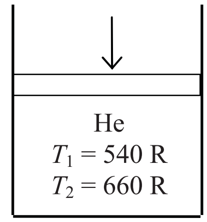
8-91E A fixed mass of helium undergoes a process from one specified state to another specified state. The entropy change of helium is to be determined for the cases of reversible and irreversible processes.

Assumptions **1** At specified conditions, helium can be treated as an ideal gas. **2** Helium has constant specific heats at room temperature.

Properties The gas constant of helium is R = 0.4961 Btu/lbm.R (Table A-1E). The constant volume specific heat of helium is c_v = 0.753 Btu/lbm.R (Table A-2E).



Analysis From the ideal-gas entropy change relation,

$$\Delta S_{\rm He} = m\left(c_{v,\rm ave}\ln\frac{T_2}{T_1} + R\ln\frac{v_2}{v_1}\right)$$
$$= (15\ \text{lbm})\left((0.753\ \text{Btu/lbm}\cdot\text{R})\ln\frac{660\ \text{R}}{540\ \text{R}} + (0.4961\ \text{Btu/lbm}\cdot\text{R})\ln\left(\frac{10\ \text{ft}^3/\text{lbm}}{50\ \text{ft}^3/\text{lbm}}\right)\right)$$
$$= \mathbf{-9.71\ Btu/R}$$

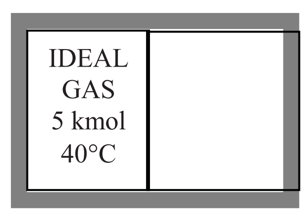
The entropy change will be the same for both cases.

8-92 One side of a partitioned insulated rigid tank contains an ideal gas at a specified temperature and pressure while the other side is evacuated. The partition is removed, and the gas fills the entire tank. The total entropy change during this process is to be determined.

Assumptions The gas in the tank is given to be an ideal gas, and thus ideal gas relations apply.

Analysis Taking the entire rigid tank as the system, the energy balance can be expressed as

$$\underbrace{E_{\rm in} - E_{\rm out}}_{\substack{\text{Net energy transfer}\\ \text{by heat, work, and mass}}} = \underbrace{\Delta E_{\rm system}}_{\substack{\text{Change in internal, kinetic,}\\ \text{potential, etc. energies}}}$$
$$0 = \Delta U = m(u_2 - u_1)$$
$$u_2 = u_1$$
$$T_2 = T_1$$



since $u = u(T)$ for an ideal gas. Then the entropy change of the gas becomes

$$\Delta S = N\left(\bar{c}_{v,\rm avg}\ln\frac{T_2}{T_1}^{\nearrow 0} + R_u\ln\frac{V_2}{V_1}\right) = NR_u\ln\frac{V_2}{V_1}$$
$$= (5\ \text{kmol})(8.314\ \text{kJ/kmol}\cdot\text{K})\ln(2)$$
$$= \mathbf{28.81\ kJ/K}$$

This also represents the **total entropy change** since the tank does not contain anything else, and there are no interactions with the surroundings.