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Enhanced CO₂ capture capacity of limestone by discontinuous addition of hydrogen chloride in carbonation at calcium looping conditions

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Abstract: Calcium looping technology is considered to be one of the most feasible techniques for CO₂ capture. A low-cost and easy method was proposed to improve the cyclic CO₂ capture capacity of the limestone by discontinuously adding hydrogen chloride (HCl) in the carbonation step in some cycles rather than in the each cycle at the calcium looping conditions. The effects of the discontinuous addition of HCl under the various conditions on the CO₂ capture performance of the limestone at the calcium looping conditions were investigated in a dual fixed-bed reactor. The results show that HCl addition during the initial several cycles leads to the formation of CaClOH and the moderate CaClOH in the carbonation product is favorable to CO₂ capture by the limestone. HCl addition only in the initial 3 cycles changes the effect of carbonation temperature on CO₂ capture by the limestone. The optimum carbonation temperature for the limestone with the addition of HCl is 700 °C in the range of 650-750 °C. Higher CO₂ volume fraction in the carbonation leads to lower CO₂ capture capacity of the limestone with the addition of HCl only in the initial 3 cycles. The discontinuous addition of HCl during the various cycles significantly enhances the CO₂ capture capacity of the limestone. HCl addition in the carbonation stage during only the initial cycles improves the pore structure of the calcined limestone and retards the fusion of CaO grains, which contributes to high CO₂ capture capacity of the sorbent in the multiple cycles.

Key words: limestone; calcium looping; HCl addition; CO₂ capture

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