Mohammad R M Abu Zahra, J Earth Sci Clim Change 2017, 8:9 (Suppl)
DOI: 10.4172/2157-7617-C1-032

3rd World Congress on

Climate Change and Global Warming

October 16-17, 2017 Dubai, UAE

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Amino-functionalized mesoporous silica-based adsorbent for CO_2 post-combustion capture

Conventional method capturing CO_2 using amine solution has been well-known and practiced in natural gas purification for long time, but it involves high energy demand, corrosion and degradation and not suitable to capture CO_2 from industrial sources like power plant flue gas. Amino-functionalized mesoporous silica adsorbent has emerged as a promising material for CO_2 post-combustion capture due to its possible reduction in regeneration energy, cheap price and ease to produce at large scale. Different types of adsorbents have been prepared by impregnating amines or grafting amino functional groups on inexpensive mesoporous silica and tested for CO_2 capture. Polyethyleneimine impregnated mesoporous silica (PEI-MPS) possesses high CO_2 loading (above 11 mg/g), it is easy to be produced at large scale and stable for multiple adsorption/regeneration cycles operating in a packed bed reactor. It lost only 16.6% CO_2 loading after 335 adsorption/regeneration cycles at 65/120°C, respectively. At high temperature, PEI-MPS encounters the vaporization of PEI causing a quick degradation, particularly in fluidized bed reactor. Amino-functionalized mesoporous silica (APTES-MPS) is synthesized by grafting method, in which, amino-functional groups form a chemical bond to silica substrate through Si-O-Si bridges. Thanks to the chemical bonding, APTES-MPS is more thermally and mechanically stable; it starts degradation at 205°C. Even though, the CO_2 loading of this adsorbent (~80 mg/g) is lower than that of PEI-MPS, it may be suitable for CO_2 capture using fluidized bed reactor. Recent study indicated that the use of PEI-MPS for CO_2 capture reduced ~46% regeneration energy in comparison with conventional 30% ethanolamine solution. This is due to the low heat capacity of solid adsorbent (~2.2 J/°C) and the avoidance of water vaporization. Mesoporous silica is produced using sodium silicate; cheap silica precursor therefore resulting amino-functionalized mesoporous silica could be inexpensive and suitable CO_2 capture. Highly stable adsorbent with significant reduction in energy consumption is a basis for an advanced CO_2 capture process.

Biography

Mohammad R M Abu Zahra is an Associate Professor and Department Head of Chemical and Environmental Engineering at Masdar Institute. His current research focuses on the development of CO_2 capture technologies including the development of advanced solvents, solid sorbents and novel processes. He is currently the Coordinator of the CCS research activities within Masdar Institute and he is leading major related projects.

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