SOLVING ENERGY CHALLENGES THROUGH CHEMICAL BONDS: CALCIUM DICARBOXYLATE HYDRATES AS THERMOCHEMICAL ENERGY STORAGE MATERIALS

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Record breaking heat waves, temperature extremes, and ecological calamities paired with the desire to achieve energy independence enforce a massive challenge on humanity. In 2021 the global demand of primary energy was 595.15 EJ with 82 % being covered by fossil fuel sources [1]. According to the IEA almost 50 % of the global primary energy consumption are devoted to the production of heat [2, 3]. In order to increase energy efficiency and drastically reduce the consumption of fossil fuels, thermal energy storage systems (TES) are a promising technology.

Thermochemical energy storage revolves around storing heat within chemical bonds, using reversible chemical reactions. Salt hydrates are feasible thermochemical materials (TCMs) for such reactions, as they combine appealing properties like high storage densities, fast kinetics, high cycle stability, and with water a cheap and non-toxic gas. Furthermore, they can be applied to low-grade heat storage (100 – 200 °C). Nonetheless it is reported that in practical applications salt hydrates often fail to meet the expectations [4]. To tackle this issue and based on previous research in our group indicating the high potential of calcium oxalate monohydrate as TCM, calcium dicarboxylate hydrates were investigated by simultaneous thermal analysis (STA) regarding their potential as TCMs [5]. With calcium malonate dihydrate and calcium terephthalate trihydrate two salts with higher storage potential were discovered. In order to achieve a deeper understanding of the structural mechanisms occurring at the de- and rehydration reactions, in-situ measurements of calcium terephthalate trihydrate and several derivatives were performed using an Anton Paar XRK 900 reaction chamber.

[1] *bp Statistical Review of World Energy 2021*. 2022. p. 60.

[2] IEA, *Co-Generation and Renewables*. 2011, IEA: Paris.

[3] IEA, *Heating Without Global Warming*. 2014: Paris.

[4] N'Tsoukpoe, K.E., et al., *A systematic multi-step screening of numerous salt hydrates for low temperature thermochemical energy storage.* Applied Energy, 2014. **124**: p. 1-16.

[5] Knoll, C., et al., *Probing cycle stability and reversibility in thermochemical energy storage – CaC2O4·H2O as perfect match?* Applied Energy, 2017. **187**: p. 1-9.