Volume Properties of the Electrolyte of The All Vanadium Redox Flow Battery. II. The System of VOSO$_4$ + H$_2$SO$_4$ + H$_2$O at 298.15

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The all vanadium redox flow battery (VRFB) proposed by Skyllas–Kazacos et al. is one of the promising candidates as an effective energy-storage system. In the VRFB, the electrolyte is the most important components, which is not only the conductor of ions, but also the energy-storage medium. Knowledge on the volumetric properties of the electrolyte solution for VRFB will give us a deep understanding of the volume changes in the battery charge and discharge processes. To this end, as a continuation of our previous investigation of vanadium electrolyte$^{2,3}$, here we report the densities of the system of VOSO$_4$ + H$_2$SO$_4$ + H$_2$O with various molalities which were measured by An Anton Paar DMA 4500M oscillating U–tube densitometer at 298.15 K. Values of apparent molar volume, $\nu_B$, of VOSO$_4$ were calculated by following equation:

$$\nu_B = \frac{1000(\rho_0 - \rho) + mM \rho_0}{m\rho_0}$$  \hspace{1cm} (1)

where $\rho_0$ and $\rho$ are the density of H$_2$SO$_4$+H$_2$O and VOSO$_4$+H$_2$SO$_4$+H$_2$O, respectively, $m$ is the molality of VOSO$_4$, and $M_B$ the molar mass of VOSO$_4$. The values of partial molar volume, $\overline{V}_a$, of VOSO$_4$ were calculated by equation (2)

$$\overline{V}_a = \nu_B + m \left( \frac{\partial \nu_B}{\partial m} \right)_{P,T}$$  \hspace{1cm} (2)

The values of mixed Pitzer's parameter of the system VOSO$_4$+H$_2$SO$_4$+H$_2$O for volumetric properties were obtained by fitting the parameters of Pitzer's model equations to experimental data. Then, according to Pitzer's model, using the values of volumetric Pitzer's parameters of the binary systems, VOSO$_4$+H$_2$O and H$_2$SO$_4$+H$_2$O and the mixed Pitzer's parameter obtained in this work, the values of apparent molar volume of VOSO$_4$ in ternary system, VOSO$_4$+H$_2$SO$_4$+H$_2$O, with various molalities can be predicted. The predicted values are highly correlated and are in good agreement with the corresponding experimental one.

REFERENCES

