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CO_2 capture over molecular basket sorbent: Promotion effect of aminopropyltriethoxysilane (APTES)

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Carbon capture, utilization and storage (CCUS) has been considered as a promising option to mitigate CO_2 emissions thus enabling continuous use of fossil fuels in short term to meet the increasing global energy demand.[1] Compared to conventional amine scrubbing, adsorption has been regarded as a promising alternative by the virtue of its non-corrosive property and lower energy penalty for regeneration.[2] Among them, molecular basket sorbents prepared by immobilizing CO_2-philic polymer such as polyethylenimine (PEI) onto nanoporous support have shown high CO_2 capacity and selectivity, good regenerability and stability, positive effect of moisture and thus received well.[3] Recently, additives such as PEG, surfactants, potassium carbonate, 1,2-epoxybutane have been studied to improve solid sorbents for CO_2.[4] Here, we report using aminopropyltriethoxysilane (APTES) as an additive to promote CO_2 sorption performance of PEI-based molecular basket sorbent.

Figure 1 shows the CO_2 capacity as a function of APTES loading over APTES/SiO_2 and 30PEI-APTES/SiO_2 sorbents at 75 °C measured by TGA. Compared to 30PEI/SiO_2, the 30PEI-APTES/SiO_2 sorbents exhibited higher capacity at the APTES loadings studied, except that with 80wt% loading, the capacity of which dropped significantly due likely to the significant decrease in the surface area and accessible amine sites caused by excess APTES loading[6]. Based on the capacities of 30PEI/SiO_2 and APTES/SiO_2, the weighted average capacity for 30PEI-APTES/SiO_2 was calculated and plotted, which is lower than the measured capacity of 30PEI-APTES/SiO_2 at the APTES loading < 45wt%, indicating the synergetic effect of PEI and APTES for CO_2 capture. The best sorbent formula is 30PEI-30APTES/SiO_2, the capacity of which was 145% better than that of 30PEI/SiO_2. Furthermore, the CO_2 sorption rate calculated from TGA profile (6.9 %/min) was 125% faster than that of 30PEI/SiO_2 (5.5 %/min).

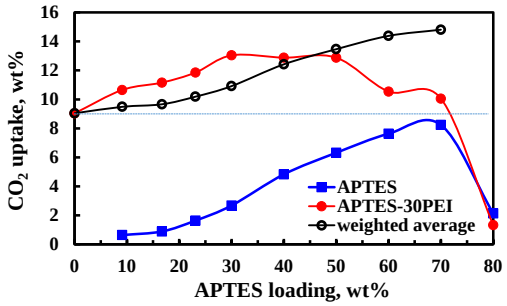

Figure 1. CO_2 capacity as a function of APTES amount over APTES/SiO_2 and 30PEI-APTES/SiO_2 sorbents.

The results demonstrate that the addition of APTES can not only enhance CO_2 sorption but also promote the sorption kinetics. The present work provides another general approach to design high performance CO_2 solid sorbents and may have a major impact on the advance of CCUS technologies.

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