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Performance of the carbonator and calciner during long-term carbonate looping tests in a 1 MW_{th} pilot plant

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Abstract

Carbon capture and utilization/storage is an effective means to reduce CO_2 emissions from power and energy intensive industries. Carbonate looping is a 2nd generation post-combustion CO_2 capture technology using solid sorbents that form carbonates when reacting with CO_2. This technology has economic benefits caused by the low efficiency penalty and the low cost of the sorbent. Autothermal continuous operation of this process at high CO_2 capture rates has been successfully proven in several pilot plants up to 1.7 MW_{th}. The 1 MW_{th} pilot plant in Darmstadt has been operated for more than 2,000 h with long periods of steady-state conditions, which allows the evaluation of the performance of the reactor system during long-term operation. This paper presents complementary results of these pilot tests focussing on the performance of the carbonator and calciner reactors. A high carbonator efficiency above 80 % is possible in the temperature range of 650 – 675 °C with a specific solid inventory above 700 kg/m^2 combined with either a high sorbent looping ratio of 16 $mole_{Ca}/mole_{CO2}$ or a high make-up ratio of 0.13 $mole_{Ca}/mole_{CO2}$. A calcination efficiency of 90 % can be achieved by a calciner space time above 6 min, if the calciner temperature is 30 K above the equilibrium temperature