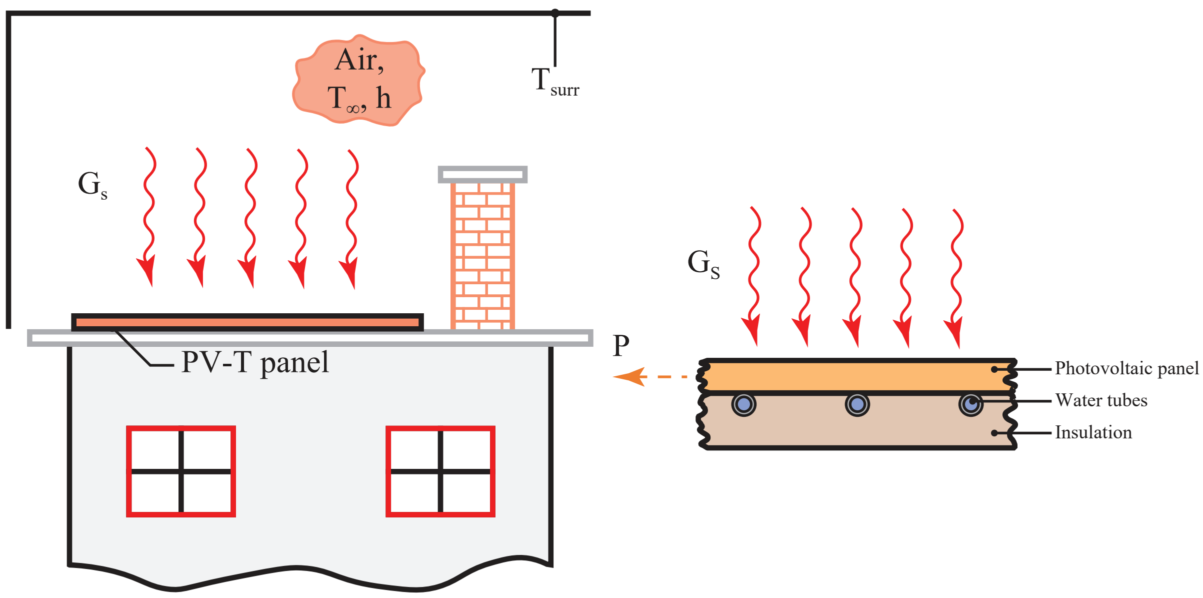
W06

A PV-T panel is a combined panel that operates simultaneously as a Photovoltaic (PV) panel and a solar thermal panel. A PV-T panel of dimension 3 m × 3 m is used to generate electricity and hot water by having water flow through tubes attached at the back of the Photovoltaic panel. The panel is irradiated with a solar flux of $G_S = 825\ \mathrm{W/m^2}$ with a surrounding temperature of $T_{surr} = 0\ ^{o}\mathrm{C}$. The absorptivity of the panel to the solar irradiation is $\alpha_S = 0.9$. The efficiency of conversion of the absorbed flux to electrical power is:

$$\eta = \frac{P}{\alpha_S \cdot G_S \cdot A} = 0.553 - 0.001 \cdot T_p$$

where T_p is the panel temperature expressed in Kelvins [K] and A is the solar panel area.



(a) PV-T panel located on the house

(b) Cross-section of the PV-T panel

Figure 9: Schematic of the situation

a) Consider a still summer day with an ambient temperature ($T_\infty = 25\ ^{o}\mathrm{C}$), where radiation exchange between the panel and its surroundings is negligible. The PV-T panel can be viewed as a horizontal plate, and a portion of the heat absorbed by the PV-T collector raises the water temperature from an inlet value (T_{in}) to an outlet temperature (T_{out}). The temperature increase of the water inside the tube is denoted as $\Delta T = T_{out} - T_{in} = 40\ ^{o}\mathrm{C}$). Determine the power generation from the panel, given a water flow rate of 28 g/s and a specific heat of 4.2 kJ/kg·K.

b) Determine the overall efficiency of the PV-T panel based on the scenario described in a).

c) In the scenario described in part a), with a panel having an emissivity (ϵ) of 0.9 for radiative heat emission, and in the absence of any pipes behind the PV panels for heat removal, calculate the power generated by the panel and determine the overall system efficiency. In this case, radiation exchange between the panel and its surroundings becomes significant.