RAPID AND HIGH-CAPACITY MGO COMPOSITES BY SALT-CONTROLLABLE PRECIPITATION FOR PRE-COMBUSTION CO_2 CAPTURE

Chang-Ha Lee, Dept. of Chem.& Biomol. Eng., Yonsei University, Seoul, Republic of Korea
leech@yonsei.ac.kr
Seongmin Jin, Dept. of Chem.& Biomol. Eng., Yonsei University, Seoul, Republic of Korea
Keon Ho, Dept. of Chem.& Biomol. Eng., Yonsei University, Seoul, Republic of Korea
Liu Lei, Dept. of Chem.& Biomol. Eng., Yonsei University, Seoul, Republic of Korea

Pre-combustion CO_2 capture at intermediate temperatures can allow for more flexibility to control over CO_2 emission in various industrial processes. For example, the pre-combustion capture can be applied for an Integrated Gasification Combined Cycle (IGCC) due to the use of relatively mild operating temperatures and accessible heat sources. Efficient materials for CO_2 capture and H_2 production in water gas shift reactor can contribute to improving the overall reliability and efficiency in IGCC process.

As a first step, we presented triple salt-promoted MgO composites (NaNaLi salts) by a precipitation method to enhance sorption capacity, rate, and stability. In the conventional precipitation method, a filtration step makes control and reproductivity of the salt composition difficult owing to the unknown residual salts. In this study, we developed a synthesis procedure of precipitation method to control the composition of salts as well as improve physical properties. As-prepared MgO exhibited excellent sorption capacities of 73.0 wt.% at 325 °C in pure CO_2 and high sorption rate within 10 min. Stability of composites were evaluated under various gas and time condition and were superior to those of the other MgO-based sorbents reported. With a wet gas mixture (29% CO_2, 3% H_2O, and balance N_2) for sorption and CO_2 regeneration, the working capacity stabilized after 20 cycles at 23 and 4.6 wt% for 60/15 min and 10/5 min cycles, respectively. The enhancement and reduction of working capacity along cycles were explained based on liquid phase sintering, i.e., rearrangement, solid-reprecipitation, and densification.

However, too long sorption time in the capacity evaluation is not practical because a fixed bed or fluidized bed has a difficulty of temperature control and a large bed size to control high volumes of gases. Therefore, further development is required for an advanced sorbent with high sorption rate and capacity in practical utilization. Therefore, as a second step, a facile method for sorbent with rapid and high-capacity CO_2 capture was developed by incorporating additional metal ion into salt-promoted MgO sorbents using a coprecipitation. At the same fast cycle (10min/5min), the cyclic sorption capacity of 12 wt.% was observed from the developed MgO composite by using wet mixture sorption (29 vol.% CO_2, vol.% H_2O and N_2 balance) and CO_2 regeneration.

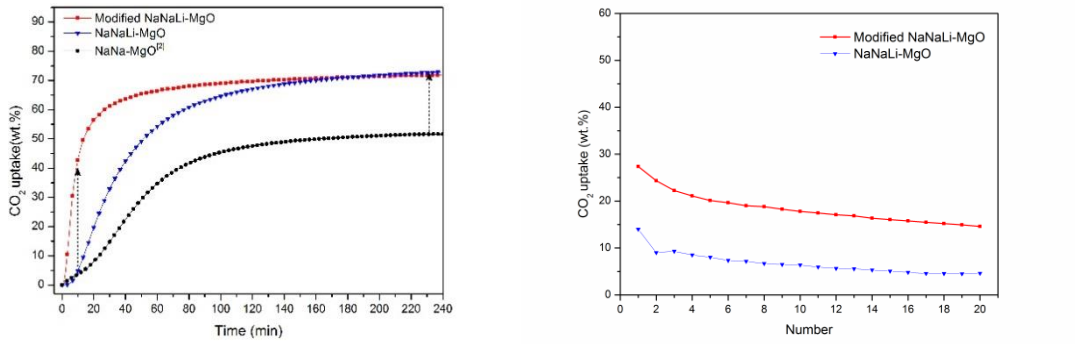

Figure. CO_2 uptake curves and cyclic capacity of NaNa-MgO, NaNaLi-MgO and modified NaNaLi-MgO.

[1] A-T Vu, Y Park, PR Jeon, CH Lee, “Mesoporous MgO Sorbent Promoted with KNO_3 for CO_2 Capture at Intermediate Temperatures,” Chem. Eng. J. 258 (2014) 254.
[2] A-T Vu, K Ho, S Jin, CH Lee, "Double Sodium Salt-promoted Mesoporous MgO Sorbent with High CO2 Sorption Capacity at Intermediate Temperatures under Dry and Wet Conditions," Chem. Eng. J, 291 (2016) 161-173.