Viscosity Measurement of a Nonaqueous Ionic Binary Mixture

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Nearly all fluids near critical points have coexistence curves of roughly cubic shape, flatter than the parabolic shape predicted by classical or mean-field equations of state such as that of Van der Waals and the equations used by engineers. The modern theory of critical phenomena has explained this non-classical cubic shape to be a consequence of critical fluctuations whose range exceeds that of the molecular interactions present in real fluids. Conversely, mean-field behavior has been proven in a model where the interaction is a long-range, weak, exponential attraction (Kac potential). Mean-field behavior has been hypothesized, but not proven, for ionic fluids where the long-range interaction is coulombic.

Mean-field behavior was revealed by previous measurements of static properties of critical solutions of the organic salt triethyl n-hexyl ammonium triethyl n-hexyl boride in diphenyl ether. This is contrary to the Ising-like behavior usually found in pure fluids and partially miscible binary mixtures. We report the first measurements of the viscosity of this ionic mixture in two novel viscometers specially designed for low shear rates. The flow impedance of the first viscometer was a glass frit which acted like many tiny parallel capillaries. The flow impedance of the second viscometer consisted of a single, 1.1 m long capillary. The sample was driven through the capillary by a pressure head as small as 1 cm. The viscosity has a weak critical anomaly similar to that observed in Ising-like fluids. The results are discussed within the framework of the restricted primitive model and other theoretical expectations.