

Volumetric and Calorimetric Investigations of Aqueous Rare Earth Element Containing Triflate Salt Systems

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The rare earth elements (REEs) have many important industrial applications including their use in the production of high field-strength magnets, as catalysts in the oil industry, and as glazes and colors in the ceramics industry. As such, knowledge of the calorimetric and volumetric properties of these systems in aqueous solution are important with respect to optimizing REE extraction processes and also enhancing our understanding of the roles of REEs within industries of high socioeconomic value. This laboratory has previously measured some volumetric and calorimetric properties for aqueous REE perchlorate, nitrate, sulfate, and chloride systems. We have now furthered our investigations to include the REE triflates. Triflate salts are good candidates for investigation because the triflate anion does not form complex species with REE cations in solution, nor is it prone to oxidation at high temperatures. The REE triflates therefore have the potential of providing precise and reliable single ion thermodynamic properties for REE cations in aqueous solution. This paper reports densities and massic heat capacities for aqueous solutions of triflic (trifluoromethanesulfonic) acid, sodium triflate, and a selection of REE triflates salts at $T=(288.15, 298.15, 313.15, \text{ and } 328.15) \text{ K}$ and $p=0.1 \text{ MPa}$. These data have been used to calculate the apparent molar volumes and apparent molar heat capacities. The concentration dependencies of the latter data have been modeled using Pitzer ion interaction equations to yield standard partial molar volumes and heat capacities. The single ion volumes and heat capacities calculated for trivalent REE cations using the triflate salt data are compared with those previously reported from a series of aqueous REE perchlorate salt investigations.