Presentation Title - Corn Biomass-Derived Porous Activated Carbons for High-Performance Carbon Dioxide Adsorption

Introduction

The increase in global temperature is mainly associated with anthropogenic emissions of greenhouse gases, among which carbon dioxide (CO_2) is the largest contributor to the greenhouse effect [1]. CO_2 accounts for the majority of greenhouse gas emissions, while methane (CH_4), nitrous oxide (N_2O), and fluorinated gases also contribute to climate change [1]. The continuous rise in CO_2 emissions from industrial activities and fossil fuel combustion has intensified global warming and environmental challenges, making the development of efficient and sustainable carbon capture technologies increasingly important [2].

Biomass-derived activated carbon has attracted significant attention as a low-cost, renewable, and environmentally friendly adsorbent for CO_2 capture because of its high surface area and well-developed porous structure [3], [4]. Corn biomass is an abundant agricultural residue that can be converted into porous activated carbon through chemical activation, providing a sustainable route for producing efficient adsorbents for carbon capture applications [4], [5]. This study investigates activated carbons prepared from different corn biomass residues and evaluates their CO_2 adsorption performance.

Method and Materials

Corn biomass residues, including husk, seed, cob, and fibre, were washed, dried, and ground into fine powder. The samples were carbonized at 400 °C for 2 h under a nitrogen atmosphere. The resulting biochar was chemically activated using $KHCO_3$ (1:3 mass ratio) and further heated between 800 and 1000 °C under continuous nitrogen flow. After activation, the samples were washed with 1 M HCl and deionized water until neutral pH, followed by drying at 100 °C overnight. The textural properties of the prepared activated carbons were characterized using nitrogen adsorption at 77 K, while CO_2 adsorption performance was evaluated at 273 K and 296 K.

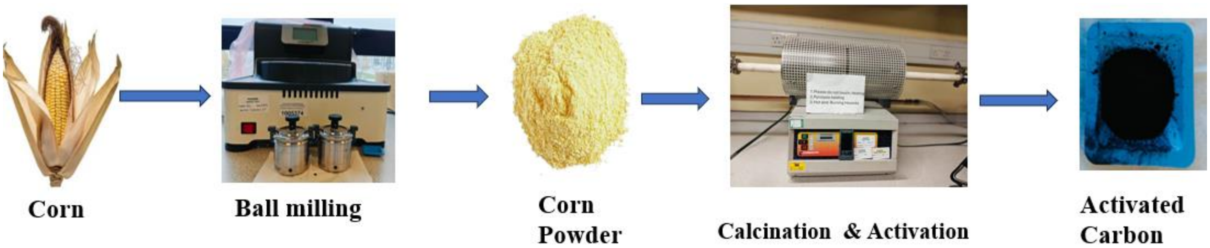

Figure 1: Synthesis process of Activated carbon

Results and Discussion

Porous activated carbons derived from different corn residues (husk, seed, cob, and fibre) exhibited highly developed hierarchical pore structures with BET surface areas ranging from 1074.9 to 3134 $m^2\ g^{-1}$. Although Fibre-900 showed the highest surface area, Husk-800 achieved the highest CO_2 adsorption capacity of 6.87 mmol g^{-1} at 273 K and 4.46 mmol g^{-1} at 296 K due to its high micropore volume (0.5652 $cm^3\ g^{-1}$). These results demonstrate that micropore volume has a greater influence on CO_2 adsorption than surface area alone. Therefore, corn biomass-derived activated carbons are promising, sustainable, and cost-effective adsorbents for carbon capture applications.

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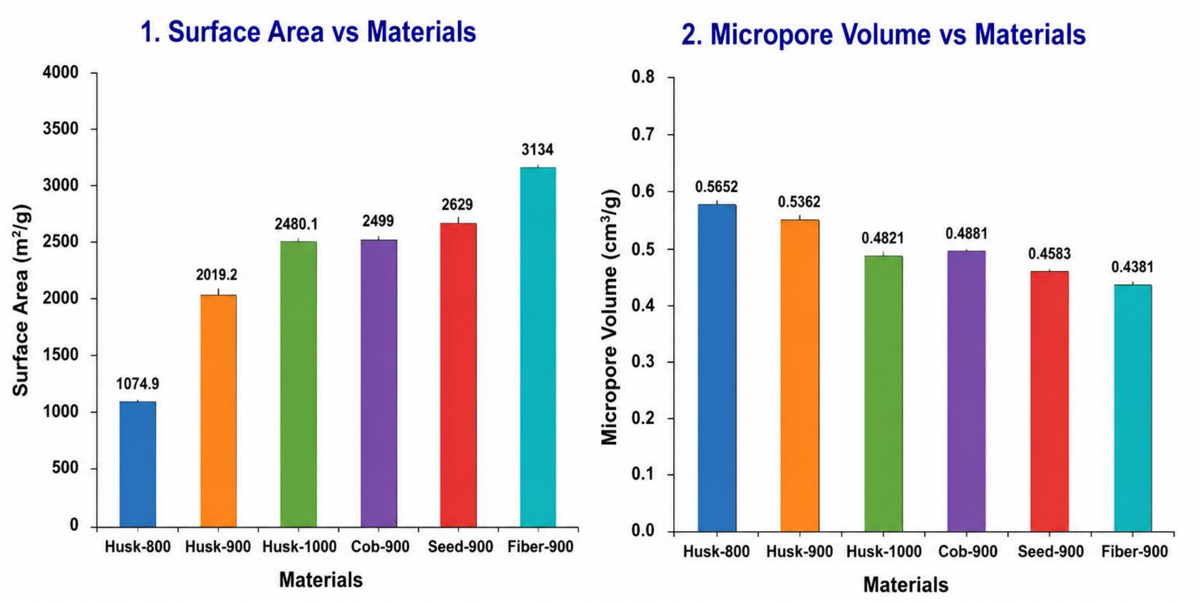

Figure 2: Textural properties of activated carbons derived from different corn biomass residues.

Conclusions

- Activated carbons with high surface area and well-developed micropores were successfully prepared from corn biomass.
- Micropore structure played a more important role in adsorption performance than surface area alone.
- CO_2 adsorption was much higher than N_2 adsorption, showing good selectivity toward CO_2.
- Corn biomass-derived activated carbon is a sustainable and promising material for carbon capture applications.

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References

1] Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2023: Synthesis Report*. Geneva, Switzerland: IPCC, 2023.

[2] International Energy Agency (IEA), *CCUS in Clean Energy Transitions*. Paris, France: IEA, 2020.

[3] H. Marsh and F. Rodríguez-Reinoso, *Activated Carbon*. Amsterdam, The Netherlands: Elsevier, 2006.

[4] S. Wang, J. Peng, and co-authors, "Biomass-derived porous carbon materials for CO_2 capture: A review," *Journal of CO_2 Utilization*, vol. 65, 2023.

[5] Y. Li, X. Zhang, and co-authors, "Recent advances in biomass-derived activated carbon for carbon dioxide capture," *Chemical Engineering Journal*, vol. 430, Art. no. 132662, 2022.