

**Experimental investigation of the CO<sub>2</sub> capture process from air by Na- and Mg-based sorbents. Performance of the solar chemical reactors for the calcination-reforming process.**

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The viability of Na-sorbents for the capture of CO<sub>2</sub> from air was examined by thermodynamic analysis of three Na-based thermochemical cycles. The temperature requirements, energy inputs, and expected products of the reaction steps were determined by thermodynamic equilibrium and energy balance computations. The total thermal energy requirement for each cycle is considerably low: from 213 to 481 kJ per mole of CO<sub>2</sub> captured. To study the feasibility of the pertinent steps of every cycle in respect of the reaction kinetics, isothermal and dynamic thermogravimetric runs were carried out for the carbonation, decomposition, and hydrolysis reactions. The thermogravimetric analysis showed slow reaction rates for the carbonation steps (from 3.5% to 9%, using NaOH and Na<sub>2</sub>CO<sub>3</sub> as sorbent, respectively). This makes the process unfavorable for a scale-up of the reactor technology and impedes the application of Na-based sorbents for capturing CO<sub>2</sub> from air. Further, MgO and Mg(OH)<sub>2</sub> carbonation were examined for CO<sub>2</sub> capture from air. The carbonation reaction, as part of a three-step thermochemical cycle, was analyzed by thermogravimetry for dry (solid-gas) reaction, and via a stirred bubble reactor for carbonation in an aqueous suspension (solid-water-gas). The dry carbonation was found to be extremely slow and consequently irrelevant in terms of a technical application. The solid-water-gas system, in contrast, was capable of reducing the CO<sub>2</sub> concentration in air by more than 30%. Concentrated solar energy at approximately 600°C could be used for the energy intensive calcination of magnesium carbonate back to magnesium oxide. For the combined calcination-reforming step, the experimental investigation of the solar chemical reactors was carried out in the ETH's High-Flux Solar Simulator. Two different reactor setups were used. Conversion of solids as well as hydrogen yield were estimated and compared to experimental data. Comparison of the results showed that one of the setups is more suitable for the calcination-reforming reaction, but for the pure calcination reaction the other setup is favorable, with a solid conversion of up to 83%.