**Relationship between Van Ness equation and The Gibbs duhem equation in calculation of molar quantities.**

The Gibbs-Duhem equation relates the partial molar quantities of a mixture to its overall composition. In mathematical form, it is:

∑i=1n xi dμi = 0

where xi is the mole fraction of component i in the mixture, μi is the chemical potential of component i, and n is the number of components in the mixture.

The Van Ness equation expresses the excess Gibbs free energy of mixing of a binary mixture as a function of the mole fractions of the two components, x1 and x2:

GE = RT[x1lnx1 + x2lnx2 + x1x2(A21 + A12)]

where R is the gas constant, T is the temperature, and A21 and A12 are the interaction parameters between components 1 and 2 in the mixture.

To derive the partial molar quantities from the Van Ness equation, we first differentiate it with respect to the mole fraction of component 1, holding the mole fraction of component 2 constant:

dGE/dx1 = RT[lnx1 + 1 + x2(A21 + A12)]

Taking the derivative of this expression with respect to x2, holding x1 constant, we get:

d^2GE/dx1dx2 = RT(A21 + A12)

This expression gives us the second partial derivative of the excess Gibbs free energy with respect to the mole fractions of the two components, which is related to the partial molar quantities through the following equation:

d^2GE/dx1dx2 = -x1x2(μ12 - μ1 - μ2)

where μ12 is the partial molar Gibbs free energy of mixing, and μ1 and μ2 are the partial molar Gibbs free energies of the pure components.

Substituting the expression for the second partial derivative of GE from the Van Ness equation into the equation relating it to the partial molar quantities, we get:

RT(A21 + A12) = -x1x2(μ12 - μ1 - μ2)

Dividing both sides by RT and rearranging, we get:

μ12 = x2(μ1 - μ12) + x1(μ2 - μ12) + x1x2(A21 + A12)

This expression gives us the partial molar Gibbs free energy of mixing, μ12, in terms of the partial molar Gibbs free energies of the pure components and the interaction parameters between them. We can now substitute this expression into the Gibbs-Duhem equation to show that it is satisfied by the partial molar quantities calculated from the Van Ness equation:

∑i=1n xi dμi = x1dμ1 + x2dμ2 + x1x2dμ12

Using the expression for μ12 derived from the Van Ness equation and differentiating with respect to x1, holding x2 constant, we get:

dμ12/dx1 = (μ1 - μ12) - x2(A21 + A12)

Substituting this expression into the Gibbs-Duhem equation and simplifying, we get:

x1dμ1 + x2dμ2 + x1x2(μ1 - μ12) - x1x2(μ1 - μ12) - x1x2x2(A21 + A12) = 0

which reduces to:

x1dμ1 + x2d