Comprehensive electrolyte density and viscosity data for vanadium flow batteries

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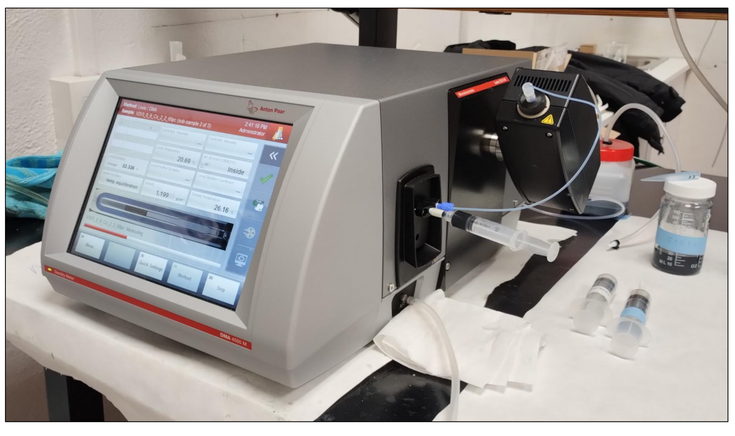
The changes in the properties of vanadium electrolytes during VFB operation have a significant impact on the electrolyte flow. Changes in density between the renewed electrolyte and that remaining in the tanks induce buoyancy effects that may lead to imperfect mixing [1]. Viscosity variations have a direct impact on the pressure drop and on ion mass transport within the cell [2]. In both cases, the properties may potentially affect the VFB performance, decreasing its capacity. This work presents a viscosity and density database of vanadium electrolytes focusing on its dependency with the State of Charge SoC while varying the total vanadium concentration c_V, the total sulphates concentration c_S , and the temperature T.

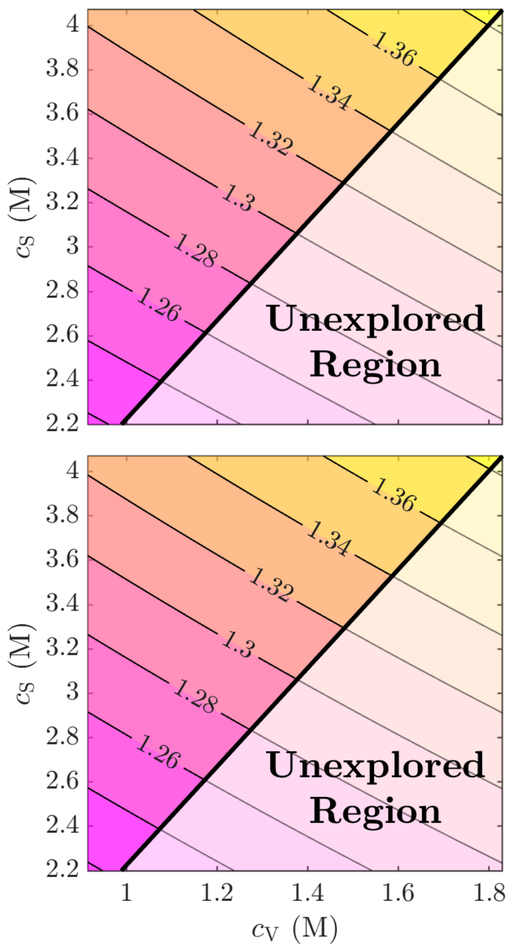
Measurements



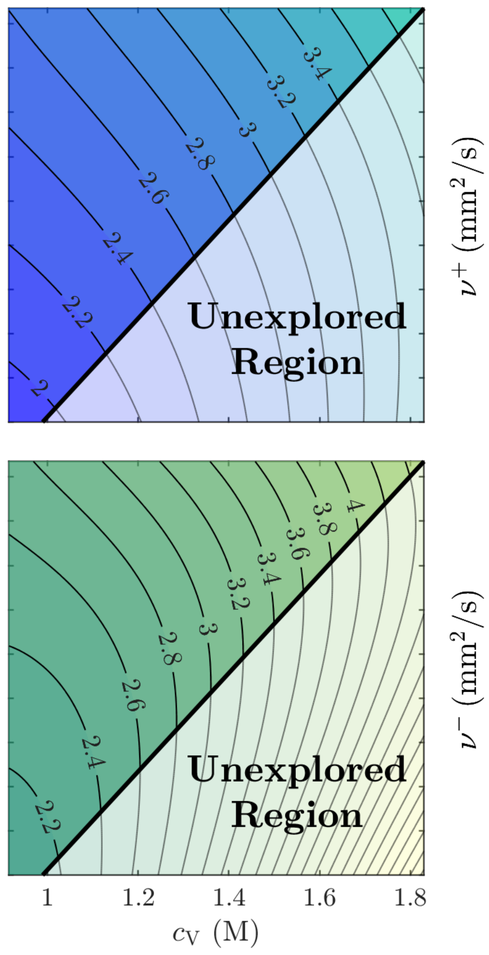
Anton Paar densimeter DMA 4500 M and viscosimeter Lovis 2000 ME, coupled with temperature management.

Samples were prepared using calibrated pipettes and reference solutions. The electrolyte was characterized by chemical and optical titration methods [3-5].

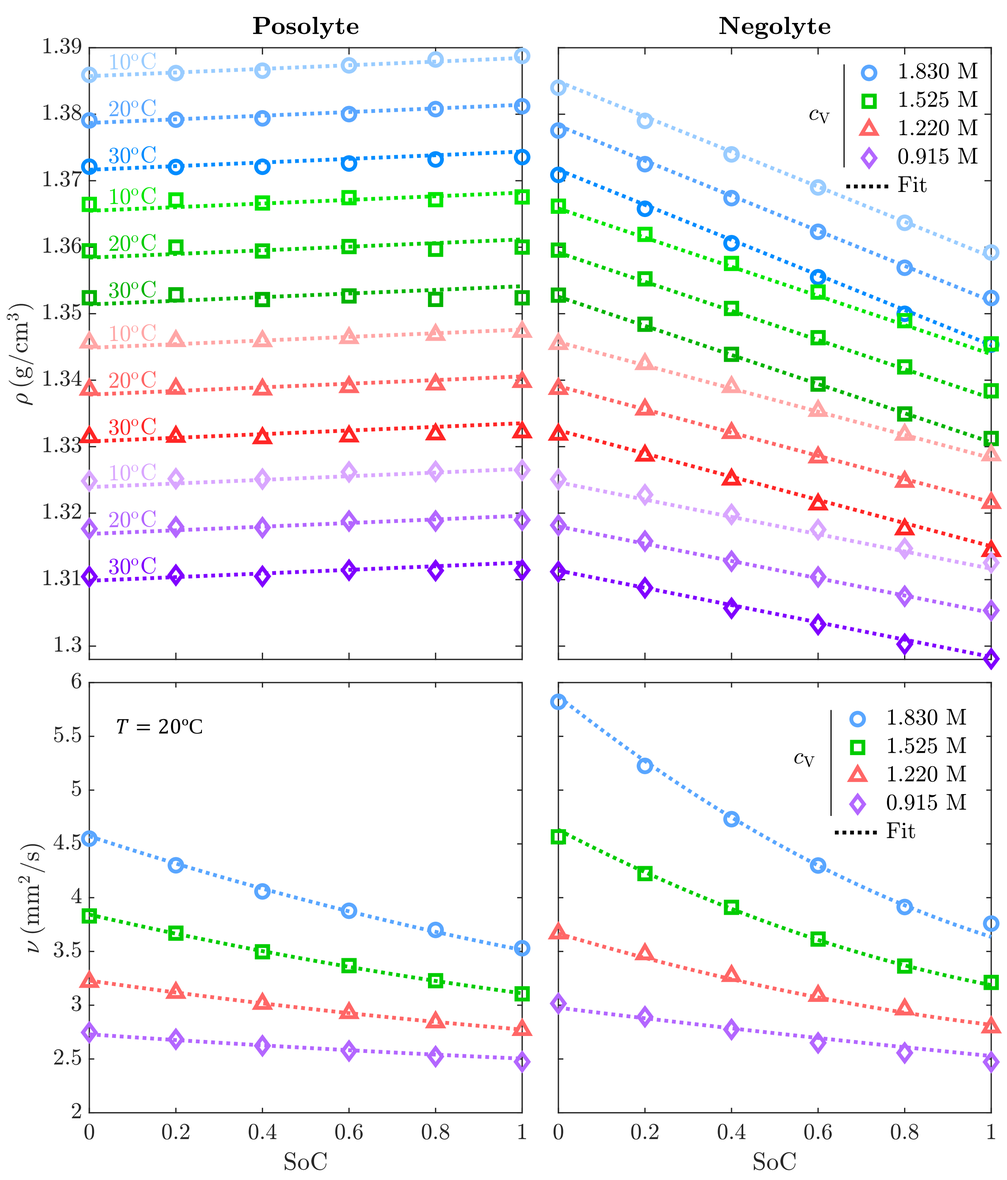
Density map



Viscosity map



Density and viscosity *vs* SoC



Density (top) and viscosity (bottom) of the posolyte (left) and negolyte (right) electrolyte versus SoC for different c_V and T using $c_S = 4.07$ M.

Empirical regressions

$$\rho^j = \rho_0^j + \rho_T^j (T - T_0) + \rho_{\mathrm{SoC}}^j \mathrm{SoC},$$

$$\rho_0^j = A^j + B^j (c_\mathrm{V} - c_{\mathrm{V},0}) + C^j (c_\mathrm{S} - c_{\mathrm{S},0}) + D^j (c_\mathrm{V} - c_{\mathrm{V},0})^2 + E^j (c_\mathrm{S} - c_{\mathrm{S},0})^2$$

$$\nu^j = \sum_{i=0}^{2}\sum_{k=0}^{2}\sum_{l=0}^{2}\sum_{m=0}^{2}\left[F_{i,k,l,m}(c_\mathrm{V} - c_{\mathrm{V},0})^i (c_\mathrm{S} - c_{\mathrm{S},0})^k (T - T_0)^l \mathrm{SoC}^m\right]$$

for $j = \{+, -\}$

Related work

Contact

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