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Selective flue gas cleaning with ionic liquids

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Introduction

- Combustion of fossil fuels leads to the emission of acidic gases e.g. NO_x and SO_2 which is a major concern in relation to atmospheric pollution.
- These gases have to be effectively removed from flue gases.
- It is difficult to find adsorbents which allow reversible and selective absorption of acidic gases.
- Pressure- and temperature swing adsorption processes, provide excellent resources for production of sulfuric acid and nitric acid.
- Ionic liquids (ILs) have in no (or negligible) vapour pressure and large liquidus.
- The structures of ILs are well-ordered even in liquid state with regular cavities which can host selected solute species depending on the IL ion composition.
- Therefore IL can be tuned to absorb selected gas molecules making them promising materials for selective, reversible absorption of gaseous pollutants in e.g. power plant flue gases and other exhaust or industrial off-gases.[1,2,3,4]

Structural Characterisation

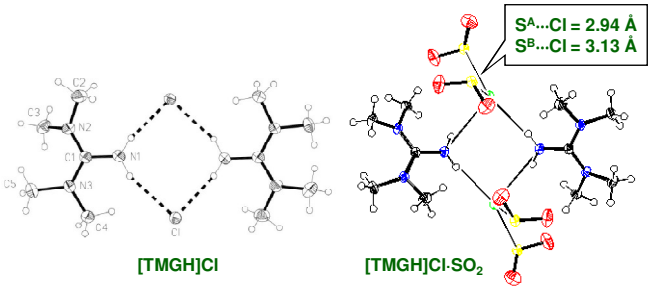

Fig.1. X-ray crystal structures of [TMGH]Cl[a] (left) and [TMGH]Cl·SO_2 (right)[5]

Table 1. Selected hydrogen bond distances to chloride ions[5]

Compound	D-H···A (Å)	D-H (Å)	H···A (Å)	D···A (Å)	D-H···A (°)
[TMGH]Cl[b]	N-H^A···Cl	0.92(2)	2.42(2)	3.29(2)	158.4(1)
(δ = 1.22 g/cm³)	N-H^B···Cl	0.87(2)	2.37(2)	3.23(2)	168.9(1)
[TMGH]Cl·SO_2	N-H^B···Cl	0.87(2)	2.49(2)	3.26(2)	158.4(1)
(δ = 1.38 g/cm³)	N-H^A···Cl	0.86(2)	2.46(2)	3.22(2)	168.9(1)

[a] [TMGH]Cl: 1,1,3,3-Tetramethylguanidinium chloride
[b] Fischer and Jones, *Acta Cryst. E*, 58, 2002,o218

SO_2 absorption with SILP absorber

- Supported Ionic Liquid-Phase (SILP) absorber: [TMGH]Cl (0-50 wt%) on high surface area SiO_2
- Fixed-bed reactor: 100 ml/min SO_2 (0-30.000 ppm) in N_2.
- Absorption / desorption temperatures 30-110 °C.

$$[TMGH]Cl + SO_2 \longrightarrow [TMGH]Cl{\cdot}SO_2$$

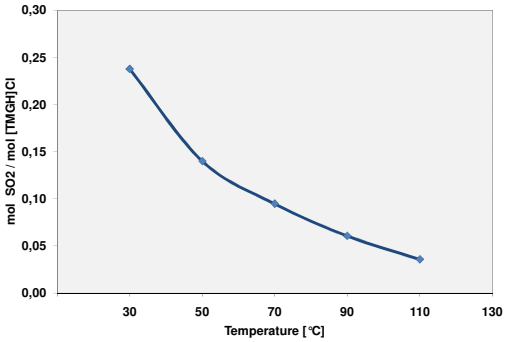

Fig. 2. Absorption of SO_2 gas in 20 wt% [TMGH]Cl on supported SiO_2 at different temperatures.[6]

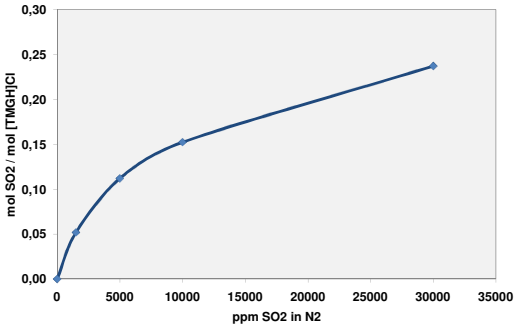

Fig. 3. Absorption of different concentrations of SO_2 gas in 20 wt% [TMGH]Cl on supported SiO_2.[6]

Conclusions

- The results show that SO_2 can be reversible and selective adsorbed using [TMGH]Cl.
- Supported Ionic Liquid-Phase (SILP) absorbers are promising materials for flue gas cleaning.
- Absorption / desorption can be tuned with temperatures, pressures and gas concentrations.

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