Absorption of Ethyl Acetate from Contaminated Air Flow in Ionic Liquids

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Introduction

The avoidance of environmental contamination with solvents (VOCs) becomes more and more important. Packing e.g. of beverages and meals into recyclable plastic bottles and boxes becomes common. In order to attract customers, packages are directly printed customarily with colorful advertisement and necessary product information, or wrapped with printed banderole. Up to now, printing on plastic materials requires toxic or otherwise harmful organic solvents, e.g. chlortrimethylhydrocarbons, toluene or ethyl acetate [1]. Ethyl acetate is too toxic in low air concentrations (1,500 mg ethyl acetate in 1 m³ air) compared to other solvents. Nevertheless, a high throughput printing plant has to recover approximately 100 kg ethyl acetate per hour from the exhaust-air stream.

The absorption properties of ionic liquids (ILs), based on the imidazolium core, were examined to evaluate their possible use for VOCs purification from the exhaust air of a printing plant. To simulate equivalent production conditions, an air stream of 200 mL min⁻¹ was contaminated with 0.128 g (8.6 mL h⁻¹) ethyl acetate at 30°C. Octyl-methylimidazolium dicyanamid ([OMIM][DCA]) shows the highest capability (472 mg mL⁻¹ IL) to accumulate the solvent, followed by dimethylimidazolium acetate ([DMIM][OAc]) with 462 mg mL⁻¹ IL. The absorbed ethyl acetate could be recovered by distillation from the IL. Both, the ethyl acetate and the IL, can be reused with little loss in activity.

Micro-flow synthesis and purification of DMIM[OAc]

Raw solution of N,N'-dimethylimidazolium-2-dimethyl-carbonate (from carboxylation reactor 200°C, 80bar, excess of MeOH)

Mixed bed reactor: cation-exchanger/ MgSO₄, slice

MeOH, acetic acid methylster

Stripping

Purified N,N'-dimethylimidazolium acetate

Esterification of excess of acetic acid

Formation of N,N'-dimethylimidazolium acetate

CO₂

Glacial acetic acid

Oil bath (140°C)

T-piece

Setup for EtOAc absorption from contaminated air

Dry air

Syringe pump 50 mL ethyl acetate

Preheater coil 5 m

Preheater coil 10 m

Thermostate 30°C

Exhaust air

Digital balance

Silica gel siccative

CaCl₂ siccative

EtOAc absorption/desorption process

Absorption/desorption of EtOAc in OMIM[DCA] at different EtOAc / air ratios

<table>
<thead>
<tr>
<th>Air flow: 200 mL min⁻¹</th>
<th>Temperature: 30°C</th>
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<td>Ethyl acetate µL mL⁻¹ air:</td>
<td>0.72</td>
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Absorption/desorption of EtOAc in BzMM|DCA, OMIM[DCA] and DMIM[DCA]

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Summary

- Printing on plastics requires volatile organic solvents (VOCs) that are toxic or otherwise environmentally harmful by pollution into the air.
- The amount of VOCs, which are released during the printing process is high and not tolerable.
- Special ionic liquids can be applied as absorbents for VOCs. After stripping and condensation VOCs as well as the ionic liquid can be recirculated.
- A remarkable loss of capacity could not be observed after several absorption/desorption cycles under lab-scale conditions.

References
