Description of Singular Part of Thermal Conductivity on Base of Corresponding States Law

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Singular part of thermal conductivity in a broad vicinity of critical point can be described by a relationship [1]

$$\lambda_s = \Lambda \cdot X^{-\psi} \cdot \cos\theta,$$

where

$$X = t + |\gamma|^{u\beta}, \qquad = \gamma \frac{3}{2B}[\omega + (B - 1) \cdot t] \qquad \theta = \arctan \frac{Y}{X^{\beta}}$$

$$t = (T - T_c)/T_c, \qquad \omega = (\rho - \rho_c)/\rho_c, \qquad \beta = 0.323, \ \psi = 0.646.$$

In spite of some weakness this relationship has an important advantage - it contains only two individual constants apart from critical temperature T_c and critical density ρ_c. Dimensionless constant B are functions of $z_c = P_c \ V_c / (R \cdot T_c)$ [1]. According to one parameter corresponding states low Λ/λ must be function of z_c too,

$$\lambda^* = \left(\frac{R^3 T_c}{M}\right)^{1/2} / (N_A V_c)^{1/3},$$

where R, N_A, V_c, M are the universal gas constant, the Avogadro number, critical molar volume, and molar mass, respectively.

On basis of experimental data for thermal conductivity of H_2O, O_2, CO_2, Ar, n-C_4H_{10} in critical region we established the correlation $\Lambda/\lambda^* \approx 0.59 - 1.27 \cdot z_c$. This relation provides a way of estimating a singular part of thermal conductivity on base of values T_c, ρ_c, and z_c.

[1] L.P. Phylippov, “Calculation and Prediction Methods for Substance Properties,” Moscow, Moscow State University (1988).