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INVESTIGATION OF THE USE OF IONIC LIQUIDS IN THE CAPTURE OF VOLATILE ORGANIC COMPOUNDS

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1. INTRODUCTION

Escalating amount of Volatile Organic Compounds (VOCs) have in recent years been emitted into the air from manufacturing industries, some of which are classified as Hazardous Air Pollutants (HAPs). VOCs are well-known as typical air pollutants characterized by their high vapour pressure and low melting point. As one of the main ingredients of photochemical reaction in the atmosphere, VOCs react with nitrogen oxides in the presence of sunlight to form ozone, which is a primary component of smog.

2. IONIC LIQUIDS

The ionic liquids (ILs) are organic salts that are in a liquid state at ambient temperature. ILs generally contain a bulky asymmetrical cation and simple anion. ILs appear to be excellent alternatives to the traditional organic solvents due to their unique properties:

- High solvation capacity to a variety organic compounds
- Negligible vapour pressure
- Thermal and chemical stability
- Potential to be tailor-made
- Non-flammability

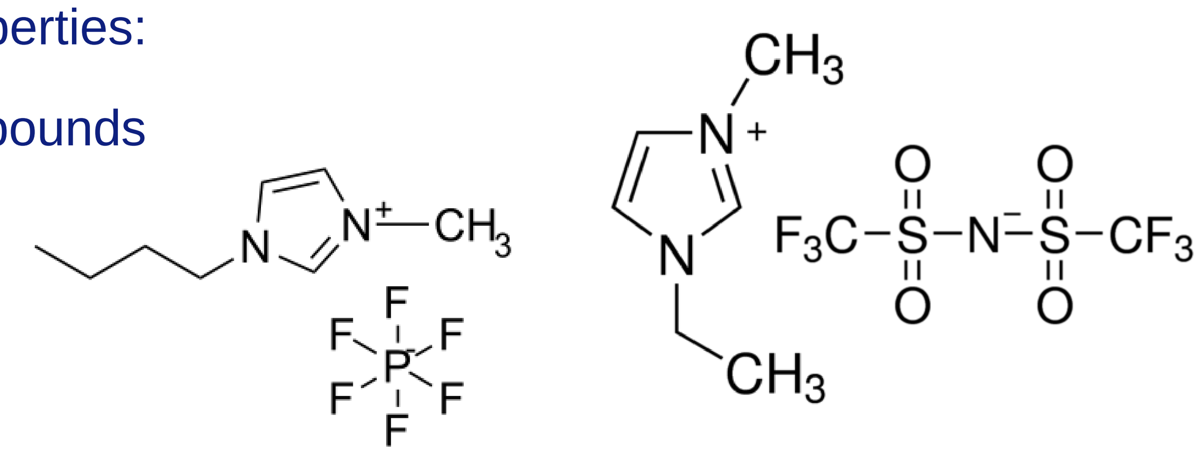

Figure 1 Selected ILs: [Bmim][PF6] (left) and [Bmim][NTf2] (right)

3. METHODOLOGY

The use of Ionic Liquids to capture VOCs selectively from exhaust gases is investigated through the following steps.

Literature review	Selection protocol	Volatility test	Absorption test	Ionic liquids recovery	Research output
Phase I	**Phase II**	**Phase III**			

Phase I : Undertake literature reviews on application of ionic liquids, current VOCs removal techniques, and interactions between ionic liquids and VOCs.

Phase II : Select two typical VOCs and two commonly used ionic liquids based on literature review.

Phase III: Implement the volatility test using liquid VOC prior the absorption test. The ability of ionic liquid to capture VOC is demonstrated via VOC concentration reduction after passing through ionic liquid. The concentration of VOC can be calculated from the UV-vis data.

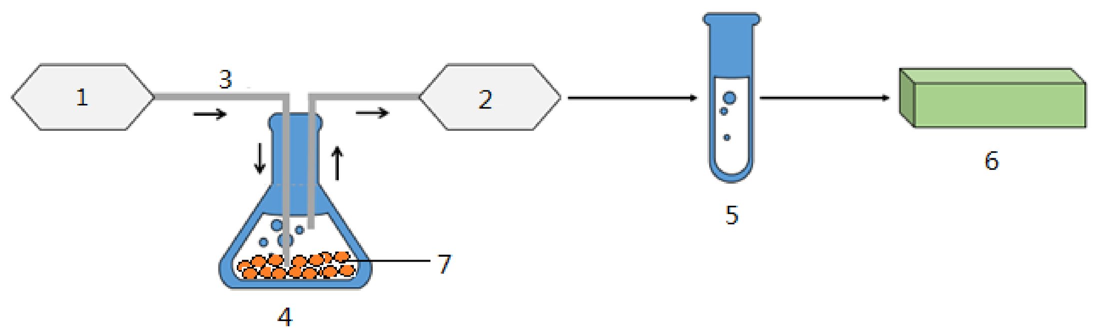

Figure 2 The absorption test demonstration
1: Tedlar bag with VOC gas sample; 2: The vacuum Tedlar bag;
3: PTFE tube; 4: Ionic liquid;
5: A glass vial with known amount of solvent;
6: UV-visible spectrometer; 7: Glass beads, 3mm diameter

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4. RESULTS

Toluene and acetone are selected as the represent VOC in the experiments. Toluene, the typical aromatic hydrocarbon, is one of the top 50 chemicals manufactured each year.

Acetone, with a carbonyl moiety, C=O, plays a very important role in atmosphere, because (i) it is formed by the photochemical oxidation of almost all hydrocarbons; (ii) it leads to production of very reactive and hazardous free radicals (Stanley, 2001).

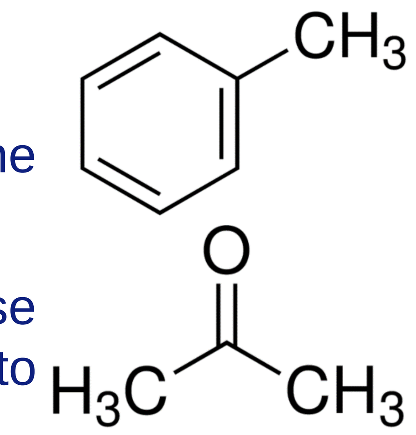

Figure 3 Chemical structure of toluene (top) and acetone (bottom)

The results of VOC removal effectiveness in absorption test are summarised in Table 1. the maximum light absorbance of toluene and acetone occurs at 261nm and 265 nm respectively.

Table 1 Summary of light absorbance and removal effectiveness of toluene and acetone

Compound	λ_{max} (nm)	Light absorbance (AU)		VOC removal effectiveness
		Before IL	After IL	
Toluene	261	0.856	0.114	86.07%
Acetone	265	0.053	0.026	54.37%

The efficiency of VOC removal can be boosted by increasing residence time, or surface area between VOC and IL. Two approaches are proposed: (1) multiple passes through IL; (2) applying glass beads in the IL. The improvements in VOC removal effectiveness are summarised in Table 2 below.

Table 2 Summary of removal effectiveness of toluene and acetone, with modifications in the experiments

Compound	VOC removal effective after pass through IL		
	Single pass	Multiple passes	Single pass with glass beads
Toluene	86.07%	92.39%	96.92%
Acetone	54.37%	74.87%	94.83%

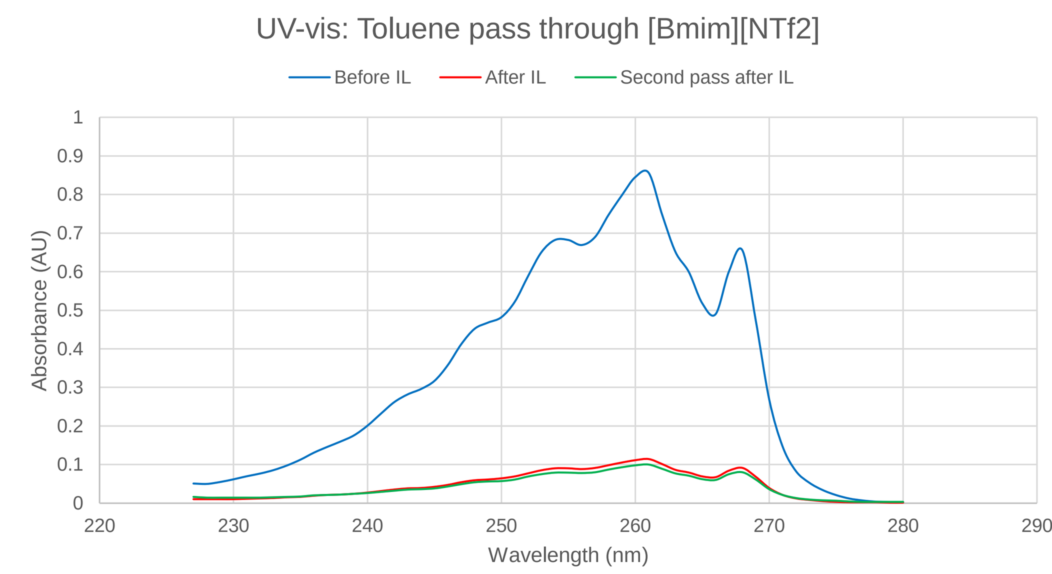

Figure 4 Toluene removal effectiveness with multiple passes through IL

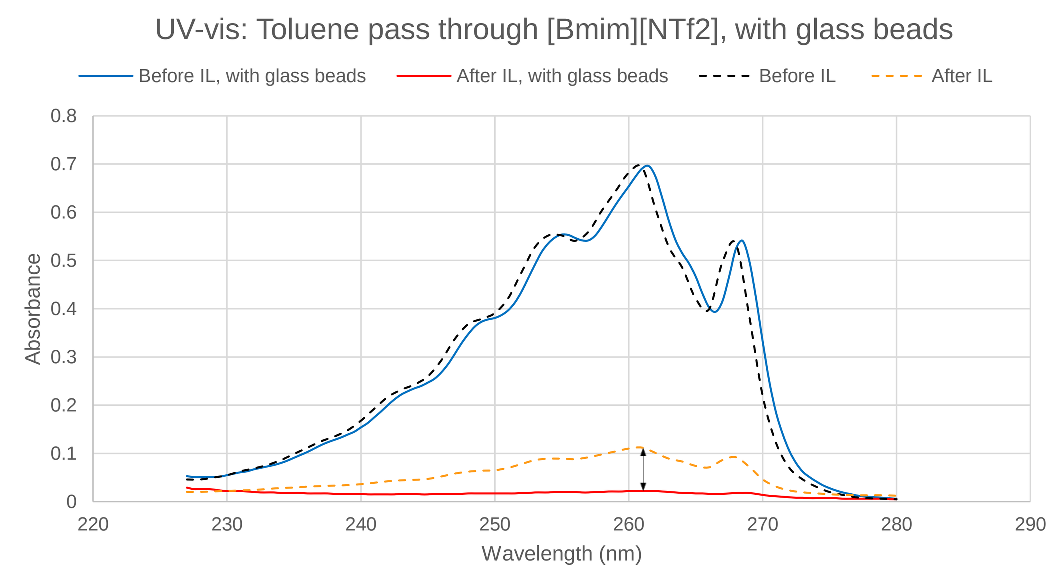

Figure 5 Toluene removal effectiveness with glass beads in IL

5. CONCLUSION

For the first time it is reported that the IL has been used successfully to extract toluene and acetone at room temperature. Also the recovery of IL has been achieved and the IL can be reused in industrial applications.

REFERENCES

Stanley, E. M. (ed.) (2001) Environmental chemistry, ninth edition. New York, Taylor & Francis Group Publishing.