Liquid Volume Fraction Model for Vapor-Liquid Surface Tension Data for the Binary Mixtures {Ar + Kr} and {CH4 + Kr}

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A simple, unique method to correlate vapor-liquid surface tension data for binary mixtures of {Ar + Kr} and {CH_4 + Kr} is presented. For both mixtures, the data of Holcomb and Zollweg[1] are along eight isotherms that cover the liquid-vapor coexistence region below the critical pressures of each component. These data are correlated within their estimated experimental uncertainty of (0.2 x 10^{-3} N/m) along paths of fixed overall composition for component one (X_1) for which the liquid volume fraction (LVF) is fixed at a value of one-half (1/2) to assure access to the critical line of the mixture[2]. This approach is motivated by the Van Poolen phase rule[3] that accounts for system-intensive variables along with the phase-intensive variables of the Gibbs phase rule. The degrees of freedom given by the Van Poolen phase rule ($^o f = \{C + 1\}$ where C is number of components) is in this case = 3. In addition to the two system-intensive variables, X_1 and LVF = ½, the third variable is the phase-intensive variable temperature (T). Similar surface tension data of Nadler, et al.[4], for the mixture {Ar + Kr} are also correlated using this method. The correlations of the two separate data sets indicate an offset of 0.1 x 10^{-3} N/m between them -- a value within experimental uncertainty. Mixture surface tension (σ) is represented by the equation (from the theory of critical behavior):

$$\sigma = \sigma_o \left[(T_c - T) / T_c \right]^{\mu},$$

where σ_o is the surface tension coefficient and T_c is the critical temperature both given as a function of X_1 (for which LVF = ½), and μ is the non-classical scaling exponent = 1.26. The equations for σ_o and T_c each required one fitted constant. This equation correlates the surface tension data removed from the critical region while allowing for estimation of two-phase, binary-mixture surface tension in the critical region for which data were not available.

[1] C.D. Holcomb and J.A. Zollweg, *Fluid Phase Equilibria*, **75** 213 (1992).
[2] L.J. Van Poolen, C.D. Holcomb, and J.C. Rainwater, *Industrial and Engineering Chemistry Research*, **40** 4610 (2001).
[3] L.J. Van Poolen, *Fluid Phase Equilibria*, **58** 133 (1990).
[4] K.C. Nadler, J.A. Zollweg, W.B. Street and I.A. McLure, *Journal of Colloid and Interface Science,* **122** (2) 530 (1988).