

Faz dönüşümlerinin termodinamiği

G = serbest entalpi

$$G = f(T, P)$$

$\alpha \rightleftharpoons \beta$ faz dönüşümü için

$\mu_\alpha = \mu_\beta$, $T_\alpha = T_\beta$ ve $P_\alpha = P_\beta = P$ (fazlar arası denge koşulları)

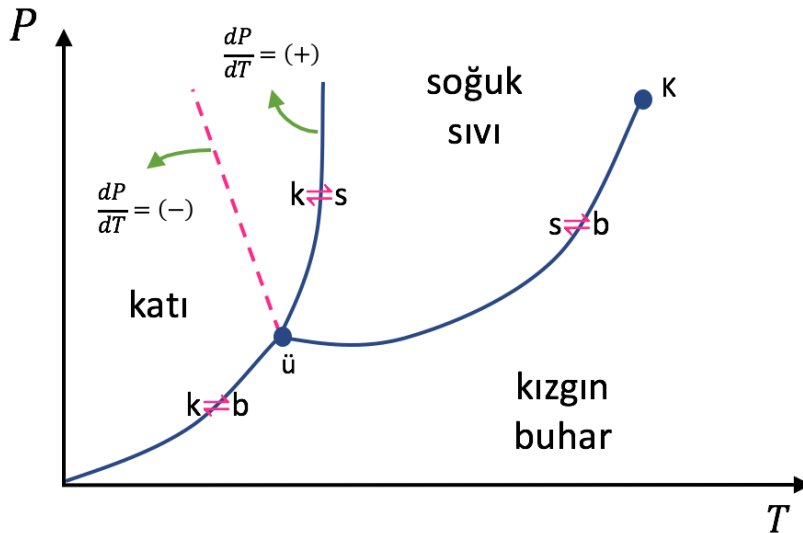
$$dG = -SdT + VdP$$

α fazı için $dG_\alpha = -S_\alpha dT + V_\alpha dP$

β fazı için $dG_\beta = -S_\beta dT + V_\beta dP$

$$\frac{dP}{dT} = \frac{S_\beta - S_\alpha}{V_\beta - V_\alpha} = \frac{\Delta S_{\alpha\beta}}{V_\beta - V_\alpha} = \frac{\Delta H_{\alpha\beta}}{T(V_\beta - V_\alpha)} = \frac{\Delta H_{\alpha\beta}}{T \Delta V_{\alpha\beta}}$$

**Clapeyron
Denklemi**



$$V_s > V_k \Rightarrow \frac{dP}{dT} = (+)$$

(genelde)

$$V_s < V_k \Rightarrow \frac{dP}{dT} = (-)$$

(su ve bizmut)

$$H = U + PV$$

$$U = H - PV$$

α ve β fazları için

$$U_\beta - U_\alpha = (H_\beta - H_\alpha) - P(V_\beta - V_\alpha)$$

$$\Delta U_{\alpha\beta} = \Delta H_{\alpha\beta} - P\Delta v_{\alpha\beta}$$

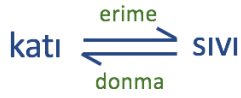
$$\left[\frac{\partial(G/T)}{\partial T} \right]_P = -\frac{H}{T^2} \quad \text{Gibbs-Hemholtz Denklemi}$$

$$\left[\frac{\partial(G_\beta - G_\alpha)/T}{\partial T} \right]_P = -\frac{H_\beta - H_\alpha}{T^2}$$

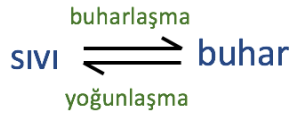
$$\left[\frac{\partial(\Delta G_{\alpha\beta}/T)}{\partial T} \right]_P = -\frac{\Delta H_{\alpha\beta}}{T^2}$$

$$\left[\frac{\partial \Delta G_{\alpha\beta}}{\partial T} \right]_P = -\frac{\Delta H_{\alpha\beta}}{T}$$

$$\left[\frac{\partial \Delta G_{\alpha\beta}}{\partial T} \right]_P = -\Delta S_{\alpha\beta}$$



$$\frac{dP}{dT} = \frac{\Delta S_{ks}}{\Delta V_{ks}} = \frac{\Delta H_{ks}}{T(V_s - V_k)} = \frac{\Delta H_e}{T(V_s - V_k)}; \quad T = \text{sabit}$$



$$\frac{d \ln P}{dT} = \frac{\Delta H_{sb}}{RT^2} \quad \text{Clausius-Clapeyron Denklemi}$$

$$\ln P = -\frac{\Delta H_{sb}}{RT} + c$$

$$\ln \frac{P_2}{P_1} = -\frac{\Delta H_{sb}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\Delta S_{sb} = \frac{\Delta H_{sb}}{T} \approx 88 \frac{J}{\text{mol K}} \approx 21 \frac{\text{cal}}{\text{mol K}}$$

$$\Delta H_{sb} = 88T_b \quad \text{Trouton Kuralı}$$

Sıvılar için Trouton kuralına göre buharlaşma entropisi yaklaşık 88J/molK'dir. Ancak moleküller arasındaki etkileşimler (kuvvetler) nedeniyle bazı sıvılarda sapma görülür.

katı $\xrightarrow{\text{süblimleşme}}$ buhar

$$\Delta H_{\text{süb}} = \Delta H_e + \Delta H_{sb}$$

$$\Delta S_{\text{süb}} = \Delta S_e + \Delta S_{sb}$$

$$\frac{d \ln P}{dT} \cong \frac{\Delta H_{\text{süb}}}{RT^2} \quad \text{Clausius-Clapeyron Denklemi}$$

$$\ln P = -\frac{\Delta H_{\text{süb}}}{RT} + c$$

$$\ln \frac{P_2}{P_1} = -\frac{\Delta H_{\text{süb}}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

Üçlü Noktanın Koordinatlarını Bulmak İçin;

$$\ln P = -\frac{\Delta H_{\text{süb}}}{RT} + c_{\text{süb}}$$

$$\ln P = -\frac{\Delta H_{sb}}{RT} + c_{buh}$$

Denklemlerinin ortak çözümünden $P_{\ddot{u}}$ ve $T_{\ddot{u}} = ?$

$$\Delta H_e = ? \implies \Delta H_e = \Delta H_{\text{süb}} - \Delta H_{buh}$$

$$\Delta S_e = ? \implies \Delta S_e = \Delta S_{\text{süb}} - \Delta S_{buh}$$