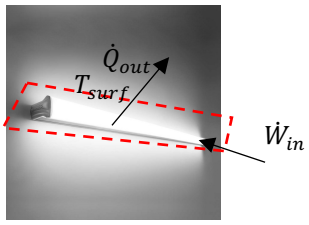
Approximately 80% of the energy into a 40 W fluorescent tube light is radiated as heat. The surface temperature of the bulb is 50 ºC. Calculate the rate of entropy production for this light bulb.

SOLUTION:



Apply the Entropy Equation to the control volume shown in the figure,

$$\frac{dS_{CV}}{dt} = \sum_{in} \dot{m}s - \sum_{out} \dot{m}s + \int_b \frac{\delta \dot{Q}_{in}}{T} + \dot{\sigma}, \quad (1)$$

where,

$$\frac{dS_{CV}}{dt} = 0 \quad \text{(assuming steady state operation)}, \quad (2)$$

$$\sum_{in} \dot{m}s - \sum_{out} \dot{m}s = 0 \quad \text{(no inlet or outlet)}, \quad (3)$$

$$\int_b \frac{\delta \dot{Q}_{in}}{T} = -\frac{\dot{Q}_{out}}{T_{surf}}, \quad (4)$$

$$\dot{\sigma} = ?, \quad (5)$$

Substitute and solve for the rate of entropy production,

$$0 = -\frac{\dot{Q}_{out}}{T_{surf}} + \dot{\sigma}, \quad (6)$$

$$\dot{\sigma} = \frac{\dot{Q}_{out}}{T_{surf}}. \quad (7)$$

Using the given data,

$\dot{Q}_{out} = 0.80\dot{W}_{in}$ = (0.80)(40 W) = 32 W,

T_{surf} = 50 ºC = 323 K,

⇨ $\boxed{\dot{\sigma} = 0.0990 \text{ W/K}}$.