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New Applications of Solid Phase Adsorbents

E. Rosenberg, *Organizer*

ABSTRACTS

IEC 13

Continuous ion exchange – extending sorbent horizons

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Traditionally the design and application of adsorbents, and specifically ion exchange materials, has been focused on Fixed Bed System designs. The advent of mature CIX (Continuous Ion exchange) equipment systems has precipitated an interest in utilizing ion exchangers in new areas based upon the advantages gained through proper application of CIX principles. Sorbent manufacturers have still to adapt their products to be used in an optimized manner with CIX plant design. This paper will outline the multiple benefits of applying CIX in place of Fixed Beds and also cite examples of how complex schemes can be integrated into a well designed system. Benefits described will stress the economic impact of CIX including upstream and downstream savings from use of sorbents in combination with state-of-the-art CIX technology.

IEC 14

Short bed ion exchange process

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Traditional ion exchange processes use a cylindrical vessel half filled with conventional resin and pass the process fluid and regenerant chemical co-currently down through the bed. Short bed ion exchange optimizes this process by altering the properties of the resin and the contacting process. This is done by a 75% reduction of bead diameter to

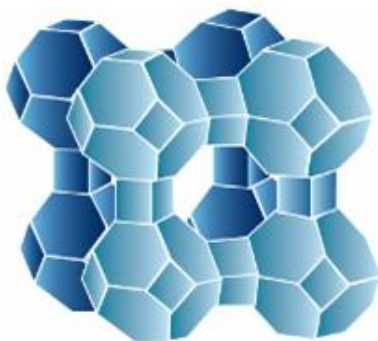
improve kinetics, a reduction in bed depth to 3" – 24" to reduce resin inventory, removal of column freeboard to minimize dilution, counter-current regeneration to minimize chemical consumption, a reduction in resin loading per cycle to improve kinetics and minimize resin swelling. This presentation will describe short bed IX technology and its various uses. Applications include the separation of acids and metals in hydrometallurgical processes, removal and recovery of metals in surface finishing, selective separation of Cl using amphoteric resins, hardness and sulphate separation from brine using impregnated resins, and demineralization and water softening.

IEC 15

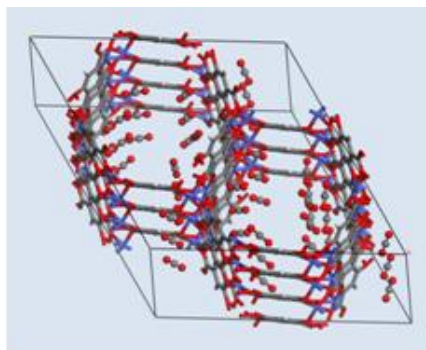
Solid adsorbents for CO₂ separation

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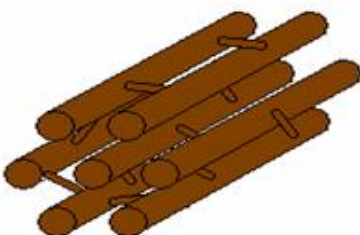
Concern about global warming has sparked interest in the potential of solid adsorbents to capture CO₂ from large emission sources such as fossil-fuel power stations. Adsorbents that have been considered include carbons, zeolites, mesoporous silico-aluminates, metal organic frameworks (MOFs), together with materials that have been further modified by the incorporation of (usually) amines. In the former cases separation is achieved via physisorption phenomena, whereas with the latter materials it is via a chemisorption mechanism. The objective of adsorbent development is to tailor materials that have a high and reversible capacity for CO₂ adsorption, high selectivity over N₂, tolerance to H₂O and trace impurities in the feed gas stream. Sequestration ready CO₂ can be recovered using a temperature or pressure swing. The presentation will focus on the attributes and weaknesses of the various adsorbent types for CO₂ separation under various process conditions and on strategies to improve these sought-after characteristics.



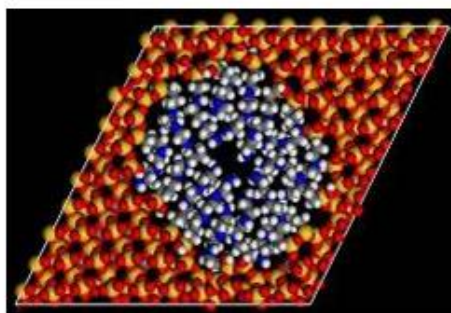
Zeolites



MOFs



**Mesoporous
Carbons**



Hybrids

IEC 16

New 'non-porous' sorbents for gas storage and separation

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More than 800 papers have been published on p-tert-butylcalix[4]arene. However, we have recently discovered that this well-known macrocycle undergoes single-crystal-to-single-crystal phase transitions upon guest uptake and release. The calixarene does not possess pores or channels in the solid state. However, despite a lack of porosity of the material, guest transport through the solid occurs readily until a thermodynamically stable structure is achieved. In order to actively facilitate this dynamic process, the host molecules undergo significant positional and/or orientational rearrangement. This transformation of the host lattice is triggered by weak van der Waals interaction between the molecular components. In order for the material to maintain its macroscopic integrity, extensive cooperativity must exist between molecules throughout the crystal, such that rearrangement can occur in a well-orchestrated fashion. Implications of this discovery for gas separation and gas storage will be discussed. Several new, non-porous organic solids have also been found to exhibit remarkable sorption behavior. This has led us to the so-called 'frustrated organic solids'.