CH365 Chemical Engineering Thermodynamics

Lesson 23
Calculation of Entropy and Entropy Changes for an Ideal Gas

BONUS OP

Chemical Engineering Plebe Majors Fair

22 OCT 2025 from ~1220 to ~1350
Thayer Hall Room 336, 368, or 370[1]

30 minutes = 5 points[2]
Max 1.5 hours (15 points)

Notes:
1. We will only occupy one room.
2. Sign in and out on the provided roster with time in and time out. Interact with prospective cadets and answer questions. Stay active. Try not to congregate in “friends” clusters.

Summary of Section 5.4

There exists a property called entropy S, which is an intrinsic property of a system, functionally related to the measurable coordinates characterizing the system. For a reversible process, changes in this property are given by Eq. 5.1.

$$dS^t = \frac{dQ_{rev}}{T} \qquad \text{Eq. 5.1} \qquad \text{(Axiom to 2}^{nd}\text{ Law)}$$

The change in entropy for any system undergoing a finite reversible process is:

$$\Delta S^t = \int \frac{dQ_{rev}}{T} \qquad \text{Integral of Eq. 5.1}$$

When a system undergoes an irreversible process between two equilibrium states, the irreversible path cannot be directly integrated. The entropy change of the system is evaluated by integrating Eq. 5.1 along an arbitrarily chosen reversible process that accomplishes the same change of state as the actual process. Because entropy is a state function, the entropy changes of the irreversible and reversible processes are identical.

Independent of Path – State Function

Entropy Changes for an Ideal Gas

Integrated Forms

$$ICPS = \int_{T_0}^{T} \frac{C_P^{ig}}{R} \frac{dT}{T} = A \cdot \ln \frac{T}{T_0} + \left[B + \left(C + \frac{D}{T_0^2 T^2} \right) \cdot \left(\frac{T + T_0}{2} \right) \right] \cdot (T - T_0)$$

Eq. 5.11

$$MCPS = \frac{\langle C_P^{ig} \rangle_S}{R} = A + \left[B + \left(C + \frac{D}{T_0^2 T^2} \right) \cdot \left(\frac{T + T_0}{2} \right) \right] \cdot \left(\frac{T - T_0}{\ln(T / T_0)} \right)$$

Eq. 5.13

where $$\langle C_P^{ig} \rangle_S = \frac{\int_{T_0}^{T} C_P^{ig} dT / T}{\ln(T / T_0)}$$

Eq. 5.12

$$\frac{\Delta S}{R} = \int_{T_0}^{T} \frac{C_P^{ig}}{R} \frac{dT}{T} - \ln \frac{P}{P_0}$$

Eq. 5.10

$$\frac{\Delta S}{R} = ICPS - \ln \frac{P}{P_0}$$

$$\frac{\Delta S}{R} = MCPS \cdot \ln\left(\frac{T}{T_0} \right) - \ln \frac{P}{P_0}$$

Eq. 5.14

Example 5.4

Methane gas at 550 K and 5 bar undergoes a reversible adiabatic expansion to 1 bar. Assuming methane to be an ideal gas at these conditions, find its final temperature.

Example 5.4

Questions