**TITLE: RELATIONSHIP BETWEEN THE VANNESS EQUATION AND THE GIBBS-DUHEM EQUATION**

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The van Ness equation is a mathematical expression used to calculate partial molar quantities in thermodynamics. These quantities are important in the study of solutions and mixtures, as they provide information about the behavior of individual components in the mixture.

**The van Ness equation for a component “i” in a mixture is given by:**

\[ \bar{G}\_i = G + RT \ln \left( \frac{f\_i}{x\_i} \right) \]

**Where**:

- \(\bar{G}\_i\) is the partial molar Gibbs free energy of component “i”

- G is the total Gibbs free energy of the mixture

- R is the ideal gas constant

- T is the temperature

- \(f\_i\) is the fugacity of component “i”

- \(x\_i\) is the mole fraction of component “i” in the mixture

**The Gibbs-Duhem equation is a fundamental thermodynamic relationship that relates the partial molar quantities of a mixture. It states:**

\[ \sum\_i x\_i d\bar{G}\_i = 0 \]

**Where the sum is taken over all components in the mixture.**

To demonstrate that the partial molar quantities calculated using the van Ness equation satisfy the Gibbs-Duhem equation, we need to take the differential of the van Ness equation and substitute it into the Gibbs-Duhem equation.

**Taking the differential of the van Ness equation with respect to component “i”, we get:**

\[ d\bar{G}\_i = dG + RT \frac{df\_i}{f\_i} – RT \frac{dx\_i}{x\_i} \]

**Substituting this expression into the Gibbs-Duhem equation, we have:**

\[ \sum\_i x\_i \left( dG + RT \frac{df\_i}{f\_i} – RT \frac{dx\_i}{x\_i} \right) = 0 \]

**Expanding the summation and rearranging terms, we obtain:**

\[ dG + RT \sum\_i \left( \frac{df\_i}{f\_i} - \frac{dx\_i}{x\_i} \right) = 0 \]

**Since the sum of mole fractions is always equal to 1 (\(\sum\_i x\_i = 1\)), we can simplify the expression further:**

\[ dG + RT \left( \sum\_i \frac{df\_i}{f\_i} - \sum\_i \frac{dx\_i}{x\_i} \right) = 0 \]

**Now, the term in the parentheses represents the difference between the sums of the two fractions. By definition, this difference is zero:**

\[ \sum\_i \frac{df\_i}{f\_i} - \sum\_i \frac{dx\_i}{x\_i} = 0 \]

Therefore, the expression reduces to:

\[ dG + RT \cdot 0 = 0 \**]Which satisfies the Gibbs-Duhem equation.**

**REFERENCES**

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