Deep Eutectic Solvents to remove rust and limescale from surfaces

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Limescale deposition and rusting of steel are two phenomena, which can impair the usability of machines or cause heavy damage to devices or constructions. The removal of both is therefore essential. Conventional methods include the use of highly acidic or environmentally harmful compounds, making sustainable and non-hazardous solutions a favourable alternative. Deep Eutectic Solvents (DES) have already shown to dissolve metal oxides [1,2]. When employing type III DESs, made from a quaternary ammonium salt and an hydrogen bond donor [3], they can be made from environmentally uncritical substances with negligible toxicity [4,5]. Thus, the possibility to employ DESs as rust and limescale removing agents was investigated.

For this study, DESs were prepared from choline chloride (ChCl) in combination with a selection of hydrogen bond donors. The amount of dissolved calcium carbonate (as a representation of limescale) and rust was analysed via complexometry and manganometry, respectively. The acidity of the DESs was investigated. Neutral pH was favoured as acidic compounds for the desired purposes are already widely available.

A DES made from ChCl and D-fructose showed favourable properties, being able to both dissolve calcium carbonate and rust obtained from steel samples while remaining at a mildly acidic pH value. However, the DES showed a high viscosity at room temperature when water content was below 1000 ppm. Addition of water to reduce viscosity was investigated towards its influence on the DES's ability to remove rust and limescale. Finally, a non-ionic alkyl polyglycoside surfactant was added to the DES. It was investigated, if a product that additionally removes conventional soil without sacrificing any of the other properties can be obtained. A colorimetric method was used to analyse the mixture's cleaning behaviour of dyed fats on worsted wool fabric. With added surfactant, removal of the dyed soil was achieved, while DES without surfactant did not remove fatty soil.

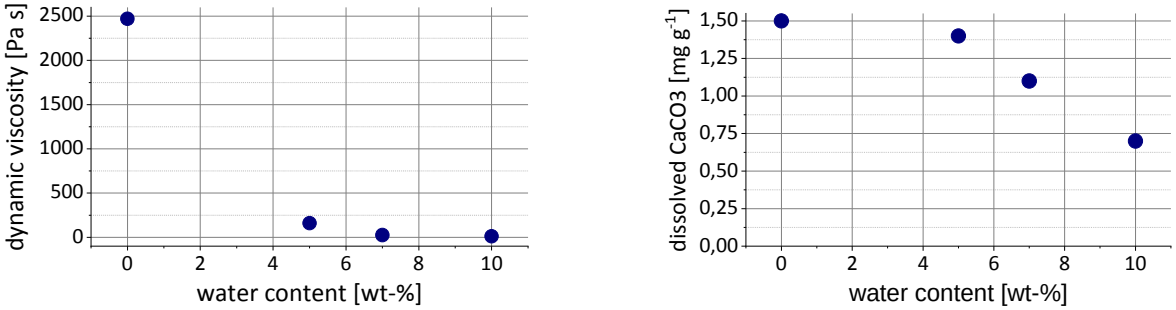

Figure 1. Left: dynamic viscosity of the DES made from ChCl and D-fructose at 25 °C with rising water content. Right: dissolved calcium carbonate in the DES with rising water content at 50 °C. The viscosity drops severely upon water addition. The $CaCO_3$ solubility does only start to decrease significantly at water contents higher than 5 wt-%, suggesting that the structure of the DES is broken up, causing a drastic change in its properties.

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