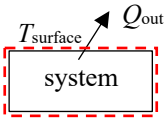
During a process involving a 1 kg mass of material, 9000 J of heat leaves the system and enters the surroundings. The temperature at the surface of the system is 300 K. Determine if the process is internally reversible, internally irreversible, or impossible for the following conditions:

a. The change in the specific entropy of the system is -30.0 J/(kg.K).
b. The change in the specific entropy of the system is -20.0 J/(kg.K).
c. The change in the specific entropy of the system is -40.0 J/(kg.K).

SOLUTION:



The Entropy Equation applied to the control volume shown in the figure,

$$\Delta S = \int_b \frac{\delta Q_{into}}{T} + \sigma \Rightarrow \frac{\sigma}{m} = \Delta s + \frac{1}{m}\frac{Q_{out}}{T_{surf}}. \qquad (1)$$

We're given that m = 1 kg, Q_{out} = 9000 J, and T_{surf} = 300 K. Now consider the different cases,

a. $\frac{\sigma}{m} = -30.0\ \frac{\text{J}}{\text{kg.K}} + \frac{1}{(1\text{ kg})}\frac{(9000\text{ J})}{(300\text{ K})} = 0 \Rightarrow$ This process is internally reversible.

b. $\frac{\sigma}{m} = -20.0\ \frac{\text{J}}{\text{kg.K}} + \frac{1}{(1\text{ kg})}\frac{(9000\text{ J})}{(300\text{ K})} = 10.0\ \frac{\text{J}}{\text{kg.K}} \Rightarrow$ This process is internally irreversible.

c. $\frac{\sigma}{m} = -40.0\ \frac{\text{J}}{\text{kg.K}} + \frac{1}{(1\text{ kg})}\frac{(9000\text{ J})}{(300\text{ K})} = -10.0\ \frac{\text{J}}{\text{kg.K}} \Rightarrow$ This process is impossible.