Thermal Conductivity of Ionic Liquids and IoNanofluids

Xavier Paredes, Maria José Lourenço, and Carlos Nieto de Castro [C, S]
Centro de Química Estrutural, Universidade de Lisboa, Faculdade de Ciências, Lisboa, Portugal
cacastro@ciencias.ulisboa.pt

William A. Wakeham
Chemical Engineering Department, Imperial College London, London, United Kingdom

Ionic liquids have been suggested as new engineering fluids, namely in the area of heat transfer, as alternatives to current biphenyl and diphenyl oxide, alkylated aromatics and dimethyl polysiloxane oils, which degrade above 200 °C and pose some environmental problems. The addition of nanoparticles to produce stable dispersions/gels of ionic liquids have proved to increase the thermal conductivity of the base ionic liquid, contributing to a better efficiency of heat transfer fluids.

It is the purpose of this paper to analyze the prediction and estimation of the thermal conductivity of ionic liquids and IoNanofluids as a function of temperature, using the molecular theory of Bridgman [1,2] and the estimation method of Koller et al. [3] for the base fluid and the models based on the importance of the interfacial area IL-NM for the thermal conductivity enhancement [4].

Results obtained show that it is not currently possible to predict or estimate the thermal conductivity of ionic liquids with an uncertainty commensurate with the best experimental values. In the case of the thermal conductivity enhancement, more work, either using imaging techniques at nanoscale or molecular dynamics simulations, is necessary.

References

[1] Bridgman, P.W. The Thermal Conductivity of Liquids. Proc. Natl. Acad. Sci. USA 1923, 9, 341–345. DOI: https://doi.org/10.1073/pnas.9.10.341
[2] Biddle, J.W.; Holten, V.; Sengers, J.V.; Anisimov, M.A. Thermal conductivity of supercooled water. Phys. Rev. E, 2013, 87, 042302. DOI: https://doi.org/10.1103/PhysRevE.87.042302
[3] Koller, T.M.; Schmid, S.R.; Sachnov, S.J.; Rausch, M.H.; Wasserscheid, P.; Fröba, A.P. Measurement and Prediction of the Thermal Conductivity of Tricyanomethanide- and Tetracyanoborate-Based Imidazolium Ionic Liquids. Int. J. Thermophys., 2014, 35, 195–217. DOI: https://doi.org/10.1007/s10765-014-1617-1
[4] Leong, K.; Yang, C.; Murshed, S. A model for the thermal conductivity of nanofluids - the effect of interfacial layer. J. Nanopart. Res., 2006, 8(2), 245–254. DOI: https://doi.org/10.1007/s11051-005-9018-9