Equations of Liquid-Vapor Equilibrium in Binary Mixtures of Krypton with Air Components

Aleksandr Vasserman [C] and Vitaliy Galkin
Ship`s Mechanical Faculty Chair of Ship's Power Plants, Odessa National Maritime University, Odessa, Ukraine
avas@paco.net

Ilmutdin Abdulagatov [S]
Applied Chemicals and Materials Division, NIST, Boulder, CO, U.S.A.

For binary mixtures dependence of coexisting phases, pressure from temperature and composition is determined by the correlation between temperature of mixture and critical temperatures of components. To calculate the liquid and vapor pressures at phase equilibrium at temperatures below the critical temperatures of components we used the equation:

$$p' = p_a + (p_{s1}-p_{s2})\sum M'_k x^{ik}(1-x)^{jk}T^{lk},$$

where p' is liquid pressure, p_a is linear combination of the saturation pressures of components, p_{s2} and p_{s1} are saturation pressures of components with low and high boiling points, x is molar concentration of a low–boiling point component in liquid phase, T is absolute temperature, M'_k are coefficients of equations. Equation for vapor pressure p'' has an identical form with coefficients M'' and concentration y. Equation satisfies limiting conditions: $p_{mix} \rightarrow p_{s1}$ at $x \rightarrow 0$and $y \rightarrow 0$ and $p_{mix} \rightarrow p_{s2}$ at $x \rightarrow 1$and $y \rightarrow 1$. The effectiveness of equation was verified using experimental data for mixtures krypton-nitrogen (40 points, T=100-125 K, p=0.13-1.45 MPa), krypton-oxygen (122 points, T=84-148 K, p=0.068-0.69 MPa) and krypton-argon (199 points, T=90-149 K, p=0.023-4.4 MPa). Pressures of components and values p_a were calculated from exact equations for vaporization curves. Coefficients M_k were determined by least squares method, number of coefficients was 2- 4. Root-mean-square deviations $\delta p'$ and $\delta p''$ of experimental data from calculated are 2.98-4.09 %. The obtained equations allow to define third parameter of phase equilibrium if other two are known. Calculated values of x, y, T' andT'' showed good agreement with experimental data. Root-mean-square deviations Δx, Δy, $\Delta T'$ and $\Delta T''$ of experimental data from calculated are respectively 0.010-0.024, 0.013-0.024, 0.412-0.503 K, 0.484-0.607 K. Thus, used equation is suitable for describing phase equilibrium in binary mixtures at temperatures below the critical temperatures of components.