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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]

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].

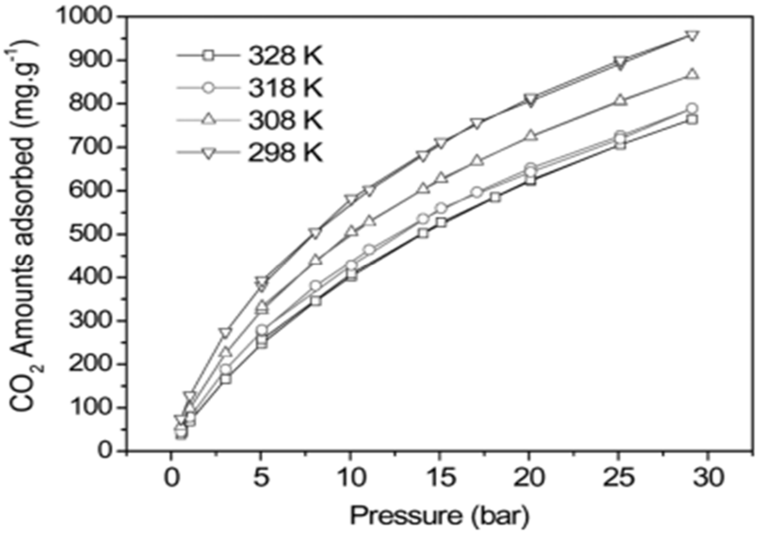
B. Instrumentation

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]

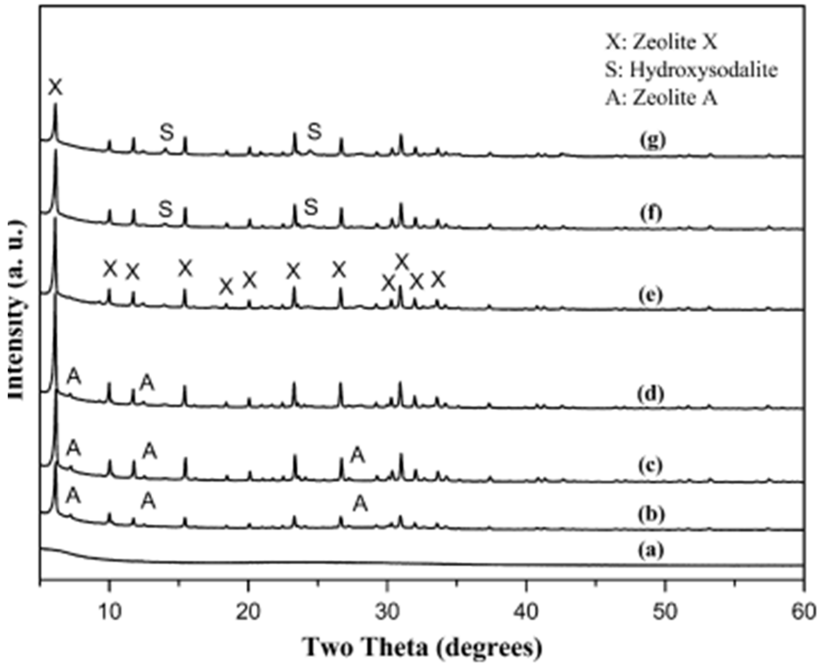
On an RUBOTHERM magnetic suspension balance, the CO2 adsorption-desorption isotherms at 298 K, 308 K, 318 K, and 328 K were measured. The Zeolite 13X sample underwent initial activation at 523 K for 10 and 4 hours, respectively, in a vacuum environment. In this study, He (U-sung, ultra-high purity) was 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.

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