

Combined Gravimetric-Optical Determination of Absorption, Swelling and Mass Transfer of Imidazolium-Based Ionic Liquids in Forced Flow-Through Atmospheres

Gerrit Dresp^{C, S} and Roland Span

Thermodynamics, Ruhr-University Bochum, Bochum, Germany
g.dresp@thermo.rub.de

Marcus Petermann

Particle Technology, Ruhr-University Bochum, Bochum, Germany

Tobias Fieback

Technical Thermodynamics, TU Bergakademie Freiberg, Freiberg, Germany

Ionic liquids are well suited for specialized sorption processes, not only due to their adjustable characteristics, but also their negligible vapor pressure. However, in laboratory scale, the absorption analysis of bulk ionic liquids can be time consuming when only diffusive mass transfer is utilized. Therefore, working in forced flow-through atmospheres can reduce equilibrium times while better representing industrial conditions. By enhancing an already unique setup for gravimetric analysis of liquid sorbents under forced flow-through conditions, we gain additional optical insights during gas absorption. Utilizing forced flow-through and thereby rather convective than diffusive mass transfer, the equilibrium times are reduced from several days down to two hours on average. However, to determine mass transfer characteristics, accurate knowledge of the constantly changing active area between gas and liquid is required. The necessary additions are therefore mainly focused around the highly accurate magnetic suspension balance of the original system and include a compatible transparent crucible, high-pressure viewing cell, and high-speed camera. The new insights include basic optical tracking of the liquid level for absorption-induced swelling and the determination of the active surface area for individual gas bubbles during their ascent through the liquid. By combining the new optical aspects with the time resolved gravimetric absorption data, we can now derive the convective mass transfer coefficients. With the enhanced system, the overall absorption capacities, swelling, and mass transfer coefficients of different imidazolium-based ionic liquids were analyzed to investigate the impact of different anions and cations on these aspects. All measurements took place in dynamic carbon dioxide and nitrogen atmospheres at up to 20 MPa. The maximum applicable temperatures were selected on the basis of additional thermogravimetric analysis of all used ionic liquids to determine the individual point of thermal decomposition.