IICC 2021 International Industrial Chemistry Conference

Virtual

1st International Industrial Chemistry Conference

26-27th February 2021

Efficient Liquid-liquid Extraction of Phenolic Compounds from Model Oil using Benzyl Imidazolium Ionic liquids.

Nadiah Sidek, **Ninie Suhana Abdul Manan**, Syarifah Mohamad, Department of Chemistry, Universiti Malaya, Kuala Lumpur

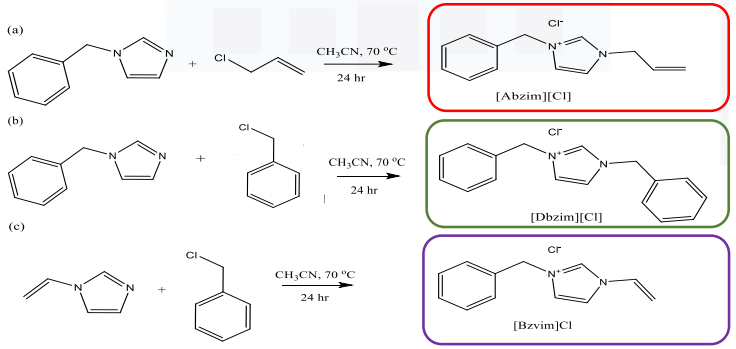
Background

Phenolic compounds are major pollutants due to its high toxicity and persistence in environment. The traditional method currently employed to separate phenols from oil mixtures is through the use of strongly alkaline and acidic chemicals- which produces excessive amount of phenol-containing wastewater. Coal tar has a relatively high concentration of phenolic compounds. Thus, it is desirable to separate phenolic compounds from the oil mixture before further refining for economic reasons. Therefore, an environmentally friendly and efficient method becomes necessary to exhaustively extract phenols from oil.

Objectives

- To design and synthesis benzyl imidazolium-based ILs
- To evaluate the ability of benzyl imidazolium-based ILs as a solvent for the removal of phenols from model oil via liquid-liquid extraction.

Synthesis of benzyl imidazolium-based ILs

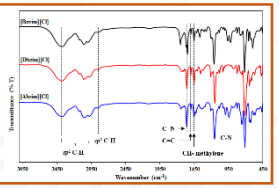


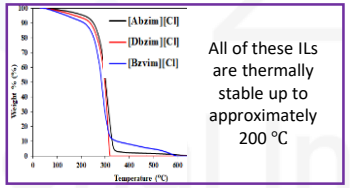
The three benzyl imidazolium-based ILs were characterized using various analytical methods namely ^{1}H NMR spectroscopy, ^{13}C NMR spectroscopy, FT-IR spectroscopy, CHN elemental analysis, and TGA analysis. Their physicochemical properties such as density and viscosity were also measured at room temperature.

Characterizations

RTIL	Molecular weight (g mol^{-1})	Yield (%)	Appearance
[Abzim][Cl]	234.73	97.29	Light golden brown liquid
[Dbzim][Cl]	284.79	98.15	Pale yellow viscous liquid
[Bzvim][Cl]	220.70	98.17	Dark brown viscous liquid

All the ILs possessed almost identical vibrational bands with the presence of similar functional groups



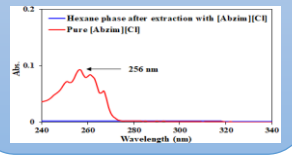


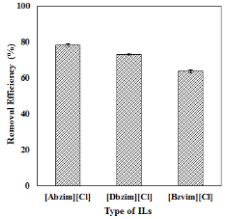
All of these ILs are thermally stable up to approximately 200 °C

Liquid-liquid Extraction

Solubility of model oil in ILs

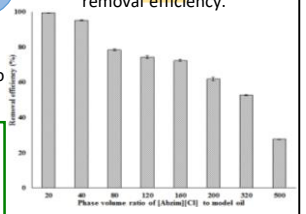
UV-vis proved that [Abzmi][Cl] does not contaminate the model oil





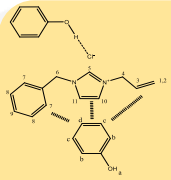
Effect of structure on the phenol removal efficiency.

Based on this result, a volume ratio of 4:0.1 of model oil to IL was selected as the optimal value and used in succeeding steps in order to decrease the usage of IL in this extraction



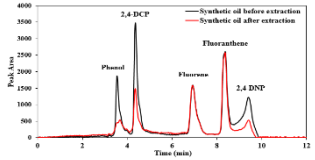
The % removal efficiency increased in the order of Ph > 4-CP > 3-CP > 2CP > 2,4-DCP > 2,4,6-TCP for chlorinated phenols while for nitrophenols, it increased in the order of 4-NP > 2,4-DNP > 2,4,6-TNP under the same experimental conditions. The hydrophilic interaction is favourable for the reaction between IL and phenols.

Reaction Mechanism

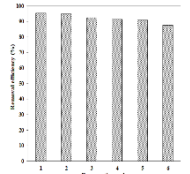


The π-π interaction of aromatic benzene ring on phenol with aromatic and allylic moiety of [Abzim]Cl as well as H-bonding of Cl- with hydroxyl group on phenol

HPLC chromatogram of the synthetic oil before and after extraction. This result proved that the performance of [Abzim][Cl] is excellent even in the presence of different types of phenolic compounds and polyaromatic hydrocarbons (PAHs)



The recycled IL can be reused several times and the phenol removal performance remains constant after 5 cycles. The efficiencies dropped gradually after 6th cycles but still maintained at approximately 90%



Conclusion

Three benzyl imidazolium-based ILs with different aromatic and double bond substituents used as extractants for the removal of phenol via LLE from oil have been successfully synthesized and characterized comprehensively. The characterization results justified the synthesis of those pure Ils.

[Abzim][Cl] form strong bonds with phenol under optimized conditions with good recyclability up to 6 cycles without significant loss in mass.

References

- Zhang, F., Li, Y., Zhang, L., Zhou, Z., Sun, W., & Ren, Z. (2016). *Industrial & Engineering Chemistry Research, 55*(33), 747–756.
- Gao H.-S., Zong Z.-M., Teng D.-G., Li J.-H., Wei X.-Y., Guo Q.-J., Zhao T.-S., Bai H.-C., Kang Y.-H. (2021) Fuel, 288
- Lan Yi, Jie Feng, Wenying Li, and Zhongyang Luo. (2019) *ACS Sustainable Chemistry & Engineering, 7* (8), 7777-7783