Phase transformation

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$$G = \Sigma \mu_i X_i = \mu_A X_A + \mu_B X_B$$

$$G = X_A G_A + X_B G_B + RT(X_A \ln X_A + X_B \ln X_B) + L X_A X_B$$

$$= X_A G_A + X_B G_B + RT(X_A \ln X_A) + RT X_B \ln X_B + L X_A X_B \underbrace{(X_A + X_B)}_{=1}$$

$$= X_A (G_A + RT \ln X_A + L X_B^2) + X_B (G_B + RT \ln X_B + L X_A^2)$$

$$\therefore \mu_A = G_A + RT \ln X_A + L X_B^2$$

$$\mu_B = G_B + RT \ln X_B + L X_A^2$$

$$\mu_A = G_A + RT \ln a_A \qquad \mu_B = G_B + RT \ln a_B$$

$$RT \ln a_A = RT \ln X_A + L X_B^2 \Rightarrow RT \ln\left(\frac{a_A}{X_A}\right) = L(1-X_B)^2 = RT \ln \gamma_A$$

$$RT \ln a_B = RT \ln X_B + L X_A^2. \Rightarrow RT \ln\left(\frac{a_B}{X_B}\right) = L(1-X_A)^2 = RT \ln \gamma_B$$

$$\gamma_A = \exp\left(\frac{L}{RT}(1-X_A)^2\right) \qquad \gamma_B = \exp\left(\frac{L}{RT}(1-X_B)^2\right)$$

상평형일때 두상의 공통접선이므로

$$\mu_A^{\alpha} = \mu_A^{\beta} \Leftrightarrow G_A^{\circ}(\alpha) + RT \ln a_A^{\alpha} = G_A^{\circ}(\beta) + RT \ln a_A^{\beta}$$

i) ref $A=\alpha$ ref $B=\beta$.

$$-\Delta G_{m,A} + RT\ln a_{A,\beta} = RT\ln a_{A,\alpha}$$

$$\Delta G_{m,B} + RT\ln a_{B,\alpha} = RT\ln a_{B,\beta}$$

$$-\Delta G_{m,A} + \Delta G_{m,B} = RT\ln\left(\frac{a_{A\alpha}\cdot a_{B\beta}}{a_{A,\beta}\cdot a_{B\alpha}}\right) \quad \cdots (1)$$

ii) ref $A=\alpha$ ref $B=\alpha$

$$-\Delta G_{m,A} + RT\ln a_{A,\beta} = RT\ln a_{A,\alpha}$$

$$\Delta G_{m B} + RT\ln a_{B\alpha} = RT\ln a_{B\beta}$$

$$-\Delta G_{m A} + \Delta G_{m B} = RT\ln\left(\frac{a_{A\alpha}\cdot a_{B\beta}}{a_{A\beta}\cdot a_{B\alpha}}\right) \quad \cdots (2)$$

equations (1) and (2) are exactly same.

$\therefore$ The equilibrium composition is regardless of reference state.