Given:

Consider steady heat transfer through a 5 m by 7 m brick wall with a thickness of 30 cm. On on side of the wall, the room temperature of a house is 27°C; the outside temperature on the other side is 0°C. The temperature of the inner and outer surfaces are 20°C and 5°C, respectively, and the rate of heat transfer is measured to be 1035 W.

$$\begin{array}{lll} h:=5~\text{m} & w:=7~\text{m} & t:=30~\text{cm} \\ & & & \\ T_{room}:=27~^{\circ}\text{C} & & & \\ T_{outside}:=0~^{\circ}\text{C} & & \\ & & & \\ T_{inner}:=20~^{\circ}\text{C} & & & \\ T_{outer}:=5~^{\circ}\text{C} & & & \\ Q':=1035~\text{W} & & \\ \end{array}$$

Required:

Deteremine the rate of entropy generation in the wall and the rate of total entropy generation associated with the heat transfer process.

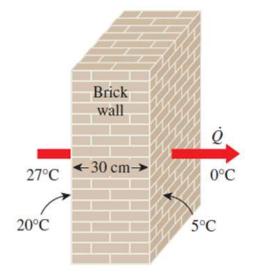
Solution:

Starting with an entropy balance with no mass transfer shows

$$\frac{d}{dt} S_{sys} = \Sigma S'_{in} - \Sigma S'_{out} + S'_{gen}$$

$$0 = \Sigma S'_{in} - \Sigma S'_{out} + S'_{gen}$$

$$S'_{gen} = \Sigma S'_{out} - \Sigma S'_{in}$$



The entropy rate in and out are determined by the heat transfer at the particular boundaries so

$$S'_{gen} := \frac{Q'}{T_{outer}} - \frac{Q'}{T_{inner}} = 0.1904 \frac{W}{K}$$

To determine the rate of entropy generation for the entire process, the process can be repeated but with a change of boundaries. Starting with an entropy balance with no mass transfer shows

$$\frac{d}{dt}S_{sys} = \Sigma S'_{in} - \Sigma S'_{out} + S'_{gen}$$

$$0 = \Sigma S'_{in} - \Sigma S'_{out} + S'_{gen}$$

$$S'_{gen} = \Sigma S'_{out} - \Sigma S'_{in}$$

The entropy rate in and out are determined by the heat transfer at the particular boundaries so

$$S'_{gen} := \frac{Q'}{T_{outside}} - \frac{Q'}{T_{room}} = 0.3409 \frac{W}{K}$$