



CO₂ Adsorption and Desorption studies for zeolite 4A

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Abstract

Fossil fuel power plants generate carbon dioxide in large amount, its capturing and storing has received widespread attention and is viewed as an indispensable action for CO₂ discharge reduction. In this study, CO₂ adsorption capacities were measured for zeolite 4A. Breakthrough adsorption studies were done. The best for carbon dioxide adsorption and desorption over zeolite 4A has been considered. Zeolite characterized by ultraviolet and amineulable spectrometers, X-ray diffraction (XRD), surface area (area of the adsorbent measured by standard strategy for Brunauer, Emmett and Teller (BET)) by Nitrogen adsorption strategy and thermogravimetric investigation (TGA). The adsorption behaviour of carbon dioxide (CO₂) on these adsorbents was explored at 30°C, 35°C, 50°C. Adsorption limit has been found for zeolite 4A at 30°C, 35°C, 50°C, is 336.77, 607.2, 406.38 mg/g of zeolite individually for given technique for adsorption. CO₂ desorption has been studied.

Keywords: Adsorption, desorption, break through capacity, XRD, Carbon dioxide.

Introduction

Burning of fossil engines lead the release of CO₂ to the climate, which is accepted to cause global warming. Fossil fuel based power plants emit carbon dioxide, its capturing has received widespread attention and is viewed as a critical approach for CO₂ emission reduction. CO₂ is by far one of the greenhouse gases being responsible for about 60% rise in greenhouse effect^[1]. The introduction pollutants which cause harm to human or other living organisms like chemicals, particulate matter, or biological materials that is air pollution^[2]. Pollution is considered one of the main problems around the world^[3]. Natural contamination and its effect on plant have very much perceived. The role of air pollutants causing injury to plants^[4,5]. The decrease released carbon dioxide to atmosphere from stationary sources like power plants, that is of critical importance^[6]. Its separation and purification process adsorption is one of the effective techniques. Adsorption of gases on smaller scale permeable adsorbents is receiving increased attention in view of the importance of removal and recovery of CO₂. In this era utilization of a lot of fossil fuels has become one of the need of human, which lead to most serious global environment problems, which is now required to be seriously addressed worldwide^[7-10].

This work is focused on studying of adsorbent capacity for CO₂ capture. In this study, the mesoporous cylindrical particles were chosen as adsorbents to study adsorption performance of CO₂, and breakthrough or dynamic method performed^[11-13]. One of the effective option for CO₂ capture is solid adsorbent adsorption. Sorbents with high adsorption capacity are desired. For viable applications on the other hand, the accomplishment of this

methodology relies on upon the determination of an adsorbent adsorption capacity with a high CO₂ selectivity. Characterization, CO₂ adsorption capacity and desorption study of the 4A zeolite^[14-17]. Zeolites are utilized broadly as a part of numerous mechanical applications mainly in adsorption, catalysis and gases separation and ion exchange purposes^[18]. Adsorption and desorption of CO₂ over zeolite 4A has been studied^[19].

Material and Methods

Zeolite are crystalline, hydrated aluminosilicates of T and B group components, specifically, sodium, potassium, magnesium, calcium, barium and strontium^[20]. Fundamentally, zeolites are structure aluminosilicate which are based on infinitely extending three dimensional AlO₄ and SiO₄ tetrahedral linked to each other by sharing all the oxygen. They can be represented by the observational equation $M_x/n(O_2 - Al_2O_3 \cdot x SiO_2 \cdot y H_2O)$ in this equation, x is for the most part equivalent to or more prominent than 2 since tetrahedral are joined only to tetrahedral SiO₄, and, n is the valency of the cation^[21]. Zeolite 4A in the form of pellets of more or less 3 mm. Adsorbent was bought from Merck, India Ltd. Carbon dioxide (99%) was received from Tata Gasco, Nagpur, India. GC grade ultra unsaturated the (99.999%) was gotten from Chemtec Technologies, Nashik, India for directing the adsorption studies^[22].

Characterization of Material: Zeolite 4A, was described, utilizing distinctive characterization procedures. X-ray diffraction has been studied utilizing a diffractometer which is of Phillips Analytical Xpert, with monochromatic Cu K α

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Zeolite Chemistry and Applications Benoit Louis, Marcelo Maciel Pereira, Qiang Wang, 2020-04-20 *CO2 Adsorbents* Ahad Ghaemi, Zohreh Khoshraftar, Fereshteh Pouresmaeil, 2025-09-10 *CO2 Adsorbents* comprehensively explores the materials and technologies used for adsorbing carbon dioxide. It covers materials synthesis, characterization, adsorption mechanisms, applications, modeling, and potential environmental and industrial impacts to help readers find the best adsorbent for their needs. Through its coverage of advanced research and technological developments in the field, such as novel adsorbent materials, innovative synthesis methods, and advancements in scalable production techniques, the book aims to contribute to the understanding of CO2 adsorption processes, materials, and their practical applications in addressing the global challenge of climate change and CO2 emissions reduction. Presents an overview of different adsorbent materials used for CO2 capture and the methods of synthesis, modification, and functionalization to enhance their CO2 adsorption performance. Describes characterization techniques used to assess the structural, morphological, and surface properties of CO2 adsorbents. Explores the fundamental mechanisms behind CO2 adsorption of various materials, the interactions between CO2 molecules and the adsorbent surface, and the kinetics and thermodynamics of CO2 adsorption processes. Discusses through real-world case studies the applications of CO2 adsorbents in various industries, such as natural gas purification, carbon capture and storage, biogas upgrading, and air purification, and their potential in mitigating greenhouse gas emissions and addressing environmental concerns. Analyzes the environmental impact and feasibility of using CO2 adsorbents in real-world scenarios and the challenges and benefits of integrating adsorption technologies into existing industrial processes. Provides insights into potential improvements, challenges, and directions for further research and development. Through its practical relevance, advanced insights, and focus on sustainability and innovation, this text serves as a valuable resource for researchers, engineers, and professionals working in the field of carbon capture and utilization, including those in chemical, environmental, and related engineering disciplines.

Advances in Carbon Capture Mohammad Reza Rahimpour, Mohammad Farsi, Mohammad Amin Makarem, 2020-08-04 *Advances in Carbon Capture* reviews major implementations of CO2 capture, including absorption, adsorption, permeation, and biological techniques. For each approach, key benefits and drawbacks of separation methods and technologies, perspectives on CO2 reuse and conversion, and pathways for future CO2 capture research are explored in depth. The work presents a comprehensive comparison of capture technologies. In addition, the alternatives for CO2 separation from various feeds are investigated based on process economics, flexibility, industrial aspects, purification level, and environmental viewpoints. Explores key CO2 separation and compares technologies in terms of provable advantages and limitations. Analyzes all critical CO2 capture methods in tandem with related technologies. Introduces a panorama of various applications of CO2 capture.

Zeolites and Related Materials: Trends, Targets, and Challenges (SET) Antoine Gedeon, Pascale Massiani, Florence Babonneau, 2008-08-19 The present book

Zeolites and Related Materials Trends Targets and Challenges reports the communications that have been presented at the 4th International FEZA Federation of European Zeolite Associations Conference in Paris September 3 6 2008 It gives an excellent overview of the present state of the art of ordered nanoporous solids including zeolites as well as synthetic layered materials clays nanosized molecular sieves ordered mesoporous solids metal organic framework compounds MOFs carbons etc with emphasis on the synthesis comprehensive characterization and advanced applications The significant research activities in this domain are due to the outstanding properties of those nanoporous materials that concentrate the collaborative efforts of researchers from material science chemistry physical chemistry and physics The understanding and development of the unique properties of porous materials relies on a unique blend of multidisciplinary knowledge covering material science with the implication of organic and colloid chemistry to prepare micro and mesoporous materials surface and adsorption sciences sustained by theory and modelling to understand the peculiar behaviour of molecules in confined systems special branches of catalysis physics chemical engineering and life science to design novel applications This book summarizes the developments in the area of nanoporous solids at the dawn of the 21st century useful for both students young researchers entering the field of nanoporous materials as well as for senior scientists Also summarizes the new family of porous compounds e g MOF s and ordered porous carbon The present state of the art and prospects of nanoporous solids for advanced applications is discussed Nanomaterials for Environmental Applications Mohamed Abou El-Fetouh

Barakat,Rajeev Kumar,2022-02-03 Nanomaterials for Environmental Applications offers a comprehensive review of the latest advances in nanomaterials based technologies for the treatment of emerging contaminants in wastewater It describes the latest developments in the synthesis protocols including the synthesis of different kinds of nanostructure materials using various physical and chemical methods Features Discusses the synthesis and characterization of important nanomaterials such as carbon nanostructures metal and metal oxide nanostructures polymer nanostructures and smart 1D 3D nanomaterials Presents the latest techniques used in the characterization of nanomaterials Covers environmental applications including the remediation of pollutants in wastewater and water purification and disinfection Examines the sources fate transport and ecotoxicology of nanomaterials in the environment Aimed at researchers and industry professionals this work will be of interest to chemical environmental and materials engineers concerned with the application of advanced materials for environmental and water remediation Mohamed Abou El Fetouh Barakat is a Professor of Environmental Sciences at both King Abdulaziz University KAU Saudi Arabia and Central Metallurgical R D Institute CMRDI Egypt He is highly qualified in the fields of industrial waste management and pollution control as well as catalysis and nanotechnology His experience includes academic research works in Japan Germany the United States and Saudi Arabia as well as initiating and leading industrial research projects in Egypt jointly with the United States Rajeev Kumar is an Associate Professor in the Environmental Science Department King Abdulaziz University Jeddah Saudi Arabia His research

activities are in the areas of wastewater treatment and materials science He studies the adsorption and photocatalytic properties of nanomaterials for the removal of contaminants from wastewater Decarbonization Technology Nik Abdul Hadi Sapiaa,Lam Man Kee,Khairulazhar Jumbri,Bamidele Victor Ayodele,Syaza Izyanni Ahmad,2025-05-25 The Proceedings of the International Conference on Decarbonization Technology ICDT2024 cover a wide range of topics including Hydrogen Solar and Thermal Energy Biomass and Biofuel Carbon Capture and Utilization Green Processes and Materials and Carbon Offsets and Accounting Keywords Hydrogen Production Bioethanol Lithium Recovery Gas Separation Refrigeration Oils Microwave Heating Rubber Waste Tyre CO2 Adsorption Nanofluids Hybrid Supercapacitor CO2 Hydrogenation Oil Palm Wastes Methanol Production Biogas Upgradation Bacterial Nanocellulose Foam Polymer Aerogel Marine Farm Palm Kernel Oil Lithium ion Batteries Beverages for Astronauts Simulation Software Blue Energy Carbon Capture and Storage Nuclear Fusion Quantum Chemistry Porous Media Carbon Quantum Dots **Research in Progress** ,1971 *The Adsorption of Straight Chain Hydrocarbons from Ternary Liquid Solutions by 5A Molecular Sieve Crystals* Moinuddin Hasan Ali,1975 Paper ,1963 **Japanese Technical Periodical Index** ,1987 *Fundamentals of Heat Transfer in Porous Media*, 1992 Massoud Kaviani,1992 *Proceedings of the 12th International Zeolite Conference* Michael M. J. Treacy,1999 The MRS Symposium Proceeding series is an internationally recognised reference suitable for researchers and practitioners Petroleum Abstracts ,1994 **Physics Briefs** ,1993 *Dissertation Abstracts International* ,2006 **Natural Zeolites** G. V. Tsitsishvili,1992 *Government Reports Announcements & Index* ,1989 **Japanese Technical Abstracts** ,1987 *Theoretical Chemical Engineering Abstracts* ,1986 **Humidity and Moisture: Applications.** E.J. Amdur, editor Arnold Wexler,1965

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