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CO2 Emission Control Using Selective Oxidation of Catalytic Zeolite13x

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Abstract: ***For this research, Zeolite 13 x was prepared under high pressure with a mixture of activated charcoal and Natural coconut residue. The isotherms of adsorption and Kinetic curves of the Co2 on the prepared adsorbent materials are measured at 328k, 318 k, 308 k, and 298 K and using the gravimetric adsorption method, and with a pressure range of 0–30 bar[1]. Separately, the mass transfer constants and adsorption activation energy Ea of CO2 on the adsorbents were calculated. The results showed that the amount of CO2 adsorbed on the zeolite 13X was greater. The linear driving force (LDF) model can accurately describe CO2 adsorption kinetics. The mass transfer constants of CO2 adsorption on both samples increased as the temperature increased. The adsorption activation energy Ea for CO2 on the two adsorbents decreased as the concentration increased[2].***

I. INTRODUCTION

Targets and tariffs are being adopted to reduce gas release to the atmosphere since there is growing concern about the environmental effect of anthropogenic gas emissions, notably carbon dioxide. [3] Global climate change and even more extreme weather conditions have occurred during the past century as a result of the fast increase in atmospheric CO2 concentration. Controlling CO2 emissions may have a tremendous influence on the planet and people in terms of social, economic, and environmental factors[4]. Global carbon dioxide (CO2) emissions from fossil fuels and industry have increased considerably since 2000, and in 2019 reached a record high of 36.7 billion metric tons of CO2. At this time, fossil fuels supply more than 85% of the world's energy needs. Coal-fired power stations are the principal source of the approximately 40% of total CO2 emissions that are attributable to fossil fuel power plants. [5]Therefore, from an energy perspective, it is thought that removing and recovering CO2 from coal-fired facilities is the most efficient strategy to lower world CO2 emissions. Separation, transport, and sequestration are the three main phases in CO2 management. [6] Although many different methods have been suggested to sequester CO2, the key to sequestration is the removal of CO2 through the gas separation process. Adsorption will be one of the most crucial methods in the commercial and industrial applications for the collection or separation of CO2. Thus, for an effective adsorptive process, it is essential to produce an adsorbent with high adsorption capacity, high selectivity, high thermal and chemical durability, and high adsorption rate[7]. Today, physisorption in micropores employing inorganic porous materials such zeolite 13X, 4A, and activated carbon for room and medium temperature use are being pursued in the sorption processes based on solid adsorbents. Siriwardene et al. used volumetric techniques to compare the CO2 adsorption capacities of molecular sieve 13X and activated carbon in the 0–20 bar pressure range. The adsorption capacity of activated carbon for CO2 was found to be lower at low pressures (25 psi) than that of the molecular sieve 13X, whereas at higher pressures (>25 psi), the activated carbon demonstrated much greater adsorption capacities. compared to 13X, CO2's ability for adsorption[8]. In their study of the CO2 adsorption isotherms on zeolite 13X and zeolite 13X=activated carbon at low pressure ranges of 0-1.0 bar, Lee et al. (31) found that the amount of CO2 adsorbed on zeolite 13X was higher than that on zeocarbon, but that the two adsorbents' adsorption capacities converged as pressure rose. At high pressures of 0-50 bar, Cavenati et al. investigated the equilibrium of CO2 adsorption on zeolite 13X. The zeolite 13X demonstrated extremely potent and selective CO2 adsorption[9].

Kinetic analyses of CO2 adsorption on porous adsorbents, however, were hardly reported. Adsorption kinetics and equilibrium are both crucial factors in determining how well an adsorbent adsorbes. [10] The performance of CO2 adsorption on zeolite 13X and activated carbon with a high surface area should therefore be studied. Studying the CO2 adsorption on zeolite 13X and activated carbon with a high surface area (AC-h) at various temperatures is the goal of this work. At various temperatures and pressures, the two adsorbents' CO2 adsorption isotherms and kinetic curves were individually measured. Separate estimates would be made for the CO2 adsorption rate coefficients and adsorption activation energies on the adsorbents. By using an Accelerated Surface Area and Porosimetry Apparatus, the textural characteristics of the adsorbents were identified (ASAP 2010). In this article, the effects of the adsorbents' pore size and surface area on the CO2 adsorption on the two adsorbents will be studied and reported. [11]

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II. EXPERIMENTATON

A. *Preparation*

Using natural coconut waste and silica-alumina gel, a 13X zeolite sample was created using alkali fusion and hydrothermal treatment. During this preparation, the zeolite was constantly introduced to the Coconut scrap waste mixture in the molar ratio or 14:3. Activated Carbon and coconut residue were ground and fused in a ceramic crucible at 100 C for 4 hours[12] [13] [14]. The fused mixture was pulverized further and added to water (10 g fused mixture/75 ml water) after cooling at room temperature. The resulting slurry was stirred for 2 hours at 50 C to homogenise it (800 r/min), and then crystallized for 24 hours (300 r/min) at 50 C[15,16,17,18]. After being separated by filtration, the solid was thoroughly cleaned with deionized water several times, and then it was dried at 105 Degrees and put inside an autoclave. After drying it out the powdered form of the modified zeolite 13x is obtained[19] [20].

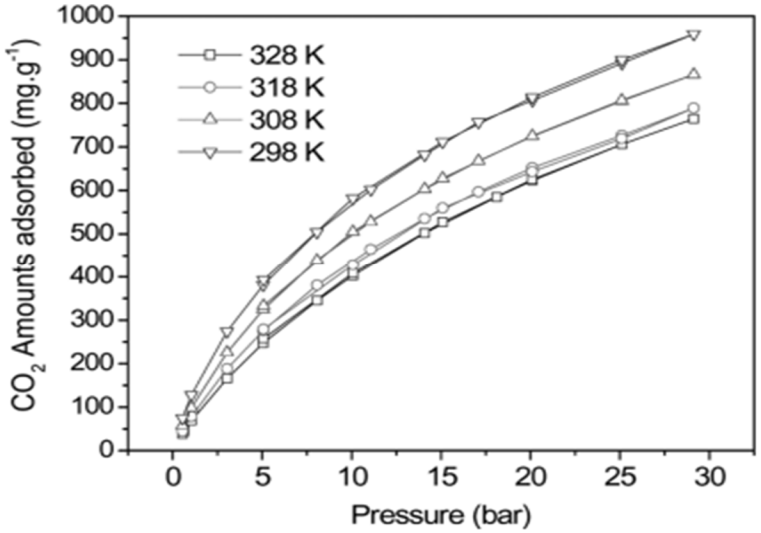
B. *Instrumentation*

Maganetic suspension balance RUBOTHERM was used to measure the adsorption isotherms and kinetic curvers of CO2 on an adsorbent. The specific surface area, pore volume, and average pore diameter of samples were measured by nitrogen adsorption at the liquid nitrogen temperature 77 K

C. *CO2 Adsorption Measurement*

On an RUBOTHERM magnetic suspension balance, the CO2 adsorption kinetic tests were performed at varied temperatures and pressures of 0.5 bar, 3.0 bar, and 20.0 bar. [21] First,1=3–1=2 The sample container was filled with (v% of sample container) adsorbent before being set on the magnetic suspension balance within the measurement cell. Before the adsorption experiment began, the zeolite 13X and the AC-h were, respectively, degassed at 523 K for 8 and 4 hours in a vacuum atmosphere, and their respective weights were then regularly measured with the use of a magnetic suspension balance as the adsorption took place. Additionally, the quantities of CO2 adsorbed on the two adsorbents as a function of time were assessed using the adsorption kinetic curves. Third, the adsorption kinetic experiment came to a conclusion when the sample's weight stopped fluctuating, indicating that equilibrium had been reached (the two adsorbents were saturated with CO2). The above-mentioned adsorption kinetic experiments of these two adsorbents were conducted separately at 0.5 bar, 3.0 bar, and 20.0 bar in order to obtain the adsorption kinetic curves for the adsorption of CO2 on the zeolite 13X and the AC-h under the condition of different pressures. [22]

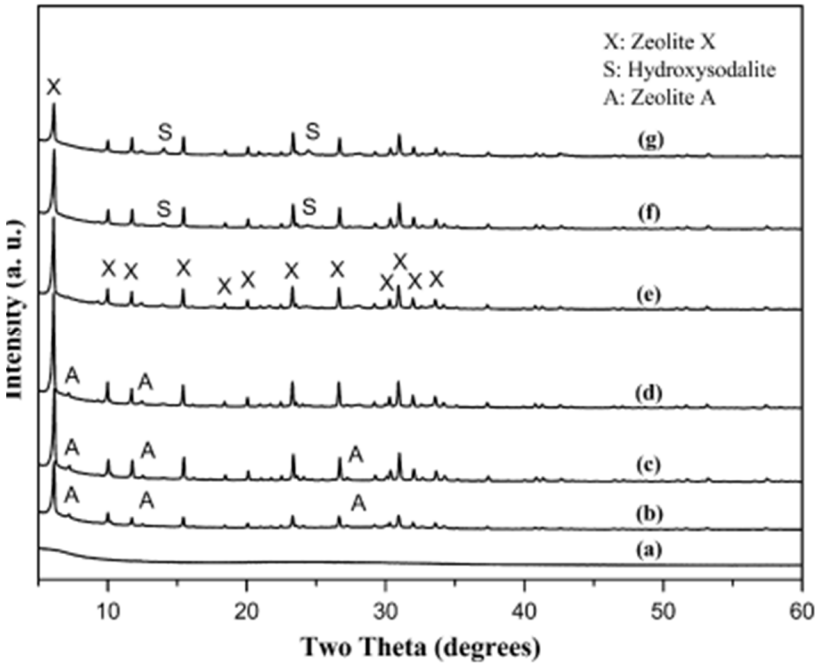
On an RUBOTHERM magnetic suspension balance, the CO2 adsorption-desorption isotherms at 298 K, 308 K, 318 K, and 328 K were measured. The Zeolite 13X sample underwent initial activation at 523 K for 10 and 4 hours, respectively, in a vacuum environment. In this study, He (U-sung, ultra-high purity) was used as a purge gas. High purity CO2 (99.999%) gas was used for the adsorption processes. Experiments on adsorption and desorption were carried out at the same temperature. The following isotherm was observed. [23,24,25]



CO2 adsorption isotherm of the newly synthesized zeolite

D. Characterization of the newly Formed Product

XRD patterns of the synthesized products obtained at different temperature (a) 50 C, (b) 70 C, (c) 90 C, and (d) 100 C. This was used to finalise the Different products involved. [26,27]



XRD patterns of the synthesized product obtained at different temperature (a) 50 C, (b) 70 C, (c) 90 C, and (d) 100 C Here Zeolite A refers to zeolite procured from Noble Catalysts, Mumbai

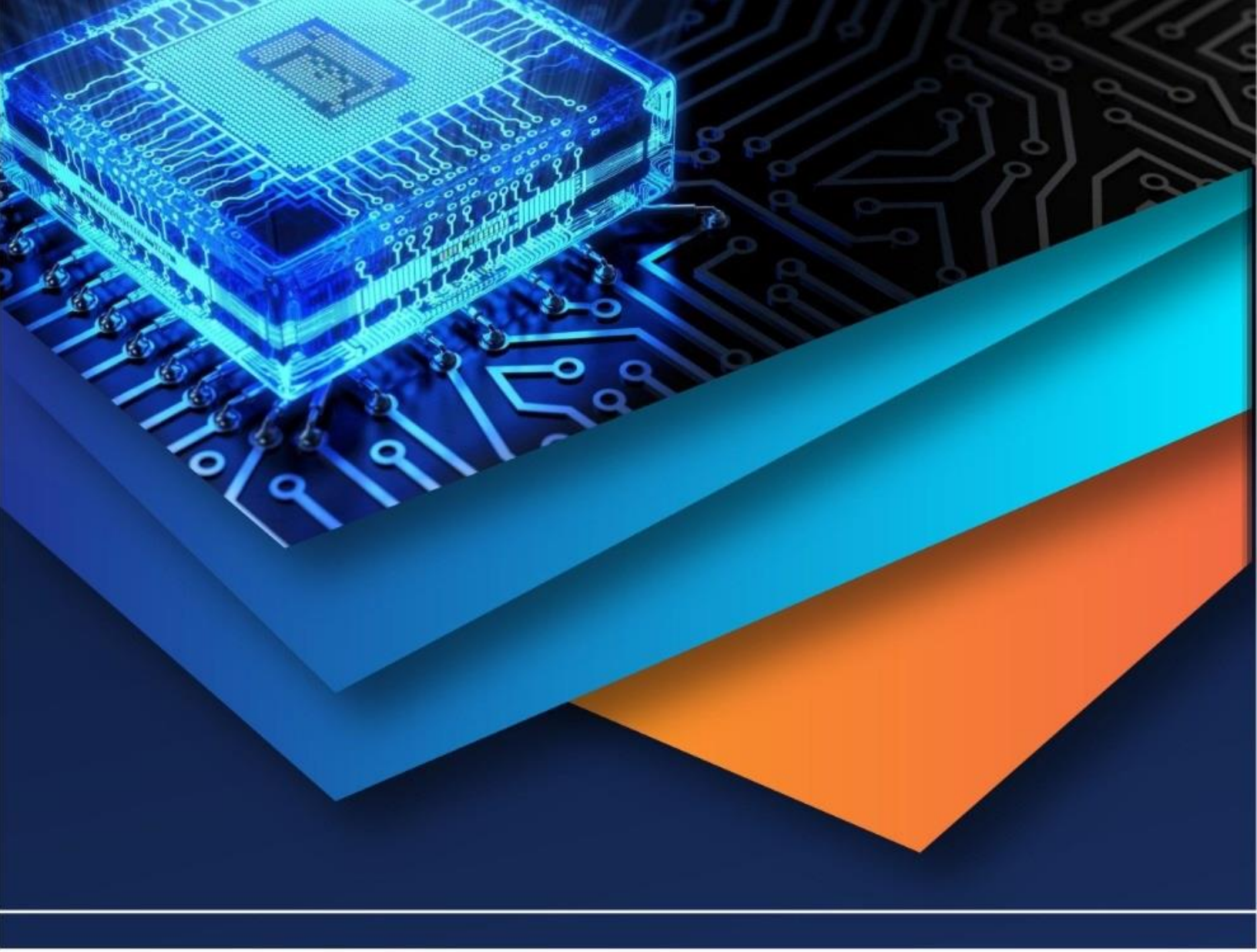
III. CONCLUSION

1) The findings of this investigation enable us to make the following deductions:
2) Zeolite 13 x was prepared under high pressure with a mixture of activated charcoal and Natural coconut residue.
3) The isotherms of adsorption and Kinetic curves of the Co2 on the prepared adsorbent materials are measured and found to have significant adsorbant values.
4) Characterization of the newly formed product was Completed.

REFERENCES

[1] Alshameri, C.J. Yan, A.A. Yasir, S.D. Ammar, I. Abdullateef, C.Y. Zhou, H.Q. Wang, An investigation into the adsorption removal of ammonium by salt activated Chinese (Hulaodu) natural zeolite: kinetics, isotherms, and thermodynamics, Journal of the Taiwan Institute of Chemical Engineers (2013), http://dx.doi.org/10.1016/j.jtice.2013.05.008.
[2] Adams T A II and Barton P I 2010 High-efficiency power production from natural gas with carbon capture J. Power Sources 195 1971–83
[3] Khojasteh Salkuyeh Y, Saville B A and MacLean H L 2017 Techno-economic analysis and life cycle assessment of hydrogen production from natural gas using current and emerging technologiesInt. J. Hydrogen Energy 42 18894–909
[4] Y. Yan, T. Bein, Zeolite thin films with tunable molecular sieve function, Journal of the American Chemical Society 117 (1995) 9990–9994.
[5] Rostrup-Nielsen J R and Rostrup-Nielsen T 2002 Large-scale hydrogen production Cattech 6 150–9
[6] T. Wajima, Y. Ikegami, Synthesis of crystalline zeolite-13X from waste porcelain using alkali fusion, Ceramics International 35 (2009) 2983–2986.
[7] H. Tanaka, A. Fujii, Effect of stirring on the dissolution of coal fly ash and synthesis of pure-form Na-A and -X zeolites by two-step process, Advanced Powder Technology 20 (2009) 473–479
[8] Hankin A and Shah N 2017 Process exploration and assessment for the production of methanol and dimethyl ether from carbon dioxide and water Sustainable Energy & Fuels 1 1541–56
[9] N.R.C.F. Machado, D.M.M. Miotto, Synthesis of Na-A and -X zeolites from oil shale ash, Fuel 84 (2005) 2289–2294.
[10] Zhou J, Zhao H, Li J, Zhu Y, Hu J, Liu H and Hu Y 2013 CO2 capture on micro/mesoporous composites of (zeolite A)/(MCM-41)with Ca2+ located: Computer simulation and experimental studies Solid State Sci. 24 107–14
[11] T. Wajima, M. Haga, K. Kuzawa, H. Ishimoto, O. Tamada, K. Ito, T. Nishiyama, R.T. Downs, J.F. Rakovan, Zeolite synthesis from paper sludge ash at low temperature (90 C) with addition of diatomite, Journal of Hazardous Materials 132 (2006) 244–252.

[12] Glover B K and Shakur M S 2018 Processes and apparatuses for removing contaminants from hydrogen streamsGoogle Patents United States UOP LLC(Des Plaines, IL, US)20180117523http://www.freepatentsonline.com/y2018/0117523
[13] R. Ruiz, C. Banco, C. Pesquera, F. Gonzalez, I. Benito, J.L. Lopez, Zeolitization of a bentonite and its application to the removal of ammonium ion from waste water, Applied Clay Science 12 (1997) 73–83.
[14] Lee H, Yanilmaz M, Toprakci O, Fu K and Zhang X 2014 A review of recent developments in membrane separators for rechargeable lithium-ion batteries Energy & Environmental Science 7 3857–86
[15] Wang Y, Du T, Jia H, Qiu Z and Song Y 2018 Synthesis, characterization and CO2 adsorption of NaA, NaX and NaZSM-5 from rice husk ash Solid State Sci. 86 24–33
[16] Wongcharee S, Aravinthan V and Erdei L 2019 Mesoporous activated carbon-zeolite composite prepared from waste macadamia nut shell and synthetic faujasite Chin. J. Chem. Eng. 27 226–36
[17] D. Chen, X. Hu, L. Shi, Q. Cui, H.Y. Wang, H.Q. Yao, Synthesis and characterization of zeolite X from lithium slag, Applied Clay Science 59 (2012) 148–151.
[18] F.G. Colina, S. Esplugas, J. Costa, High temperature reaction of kaolin with inorganic acids, British Ceramic Transactions 100 (2001) 203–206.
[19] F.G. Colina, S. Esplugas, J. Costa, High-temperature reaction of kaolin with sulfuric acid, Industrial & Engineering Chemistry Research 41 (2002) 4168– 4173.
[20] Arshad S E, Rahman M L, Sarkar S M, Yusslee E F and Patuwan S Z 2018 Hydrothermal synthesis of zeolite T from kaolin using two different structure-directing agents Mater. Res. Express 5 015011
[21] Kunecki P, Panek R, Wdowin M and Franus W 2017 Synthesis of faujasite (FAU) and tschernichite (LTA) type zeolites as a potential direction of the development of lime Class Cfly ash Int. J. Miner. Process. 166 69–78
[22] Liu Y, Luo Q, Wang G, Li X and Na P 2018 Synthesis and characterization of zeolite from coal fly ash Mater. Res. Express 5 055507 [23] Liu Y, Wang G, Wang L, Li X, Luo Q and Na P 2019 Zeolite P synthesis based on fly ash and its removal of Cu (II) and Ni(II) ionsChin. J. Chem. Eng. 27 341–8
[23] C.A. Ríos, C.D. Williams, M.A. Fullen, Nucleation and growth history of zeolite LTA synthesized from kaolinite by two different methods, Applied Clay Science 42 (2009) 446–454.
[24] C.A. Ríos, C.D. Williams, Synthesis of zeolitic materials from natural clinker: a new alternative for recycling coal combustion by-products, Fuel 87 (2008) 2482–2492.
[25] T. Jiang, G.H. Li, G.Z. Qiu, X.H. Fan, Z.C. Huang, Thermal activation and alkali dissolution of silicon from illite, Applied Clay Science 40 (2008) 81–89.
[26] M. Mezni, A. Hamzaoui, N. Hamdi, E. Srasra, Synthesis of zeolites from the lowgrade tunisian natural illite by two different methods, Applied Clay Science 52 (2011) 209–218.
[27] D. Novembre, B.D. Sabatino, D. Gimeno, M. Garcia-Vallès, S. Martínez-Manent, Synthesis of Na-X zeolites from tripolaceous deposits Crotone, Italy) and volcanic zeolitised rocks (Vico volcano, Italy), Microporous and Mesoporous Materials 75 (2004) 1–11.



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