Ionic Liquid Dehumidifing System - DEMO

Dionysios Vroulias[#], Theophilos Ioannides, Vassilios Dracopoulos[*]

Foundation for Research and Technology-Hellas, Institute of Chemical Engineering Sciences (FORTH/ICE-HT), GR-26504, Patras, Greece

Presenting * Corresponding author, emails: dvroulias@iceht.forth.gr, indy@iceht.forth.gr

ABSTRACT

Gas dehumidification using membranes is a promising technology and has many advantages over other water vapor removal methods including simple installation, ease of operation and low process cost [1]. Although hydrophilic polymers exhibit strong permeation properties, they face issues like swelling and plasticization [2]. For this reason, actual separation factors are orders of magnitude lower than the ideal selectivities [2]. Enhancing polymeric membrane properties can involve integrating ionic liquids (ILs) to form supported liquid membranes.

In this work, nicotine based ILs were investigated for gas dehumidification. After preparation, the chemical structure of ILs was confirmed with NMR and FTIR spectroscopy. Viscosity, short-term thermal stability and glass transition temperature were also investigated. Membranes were prepared by drop-casting nicotine-based ILs onto a circular hydrophobic PVDF substrate. Gas and water vapor permeability and selectivity measurements were conducted using the Wicke-Kallenbach method.

In single gas permeation experiments, the lengthening of the alkyl chain led to (a) an increase of gas permeabilities attributed to IL viscosity decrease and (b) a decrease of water vapor permeability due to IL hydrophobicity increase [3]. However, the presence of ether groups in the alkyl chain had a positive effect on water vapor permeation properties. Permeation properties under mixed gas conditions were unaltered compared to those of single gas permeation experiments and water vapor/gas performance was the highest relative to other reported SILMs with $TFSI^-$ as counter anion.

It has also been demonstrated that the water vapor permeability of IL membranes can be tuned by selection of a counter anion with high hydrophilicity. The IL membrane containing the more hydrophilic counter anion ($MeSO_4^-$) demonstrated the highest water vapor permeability (1.5×10^6 Barrer) and H_2O/gas selectivities ever measured. Due to the membrane's superior water vapor permeation properties, a patent has been filed (PCT/EP2023/083197), and a prototype system has already been constructed with the aim of improving the TRL of the ionic liquid membrane dehumidifying process from 4 to 7.

This work was supported by the project "Bioconversion of lignite power plant emissions to fuels and fine chemicals (BIOMEK)" (T1EDK- 00279) which was implemented under the "EPAnEK 2014-2020 Operational Programme", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund). The Prototype system was funded by the "GNOSI" project of PRAXI Network.

REFERENCES

[1] F. Pan et al., *J. Membr. Sci.* (2008) 323, 395–403.
[2] V. Deimede et al., *Sep. Purif. Technol.* (2020) 251, 117412.
[3] D. Vroulias et al., *J. Membr. Sci.* (2023) 684, 121878.