

EXPERIMENTAL INVESTIGATION OF THE FEASIBILITY OF CORNCOB ACTIVATED CARBON FOR ADSORBED NATURAL GAS STORAGE

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ABSTRACT

In this study, activated carbon was synthesised from corn cobs through a two-step process involving carbonization at 600°C within an airtight furnace and chemical activation utilising phosphoric acid. The resultant activated carbon derived from corn cobs demonstrated significant adsorption capabilities, with a substantial BET surface area of 860.500 m²/g and exhibiting favourable adsorption-desorption kinetics. These attributes position it as an exceptional precursor material to produce nanoporous carbon materials suitable for the storage of natural gas. Two distinct sample sizes, measuring 841 microns and 400 microns, were meticulously chosen for examination in this investigation. The findings derived from the adsorption of natural gas, quantified in terms of volume-based metrics, revealed a direct and positive correlation between increasing pressures and pore sizes, resulting in higher adsorption capacities. The experimental conditions encompassed a temperature range of 27°C to 40°C, and storage pressures spanning from as low as 3.5 psi to as high as 28 psi. The recorded adsorption capacities were observed to fall within the range of 1.3424 mmol/g to 4.3073 mmol/g. The adsorption capacity of natural gas exhibited sensitivity to variations in both pressure and temperature, with the highest recorded storage capacity of 4.3073 mmol/g occurring at a temperature of 27°C and a pressure of 23 psi. The findings of this study highlight the significant potential of utilising corncob-derived activated carbon as an adsorbent for natural gas storage. Recommendations for further optimization and integration of this technology into existing gas storage systems are discussed. This research advances the prospect of utilising agricultural waste materials for eco-friendly and cost-effective energy storage, contributing to the transition towards a greener energy landscape.

Keywords: natural gas, adsorbent, corncob, activation, carbonization, storage

INTRODUCTION

Natural gas is becoming one of the most used energy sources due to its low carbon dioxide emission. It is a clean fuel source with a vast reserve for exploration and production. The technologies for extraction differ, but they are all processed similarly to get clean gas [1]. With a volume four times that of petroleum, natural gas is difficult and expensive to store since more resources must be spent on storage due to limited storage facilities and

technologies. Adsorption storage, which involves storing the gas inside a porous adsorbent, seems to be the most potent approach for NG storage at low pressure. The distance between gas molecules inside the pores of the adsorbent is substantially less than the distance between compressed gas molecules at the same pressure because of the attractive surface tension of the adsorbent. As a result, the density of the gas trapped within the pore spaces of the adsorbent is greater than the compressed gas's density [2].

Adsorbed natural gas (ANG) is a better system as it stores gas at a lower pressure of up to 3 MPa and stores more gas up to two-thirds of the tank at a pressure of 7MPa, while CNG occupies one-third of the free spaces left at the same pressure [3]. Agro-waste biomass from corn cobs are a suitable adsorbent and can absorb gases at low pressure [4]. The volume-based methane adsorption results specified an 'increase in the methane adsorption capacities of activated carbon with increasing surface area and showed that methane adsorption capacity depends on pressure and temperature [5]. Natural gas, primarily methane, is a clean gas that can mitigate the effects of greenhouse gas emissions that contribute to global warming. Nie et al. [6] advocated ANG as a better alternative to LNG and CNG for gas storage.

Corn cob is a good precursor of activated carbon and is easily obtainable in the form of agricultural waste. It is exceedingly porous and has a high carbon content. Due to its lightweight nature, it is very simple to activate, available in large quantities, and easy to gather [7, 8]. Heavy metals like chromium, solutions like methylene blue, and gases like carbon dioxide and nitrogen have all been removed using activated carbon from corn cob [9]. Activated carbon is produced from different carbonaceous materials of organic origin that are rich in carbon, such as wood, coal, peat, fruit stones, nutshells, husks of fruits, bones, synthetic polymers, etc., followed by activation of the chars produced from them. The carbonization process increases the carbon content to around 80%. The materials are transformed into char and their pores are opened for adsorption during the carbonization process. Char, biochar, or carbonized material are terms for the result of carbonization, which is a pyrolytic process in general [10]. Activated carbon undergoes further porosity development and structural creation after activation, resulting in the formation of fine solid cavities [11]. Macroscopic pores, which are larger than 25 nm, mesopores, which are smaller than 25 nm, and micropores, which are smaller than 1 nm, are the pores that form on the surface of activated carbon [12].

Activation of carbon can be made through two processes; physical activation and chemical activation. Physical activation is a dual-phase procedure that encompasses carbonization (pyrolysis) within a neutral environment, followed by activation using oxidizing gases like steam, carbon dioxide, or mixtures of carbon dioxide and nitrogen or air. The temperature progressively rises within the range of 800–1100°C during this activation process [13]. This technique can generate activated carbon characterized by a porous structure and robust physical strength. It is an economical means of preparing activated carbon and is considered environmentally friendly due to its chemical-free nature [10, 14, 11]. In chemical activation, organic precursors are activated at high temperatures in the presence of chemicals, which produces activated carbon [15, 16, 11]. The raw material is saturated with oxidizing and highly dehydrated chemicals in the first stage of chemical activation. The suspension is dried after impregnation, and the leftover mixture is heated for a predetermined amount of time. At temperatures between 400 and 900 °C, which is the point at which cellulose degrades, activation might occur depending

on the activating material and the final product's characteristics. After the final combination is repeatedly washed, activated carbon is eventually produced. Another purpose of the final rinse is the recovery of active substances [16]. The amount of impregnation and the weight ratio of chemical agents to dry precursor are the variables in the chemical activation process that influence the properties of the final activated carbon [17]. A porous structure is created when activated chemicals react with carbon matrices and release gas products [18].

The scope of this paper encompasses the synthesis of activated carbon from corn cobs and the investigation of its potential as an adsorbent for natural gas storage. The study fills the gap in understanding the use of agricultural waste materials for eco-friendly and cost-effective energy storage, particularly focusing on natural gas adsorption at low pressures. The novelty of this study lies in its detailed analysis of the adsorption capacities of activated carbon derived from corncobs, its implications for natural gas storage, and the recommendations for further optimization and integration of this technology into existing gas storage systems.

MATERIALS AND METHOD

Materials used for gas hydrate experiments include phosphoric acid corncobs, water, propane gas, gas adsorption equipment, and other apparatus to aid the production of activated carbon and gas adsorption. The methodology used during this experiment is summarized in Figure 1 and the schematic of the experimental equipment for the adsorption process is presented in Figure 2.

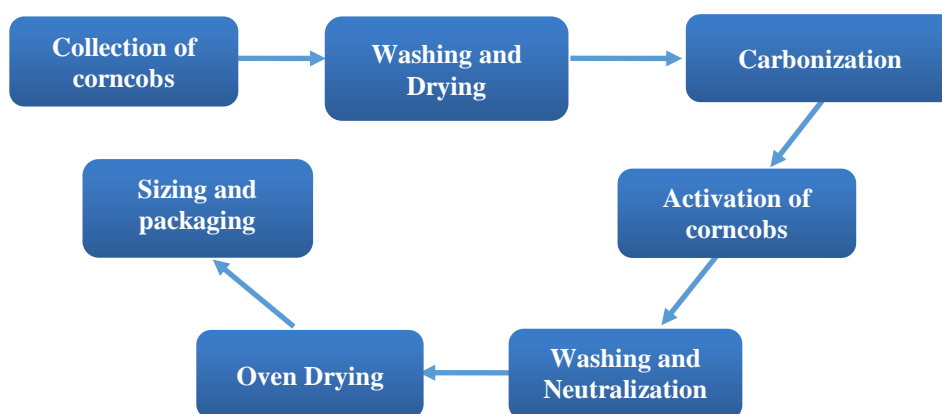


Figure 1. Activated carbon preparation process flow

Preparation of Corncob Carbon

The preparation and activation of the corncob carbon were done following the Bagheri et al. [5] model with slight modification. First and foremost, the corncobs underwent a meticulous cleansing process, effectively eliminating any clinging impurities and potential contaminants that could compromise subsequent stages.

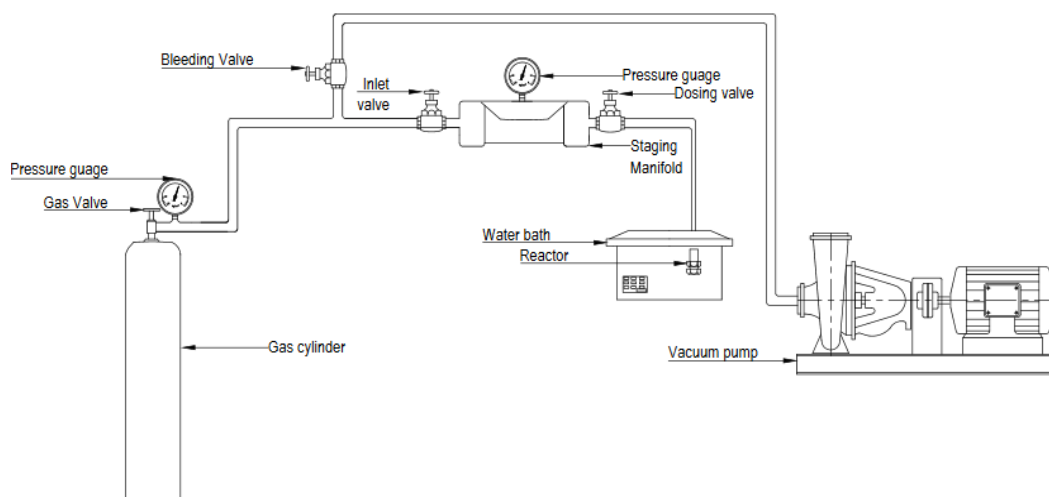


Figure 2. Schematic of experimental setup

Following this, the corncobs were exposed to the sun's natural drying process for a duration of three days, ensuring complete moisture removal as shown in Figure 3. Once thoroughly dried, the corncobs were carefully fragmented into smaller pieces by mashing them, a preparatory step preceding their introduction into the furnace. The corncob fragments were subjected to intense heat, precisely maintained at a temperature of 600°C, and subjected to combustion for a span of one hour as presented in Figure 4. This sequential procedure was conducted in a batch-wise manner, ensuring that the entirety of the corncob stockpile underwent this transformative process.



Figure 3. Sun drying of corncobs



Figure 4. Carbonization of corncob in a Vecstar Furnace

The outcome of this combustion phase was a collection of charred remnants derived from the corncobs. A subsequent pulverisation step was implemented to render these charred materials suitable for further applications, effectively breaking the char into finely textured particles and sieving them to different sizes. Subsequently, the finely pulverised char underwent an activation procedure as presented in Figure 5.

Activation of Corncob Carbon

The activation phase involved a chemical activation of the pulverised char, significantly enhancing its properties and potential applications. Through the chemical activation method, the pulverised char was induced to undergo changes that endowed it with specific characteristics conducive to its intended purpose. The aqueous corncob based carbon is presented in Figure 6.



Figure 5. Completely carbonized corncob char.



Figure 6. Activation of Corncob Char

0.5 M of Phosphoric acid was used to activate the corncob char. The acid was introduced into the activated carbon, stirred for about 24 hours, and filtered as seen in Figure 7. The residue, which is the activated carbon, was washed thoroughly with warm water in a water bath and passed through a filter paper to achieve a clean activated carbon as seen in Figure 8. This was kept dry in the oven at 100°C for 8 hours and then allowed to cool before the pH was calculated.



Figure 7. Filtration of aqueous carbon solution



Figure 8. Neutralization of activated carbon

In summary, the journey from raw corncobs to the activated corncobs' carbon involved a sequence of steps encompassing cleansing, drying, combustion, pulverisation, and chemical activation, as shown in Figure 1. Each step was meticulously executed to yield a final product optimised for its designated application to store natural gas.

Characterisation of activated corncobs

Activated corncobs, derived from the abundant agricultural waste of corn harvesting, have shown remarkable potential as adsorbents due to their porous structure and high surface area. This paper delves into the comprehensive characterization of activated corncobs, aiming to elucidate their intricate porous properties and adsorption capabilities. By employing advanced analytical techniques, such as SEM imaging, BET analysis, and adsorption isotherm studies, this research sheds light on the material's unique structural

features and its ability to adsorb a diverse range of contaminants. These methodologies play a pivotal role in scrutinizing gas adsorption on materials. They provide insights into the physical and chemical attributes of surfaces, empowering researchers to design enhanced adsorbent materials for diverse applications, including gas separation, catalysis, and the elimination of pollutants.

EXPERIMENTAL DESIGN

In this study, an experimental arrangement depicted in Figure 2 was devised to determine the methane (CH_4) adsorption capacity of activated carbon (AC) under conditions following combustion, by Sievert's law [20]. Initially, a conduit with a length of 59.06 inches and a diameter of 1/4 inch was established to enable the flow of methane gas from a storage cylinder to the Staging Manifold (SM), shown in Figure 2.

Within the SM, the pressure of the natural gas was gradually increased to reach post-combustion conditions, ranging from 0.15 to 1 bar. Subsequently, a water bath housing the Reactor (R), as illustrated in Figure 2 and highlighted in Figure 9, was connected to V_1 using a tubing of length 13 inches and diameter 1/4 inch. Lastly, a vacuum pump with a capacity of 1 horsepower was linked to a tubing measuring 47 inches in length and 1/4 inch in diameter. This tubing was situated between the methane storage cylinder and V_1 , facilitating the evacuation of CH_4 from the circulation system after each sorption cycle performed under specific pressure and temperature conditions.



Figure 9. Experimental setup for evaluation of methane adsorption capacity

Precautions taken during experimentation

To ensure the successful execution of the experiment, the following measures were implemented:

1. While constructing the Staging Manifold, sealants such as thread tapes and modified acrylic adhesive were utilised to seal openings. Caps were then applied to prevent any potential leaks from occurring within the system.
2. A waiting period of 15 minutes was observed to allow CH_4 gas to establish a consistent pressure within the Staging Manifold (V_1) and achieve equilibrium.

3. After each sorption cycle, when the adsorbent had reached saturation with CH₄, the CH₄ gas was meticulously purged from the experimental setup using a vacuum pump. This step marked the commencement of a new sorption cycle.
4. Before initiating the adsorption process, the reactor was permitted to reach a steady temperature by immersing it in a water bath for 30 minutes.
5. The adsorption process took place for 40 minutes within the flowline. This duration ensured that the adsorbent had sufficient retention time to adsorb CH₄ onto its surface during each sorption cycle effectively.
6. Throughout the experiments, Personal Protective Equipment (PPE) was consistently worn to ensure safety.

Experimental procedure

To begin the experimental procedure, the vacuum pump (VP) was employed to eliminate air molecules from the air-tight apparatus. This step ensured the absence of any other gases in the system before commencing the adsorption process. Subsequently, the Dosing Valve (DV) and Bleeding Valve (BV) were closed, while the Inlet Valve (IV) was opened to allow the passage of CH₄ gas. Then, a precisely measured mass of the adsorbent (CS – 1.08g, AC – 1.08g) was placed inside the Reactor (V₂) to occupy its volume.

Next, CH₄ gas was introduced into the Staging Manifold (V₁) from a CH₄ gas cylinder (CGC) with the DV and BV in a closed state. This allowed pressure to accumulate in V₁ up to a predetermined pressure level (P₁ – 10.0, 20.0, 30.0, and 40.0 psi). Once this pressure was reached, the IV was rapidly closed to maintain a consistent pressure within V₁. The Staging Manifold remained sealed for 15 minutes to identify any potential leaks, as indicated by observable pressure drops registered by the Pressure Gauge (PG). Afterward, the equilibration temperature was sustained for 30 minutes. Following this, the DV was cautiously opened, enabling CH₄ gas to flow into V₂, which was immersed in a water bath (WB) set at a constant temperature. This initiated contact between the adsorbents and CH₄ gas, facilitating adsorption. An interval of 60 minutes was allotted to ensure adequate adsorption within V₂. The final pressure, noted by the Pressure Gauge (PG) and referred to as P₂, was recorded. Upon completion of the adsorption cycle, the DV was closed, and the BV was opened to enable CH₄ entry from the CGC into V₁, gradually increasing the pressure to the desired level. This experimental cycle was replicated for each pressure increment while maintaining a constant temperature. After each sorption cycle, the DV was closed, and V₁ was disconnected from the apparatus. The apparatus was then sealed, and any remaining gas molecules were extracted using the vacuum pump (VP). A specific mass of the adsorbent was re-measured and introduced into V₁, effectively occupying its volume, and the entire experiment was repeated following the steps. The experimental temperatures employed were 26°C and 40°C, with the selected pressure levels being 10 psi, 20 psi, 30 psi, and 40 psi.

Desorption model

Desorption models for adsorbed gases in activated carbon are mathematical representations used to describe the release of adsorbed gases from the porous structure of activated carbon. These models are essential for understanding and predicting the behavior of adsorbed gases during desorption processes, which are crucial in various applications such as gas storage, gas separation, and environmental remediation. To extract the gas used from the activated carbon, the following model is used.

Thermogravimetric Analysis (TGA)

TGA is a versatile analytical technique used to measure the change in mass of a sample as a function of temperature (or time) under controlled heating conditions. In desorption studies, the AC (previously loaded with gas) is heated at a controlled rate while monitoring the mass loss as the adsorbed gas desorbs from the activated carbon. The temperature at which desorption occurs and the rate of mass loss provide insights into desorption kinetics and the strength of adsorption bonds.

Isothermal Desorption Experiments

Isothermal desorption experiments involve exposing an activated carbon sample saturated with a specific gas to a constant temperature and monitoring the release of the adsorbed gas over time. This technique provides information about the desorption kinetics and can be used to determine parameters such as the desorption rate constant and the equilibrium desorption capacity.

RESULTS AND DISCUSSION

Results of characterization of activated carbon

Characterization of activated carbon is essential for several reasons, primarily to understand its properties, performance, and suitability for specific applications. Key properties were explored during this research and the results are discussed below.

Fourier Transform Infrared Spectroscopy (FTIR)

FTIR identifies and examines chemical bonds within a specimen. In gas adsorption research, FTIR aids in comprehending the nature of surface functional groups and the interplay between gases and these groups on the material's surface. The result is shown in Figure 10.

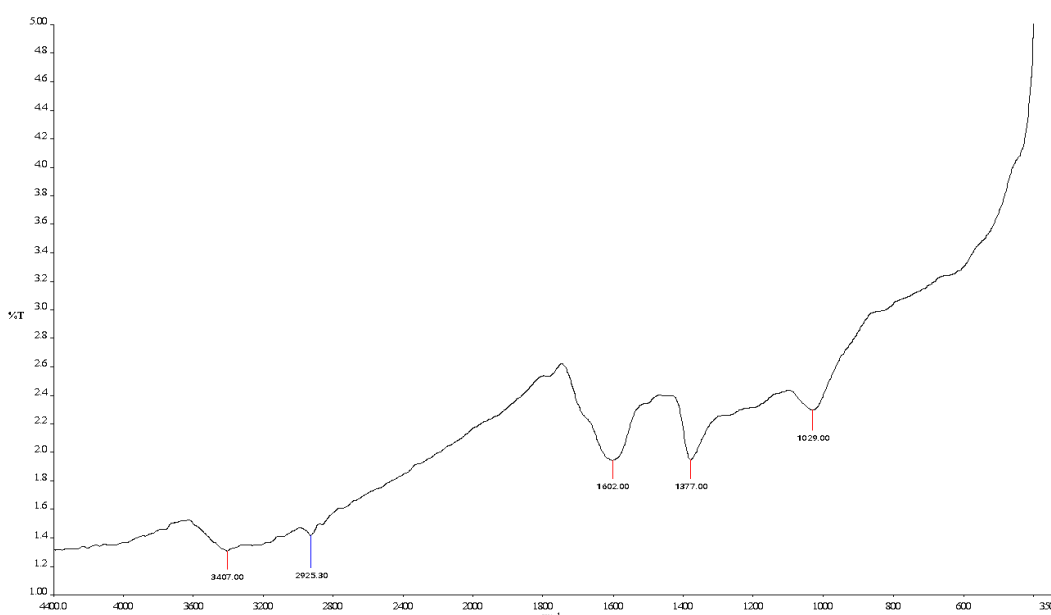


Figure 10. Fourier transform infrared spectroscopy of corncob activated carbon

The graph above (Figure 10) shows the relationship of the FTIR graph for activated carbon. It provides information about its molecular and chemical structure, including the presence of functional groups, surface chemistry, and potential impurities. This information is crucial for understanding the chemical properties of activated carbon and how they influence its adsorption behaviour and suitability for various applications.

X-ray Diffraction

X-ray Diffraction (XRD) is a method utilised to examine the crystal arrangement of substances. When investigating gas adsorption, XRD aids in comprehending how gases and material surfaces interact, revealing details regarding the structure and composition of crystalline stages. After analysis, the following results in Figure 11 was obtained.

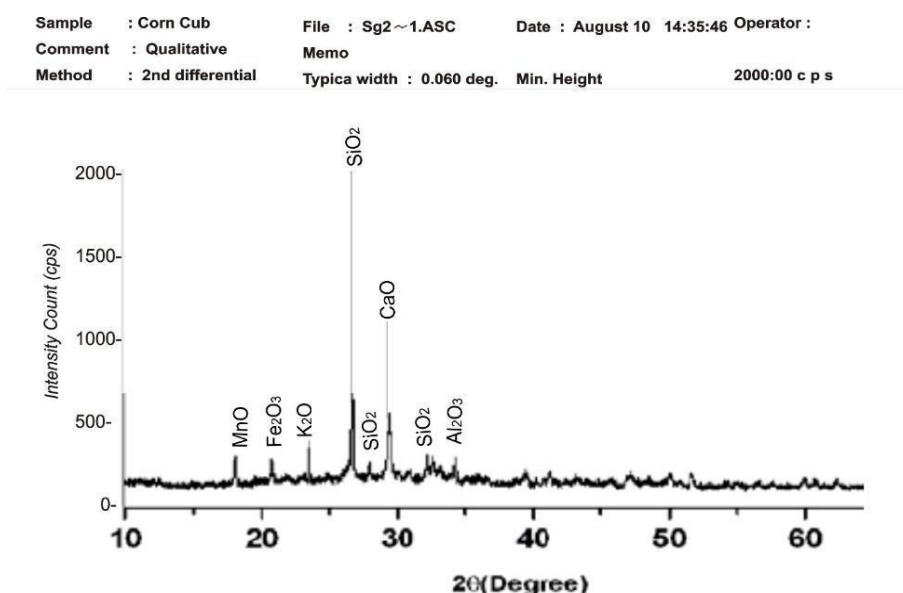


Figure 11. X-ray diffraction diagram of activated corn cob carbon

Transmission Electron Microscopy (TEM)

TEM is an imaging approach that supplies more detailed images than SEM, enabling the visualisation of internal material structures at the nanoscale. In gas adsorption investigations, TEM exposes pore arrangements and gas molecule interactions within the material. This is shown in the molecular diagram (Figure 12) at 100 nm.

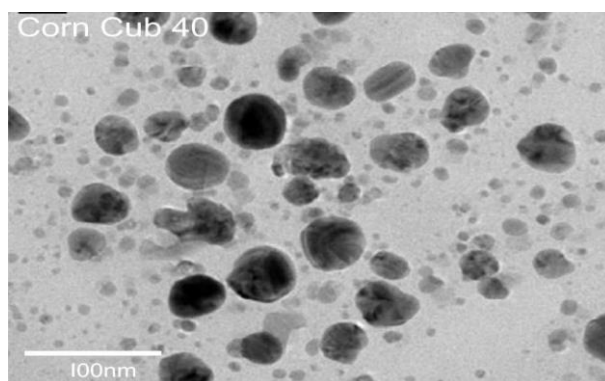


Figure 12. Transmission electron microscopy diagram of activated corn cob carbon

Scanning Electron Microscopy (SEM)

SEM is a potent imaging method offering intricate insights into surface topography. In research on gas adsorption, SEM assists in visualizing material morphology and structure, facilitating the understanding of gas-surface interactions as shown Figure 13.

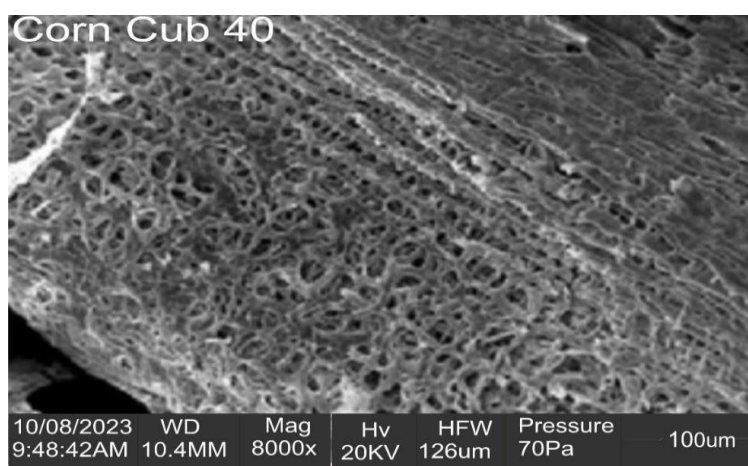


Figure 13. Scanning electron microscopy diagram of activated corncob carbon

Energy-dispersive X-ray Spectroscopy (EDX)

EDX, frequently paired with SEM, furnishes elemental analysis of a sample's surface. During gas adsorption inquiries, EDX contributes to identifying the composition of the adsorbent material and detecting any modifications post-gas adsorption as can be seen in Figure 14.

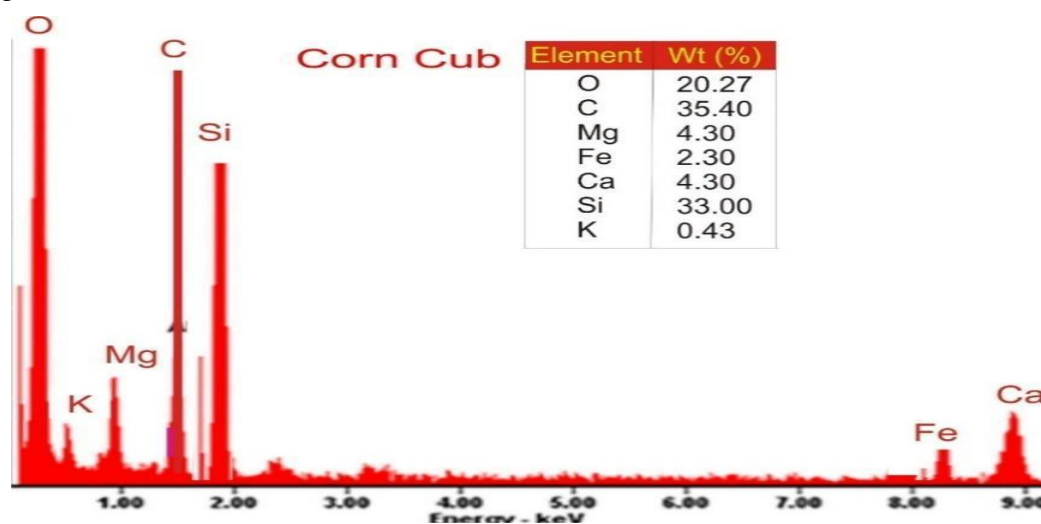


Figure 14. Energy-Dispersive X-ray Spectroscopy

Results of Gas Adsorption Capacity of Corncob-Based Activated Carbon

The results of the gas adsorption using corncob-based activated carbon is shown in the Table 1.



Table 1. Adsorption Capacity of Corncob-Based Activated Carbon

Sample Size = 841 Microns				
S/N	Temp. (°C)	Initial Pressure (PSI)	Final Pressure (PSI)	Adsorption Capacity (mmol/g)
1	27	10	5.5	1.1416
2		20	11	2.2831
3		30	18	3.0363
4		40	25	3.7894
Sample Size = 841 Microns				
S/N	Temp. (°C)	Initial Pressure (PSI)	Final Pressure (PSI)	Adsorption Capacity (mmol/g)
1	40	10	5	1.2183
2		20	10	2.4366
3		30	17	3.1585
4		40	26	3.3840
Sample Size = 600 Microns				
S/N	Temp. (°C)	Initial Pressure (PSI)	Final Pressure (PSI)	Adsorption Capacity (mmol/g)
1	27	10	4.6	1.3746
2		20	9	2.8010
3		30	16	3.5541
4		40	24	4.0484
Sample Size = 600 Microns				
S/N	Temp. (°C)	Initial Pressure (PSI)	Final Pressure (PSI)	Adsorption Capacity (mmol/g)
1	40	10	4.8	1.2679
2		20	9.3	2.6103
3		30	17.6	3.0096
4		40	26	3.3800
Sample Size = 400 Microns				
S/N	Temp. (°C)	Initial Pressure (PSI)	Final Pressure (PSI)	Adsorption Capacity (mmol/g)
1	27	10	3.5	1.6594
2		20	7	3.3189
3		30	15	3.8131
4		40	23	4.3073
Sample Size = 400 Microns				
S/N	Temp. (°C)	Initial Pressure (PSI)	Final Pressure (PSI)	Adsorption Capacity (mmol/g)
1	40	10	4.5	1.3424
2		20	9	2.6848
3		30	18	2.9103
4		40	28	2.8876

The experiment was conducted with a constant AC mass of 0.5 g at initial pressures ranging from 10 psi to 40 psi for 841 microns, 600 microns and 400 microns respectively. After the adsorption process, the final pressures decreased, indicating that some propane substance was adsorbed onto the AC surface.

The adsorption capacity, measured in mmol/g, increased as the initial pressure increased. This shows the high adsorption capacity of the AC at higher initial pressures and aligns with the common behaviour of adsorption processes, where a material's capacity to adsorb a substance often increases with higher initial concentrations or pressures.

A comparative graph showing the initial and final pressures for the three sizes of activated carbon used and at varying temperatures of 27 °C and 40 °C is shown in Figure 15, 16 and Figure 17.

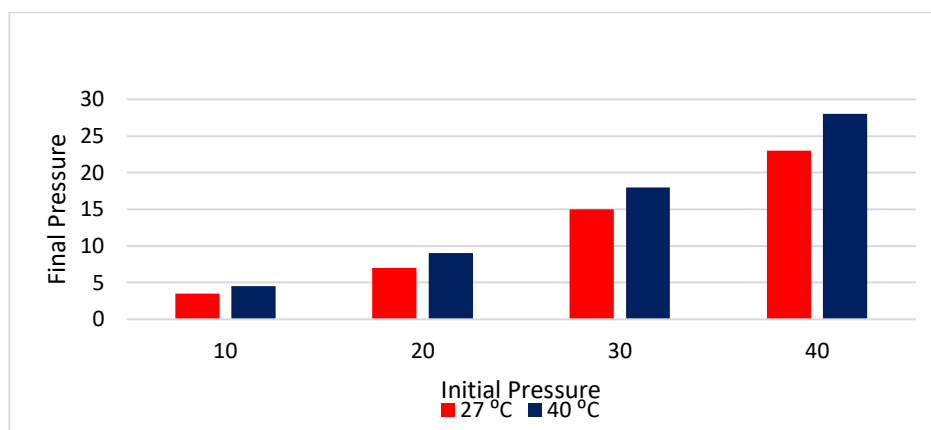


Figure 15. Graph of initial pressure vs final pressure: sample size 400 microns

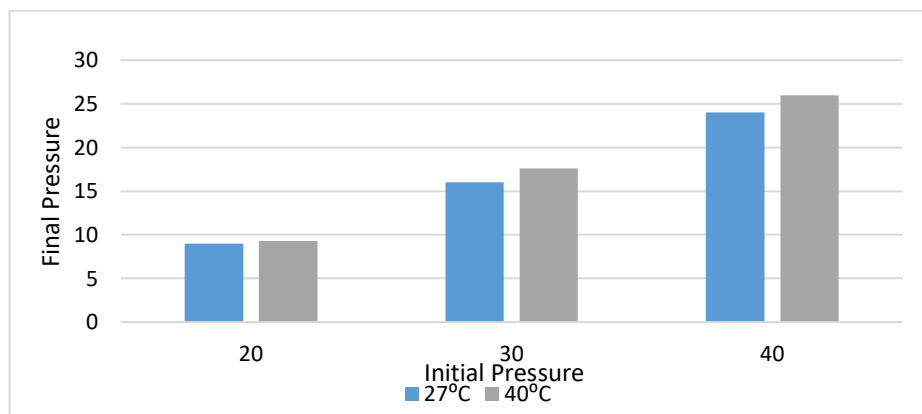


Figure 16. Graph of initial pressure vs final pressure: sample size 600 microns

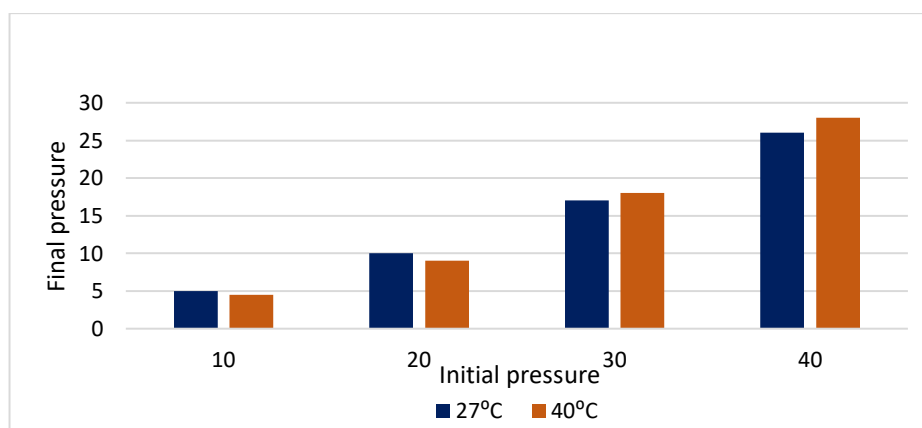


Figure 17. Graph of initial pressure vs final pressure: sample size 841 microns

Result of the effect of AC pore size on the adsorption pressure

Plotting a chart of pressure against the adsorption pressure showed a decrease in the final pressure for each sample size of 400 microns, 600 microns, and 841 microns respectively at a temperature of 27°C. Similar results were also observed when the temperature was increased to 40 °C but a slight alteration occurred as the initial pressure increased, giving a higher final pressure for AC of 400 microns. This shows that the smaller the size of the AC, the smaller the storage pressure which is beneficial for the storage capacity and suggests that an increase in temperature will result in higher adsorption capacity. This will be further analysed in the preceding discussions. The final pressures at temperatures of 27°C and 40°C respectively were plotted and compared for various sizes of AC. See Figures 18 and 19.

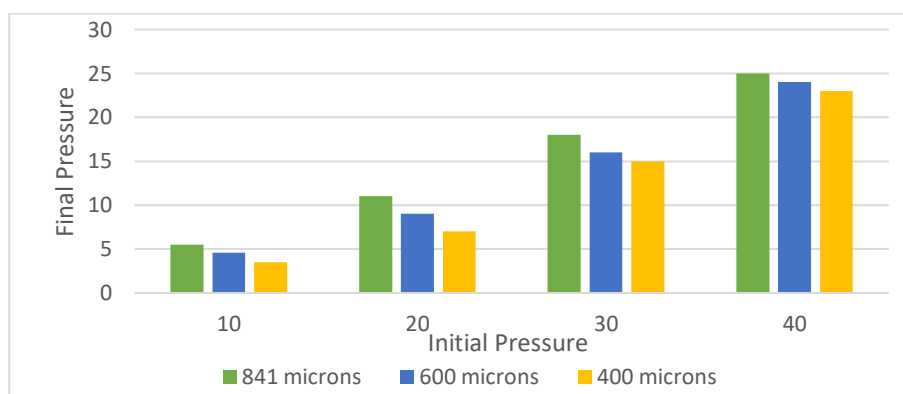


Figure 18. Graph of initial pressure vs final pressure at 27°C

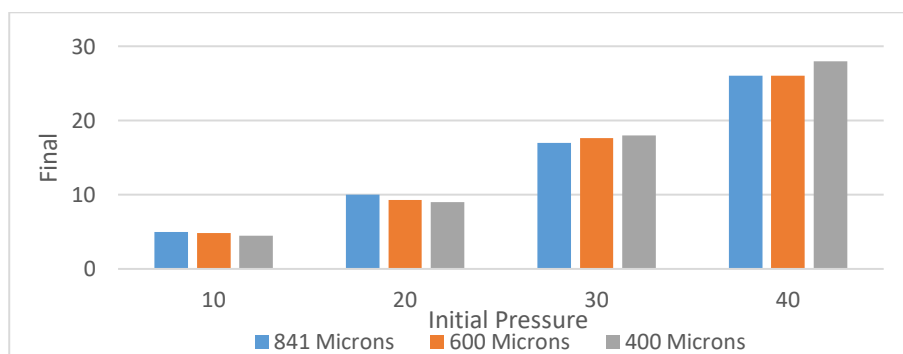


Figure 19. Graph of initial pressure vs final pressure at 40°C

Result of the effect of temperature and pore size on activated carbon adsorption capacity

The adsorption capacity of activated carbon demonstrates a positive correlation with increasing temperatures. This is because higher temperatures provide more kinetic energy to gas molecules, making them more likely to be adsorbed onto the surface of the activated carbon. This phenomenon is evident in the results as temperature increases for a consistent sample size. Refer to Figures 20, 21, and 22, for graphical representations of this effect. When the temperature reaches 40°C, the adsorption capacity is highest when using a larger-sized activated carbon. This demonstrates that the impact of temperature on adsorption capacity is more pronounced when employing larger-sized activated carbon.

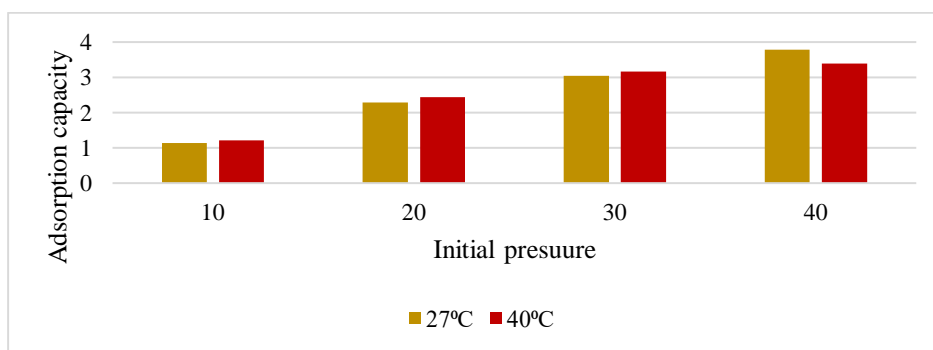


Figure 20. Graph of initial pressure vs adsorption capacity - sample size 841 microns

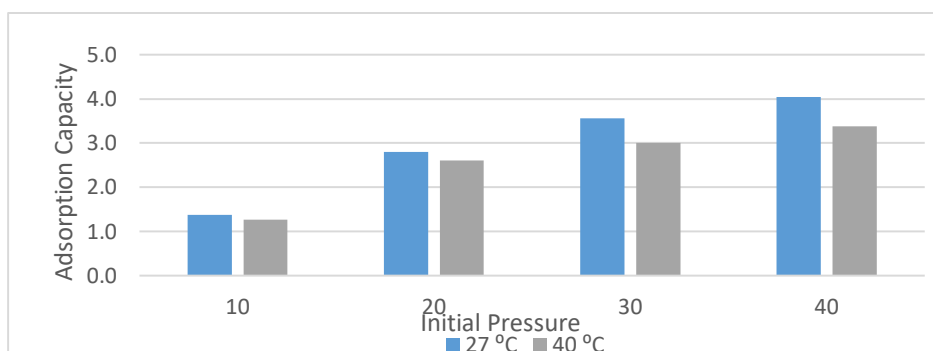


Figure 21. Graph of initial pressure vs adsorption capacity - sample size 600 microns

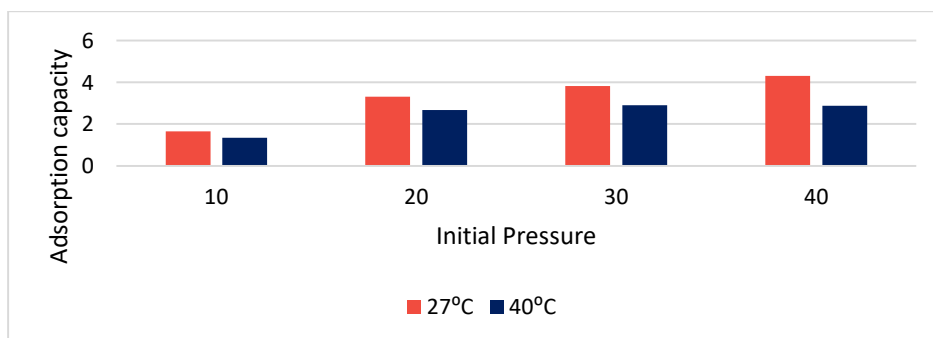


Figure 22. Graph of initial pressure vs adsorption capacity - sample size 400 microns

Furthermore, the impact of the adsorbent's dimensions becomes evident when a consistent temperature is maintained while varying the sizes. It was noted that at a temperature of 27°C, a smaller particle size of 400 microns exhibited a higher adsorption capacity in comparison to a size of 600 microns and 841 microns respectively as seen in Figure 23. Similarly, a particle size of 600 microns demonstrated greater adsorption capacity than that of 841 microns. This trend persisted when the temperature was raised to 40°C, especially at lower pressures as seen in Figure 24. However, as the pressure levels was increased to 30 psi and 40 psi, the adsorption capacity of the 841 microns activated carbon surpasses that of the 600 and 400 microns' variant. This suggests that at higher temperatures and pressures, the surface area of smaller activated carbon particles expands, enabling them to adsorb a greater amount of gas.

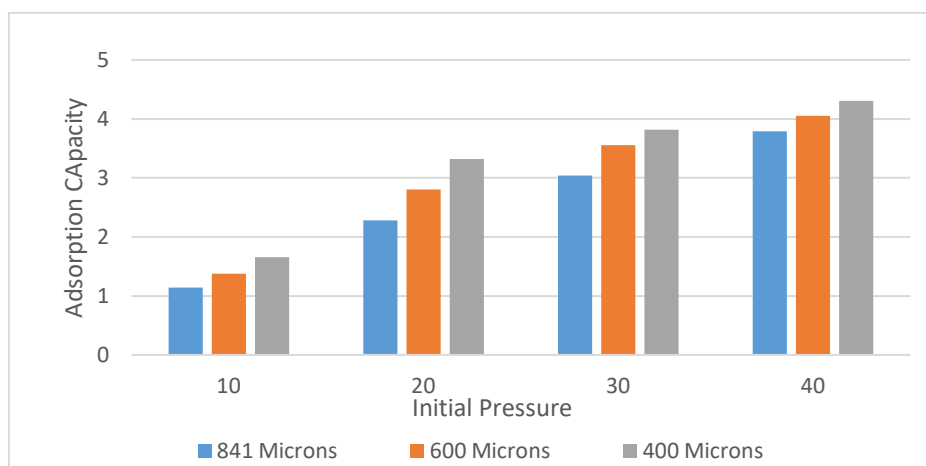


Figure 23. Graph of initial pressure vs adsorption capacity at 27°C

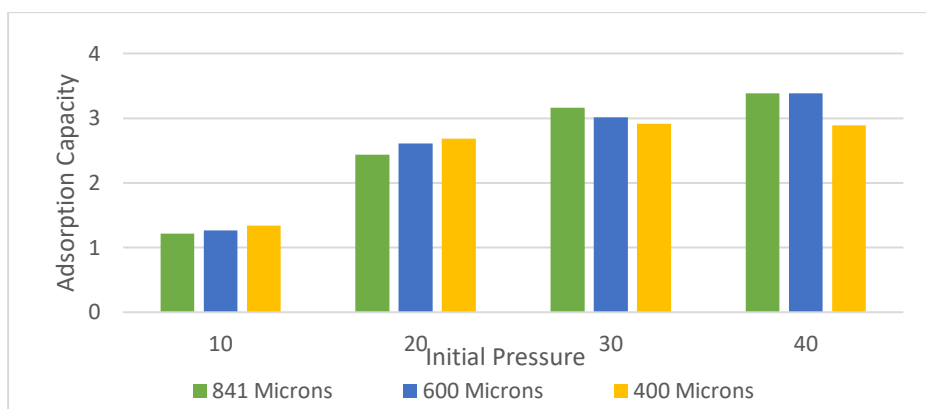


Figure 24. Graph of initial pressure vs adsorption capacity at 40°C

This study's results were subsequently related to some literatures just like Alhasan et al. [19] review of technologies for adsorbed natural gas storage. According to their study, the heat fluctuations in the ANG storage system significantly influence the results, and the adsorbent properties, thermal dynamics, desorption, and deliverability rates were the considered factors. This also aligns with the results from Ridha et al. [21] on dynamic delivery analysis of adsorptive natural gas storages at room temperature.

Also, Bagheri et al. [5] utilized maize stalks as a material for absorbing gaseous methane. Potassium hydroxide was used to activate the corncob. Using a volumetric adsorption apparatus, the researchers investigated the methane adsorptions on activated carbon derived from corn cobs at two different temperatures (298 K and 323 K) and four different pressures (500, 1000, 1500, and 2000 psi). An increase in the methane adsorption capacities of activated carbon with increasing surface area was specified by the volume-based methane adsorption results, which also demonstrated that the methane adsorption capacity is temperature and pressure dependent. At 298 K and 1500 psi, the maximum methane storage capacity was determined to be 160 (v/v).

In a more related study, Sun et al. [4] studied the application of activated corncob carbon to store gases. The corncobs were crushed to a size of 0.015–0.30 mm before it was activated. The corn cobs were divided into five, and activation was carried out using two

methods. Carbon was first activated with KOH, K₂CO₃, and NaOH in a two-step activation process up to 350 °C to remove water content and cellulose. The second method was a one-step activation, which was done with ZnCl₂ and H₃PO₄- as activators up to 700 °C. The resulting activated carbon labelled C₁, C₂, C₃, C₄, and C₅ were characterised, and the pore volume was determined using a mass spectrometer. Analysis was done on the gas adsorption efficiency of the activated carbons. It was discovered that C₁ and C₅, which have a higher pore volume, were more effective in storing hydrogen gas at 1atm and 77 K than the other activated carbons [22, 23]. This validated the theory that a higher volume will yield greater storage capacity. It was established that carbon cobs are a suitable adsorbent and can absorb gases at low pressure [24].

CONCLUSIONS

Using corncob as an adsorbent for natural gas storage shows promising potential in the field of alternative energy storage solutions [25]. This technology leverages the porous structure of corncob to effectively capture and retain natural gas molecules, offering a cost-effective and sustainable approach to gas storage. Throughout this study, it was observed that corncob-based adsorbents demonstrated impressive adsorption capacities with a BET surface area of 860.500 m²/g and favourable adsorption-desorption kinetics. Storage pressures as low as 3.5 psi and high as 28 psi were recorded throughout the experiment at temperatures of 27°C and 40°C and an adsorption capacity in the range of 1.3424 mmol/g to 4.3073 mmol/g was recorded. This indicates that corncob has the potential to compete with conventional adsorbents currently used in natural gas storage applications.

In conclusion, the application of corncob as an adsorbent for natural gas storage exhibits significant promise in the pursuit of sustainable energy solutions. This technology showcases a viable avenue for harnessing agricultural by-products to address energy storage challenges. With continued research and development, corncob-based adsorbents have the potential to play a pivotal role in the transition towards more environmentally friendly gas storage systems. The utilization of corncob as an adsorbent presents several notable advantages. It is abundantly available, renewable, and cost-effective, making it an environmentally friendly alternative to synthetic adsorbents derived from non-renewable resources. Additionally, the use of corncob supports agricultural sustainability by creating an additional market for corn production by-products.

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