A Viscosity Model for Ionic Liquids Based on the Eyring's Theory and a Cubic EoS

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A thermodynamic model based on the combined use of Eyring's activated state theory and a cubic equation of state was developed here to accurately represent the dynamic viscosity of pure ionic liquids (ILs). Within Eyring's theory, the net viscous flow of a pure IL is assumed to be governed by four main mechanisms: (1) the energy necessary for a molecule to jump from an initial equilibrium position to a new one, (2) the energy necessary to break the molecular bonds to create a hole (vacant sites) of molecular size in the liquid, (3) the availability of the vacant sites, and (4) the frequency or the mean residence time of the jumping molecules. The various activation-state energies and variables were then related to well-known thermodynamic potentials that in turn were estimated from two simple cubic equations of state of the van der Waals type (Soave or Peng-Robinson).The resulting model was successfully validated during the representation of experimental dynamic viscosities of three families of imidazolium-based ILs ([$C_x$mim][BF_4], [$C_x$mim][PF_6], and [$C_x$mim][Tf_2N]), four pyridinium-based ILs ([bmpy][BF_4], [empy][$EtSO_4$], [Et_2Nic][$EtSO_4$], and [hemmpy][Tf_2N]) and two ammonium-based ILs ([cpmam][$MeSO_4$] and [4bam][doc]) within a temperature range varying from 0 to 80 °C and at pressures from 1 up to 3 000 bar thus covering a wide viscosity range of 10-19 610 mPa-s.