3.020 – Thermodynamics of Materials Recitation 5

Problem 1

Zinc-Aluminum alloys are high performance alloys that exhibit good strength, corrosion resistance and hardness. At a temperature of 477 °C, the activity coefficient of Zinc (γ_{Zn}) in the Zn-Al alloy is given by the following equation:

$$RT \ln \gamma_{Zn} = 7233(1 - X_{Zn})^2 \qquad (J/mol)$$

a) Write down the expression of the activity of Zinc (a_{Zn}) as a function of the composition (X_{Zn}).

b) Calculate a_{Zn} at $X_{Zn} = 0.4$. Compare the result with X_{Zn}, what does this mean?

c) Calculate the slope of $a_{Zn}(X_{Zn})$ at $X_{Zn} = 1$. Link this result with the law of Raoult. Does this solution apply to Raoult's law of the solvent?

d) Calculate the slope of $a_{Zn}(X_{Zn})$ at $X_{Zn} = 0$. Link this result with the law of Henry. How does this solution apply to Henry's law of the solute?

e) Draw the $a_{Zn}(X_{Zn})$ graph using the information calculated above in (b-c-d). (You can verify your plot with the expression found in (a).)

f) Use Gibbs-Duhem integration to derive an expression of the activity coefficient of Aluminum (γ_{Al}) as a function of the composition (X_{Al}).

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