X Encontro Brasileiro sobre Adsorção
27 a 30 de Abril de 2014
Guarujá - SP

AMINE-CONTAINING NAOPOROUS MATERIALS FOR CO_2 REMOVAL: PERFORMANCE AND STABILITY

Abdel Sayari

University of Ottawa, Department of Chemistry, Ottawa ON K1N 6N5 Canada
Phone: 1 (613) 562-5483 – Fax: 1 (613) 562-5170 – Email: abdel.sayari@uottawa.ca

ABSTRACT: Amine-containing nanoporous materials gained tremendous popularity in recent years as adsorbents for CO_2 removal. Properly designed amine-functionalized materials exhibit high adsorption capacity, fast CO_2 adsorption and desorption, and low-energy requirements for recycling. This contribution summarizes our multifaceted studies dealing with the following issues (i) importance of the structural properties of the support, including the pore size, volume and length, (ii) optimization of amine-grafting conditions, (iii) CO_2 adsorption capacity and rate, (iv) selectivity toward CO_2, (v) adsorption-desorption cycling, (vi) effect of moisture, (vii) oxidative degradation, and (viii) CO_2-induced deactivation. One of the most ubiquitous impurities in CO_2-containg industrial gases is SO_2. Being more acidic than CO_2, SO_2 adsorbs more strongly on primary and secondary amines than CO_2, leading to a deleterious effect on CO_2 uptake and material recycling. Our group developed novel adsorbent based tertiary amines both as single molecules and polymers which adsorbs SO_2 selectively and reversibly in the presence of much larger concentrations of CO_2. Our studies involved different grafted aminosilanes and impregnated polyethylenimines (PEI) on PE-MCM-41 and SBA-15 mesoporous silicas. Consistent with the exothermic nature of CO_2 adsorption, all grafted amines showed decreasing uptake as the temperature increased. However, impregnated PEI materials were dominated by diffusion resistance, with maximum uptake in the range of 50 - 80 °C. The diffusion resistance was mitigated by (i) decreasing the diffusion path length using mesoporous silica with short pores, or (ii) enhancing the dispersion of PEI using large pore silica with a layer of long alkyl chains.

KEYWORDS: Nanoporous materials, CO_2 adsorption, stability of CO_2 adsorbents, selectivity of CO_2 adsorbents, SO_2 selective adsorption.