Van der Waals Transport Equations of State for the Continuity of Gaseous-Liquid States of Viscosity and Thermal Conductivity

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According to the review of liquid viscosity by Brush (1962), "there is no general agreement on whether viscosity is essentially due to the attractive and repulsive forces," but on macroscopic scale both viscosity and density are function of the thermodynamic equilibrium state of the fluid (so, both surrender to the Law of Corresponding States) while on micro-scale both properties reflect the effects of molecular motion and interaction. As the efforts on the correlation, prediction, estimation and statistical computation of transport properties have lag behind the efforts on the experimental measurements of transport properties, the methodology of the Van der Waals Transport Equation of State may provide another aspect of predicting and estimating gas and liquid transport properties for pure substances and mixtures by linkage to accurate cubic equation of state for the coexistence gas-liquid densities. Agreeing to the hypothesis articulated by Phillips (1927) and later improvements by Little-Kennedy (1966) and Lawal (1986), a method is established for predicting dynamic viscosity (η) and thermal conductivity (λ) over the entire PVT states of single-phase fluids for such substances as polar and nonpolar, inert gases (argon, helium, xenon), hydrocarbon, non-hydrocarbon (nitrogen, carbon dioxide, hydrogen sulfide) and petroleum and high-molecular-weight fluids. By using the 1986 formalism of the Van der Waals Transport Equation of State (VTEOS) development and on the basis of the phenomenological similarity between PVT and $T\eta P$ (or $T\lambda P$) spinodal graphs, accurate coexistence gas-liquid transport properties from dilute-gas to dense and supercritical fluids are predicted without resorting to the judicious choice of liquid density correlation or any volumetric or transport properties. The recently reformed four-parameter cubic equation of state which is valid over the entire PVT states, include the vapor-liquid critical point is used in the development of the VTEOS. The prediction of accurate dynamic viscosity and accurate thermal conductivity demonstrates the versatility of the approach of the VTEOS.