Millimeter-sized pitch-based spherical activated carbons with small mesopores for CO_2 capture

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Abstract

Millimeter-sized spherical activated carbons is one of the most promising industrial CO_2 adsorbent. Preparation and optimizing prosity structure of millimeter-sized spherical activated carbons will be an interesting challenge for improving the CO_2 capture performance in the near future. A simple suspension polymerization coupling with oxidative stabilization, carbonization, and H_2O steam activation are applied to synthesize a series of hierarchical porous millimeter-sized pitch-based spherical activated carbons (PSAC). The as-obtained PSAC possess a tunable specific surface area from 975 m^2 g^{-1} to 1761 m^2 g^{-1}, a pore volume of 0.44 ~ 0.82 cm^3 g^{-1}, and spherical morphology via regulation of H_2O activation time. The CO_2 adsorption capacity is closely related to the ultramicroporous volumes below 0.2 bar. The introduction of small micropores has a positively influence on CO_2 adsorption capacity that can reach 2.59 mmol g^{-1} at 1.0 bar. When the pressure increasing to 5.0 bar, the micro-mesoporous PSAC shows higher CO_2 adsorption capacity of 7.23 mmol g^{-1} at 5.0 bar than microporous PSAC, indicating that the introduction of moderate mesopores can accelerate CO_2 diffusion rate and improve the utilization of micropores active adsorption sites. Moreover, the PSAC exhibit fast adsorption/desorption rate, an excellent selectivity and sensitive of CO_2/N_2 and CO_2/H_2O, good regenerated and easily scaled up for practical application.