

Biochars for the Adsorption of Environmental Pollutants

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Introduction

- ✓ 'Biochars': High carbon product produced from thermal decomposition of biomass with limited O₂ [1].
- ✓ Has many applications including: Additive to soil, adsorption of CO₂ and water treatment [2].
- ✓ Torftech TORBED reactors thought to produce highly porous biochars. They provided us with two biomass chars and three lignite chars to test [3].

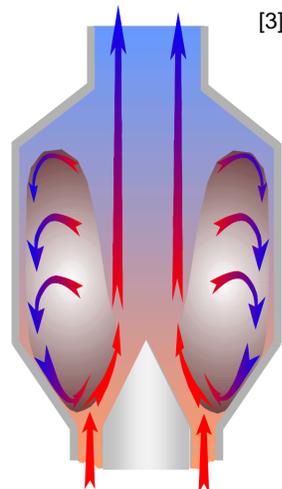
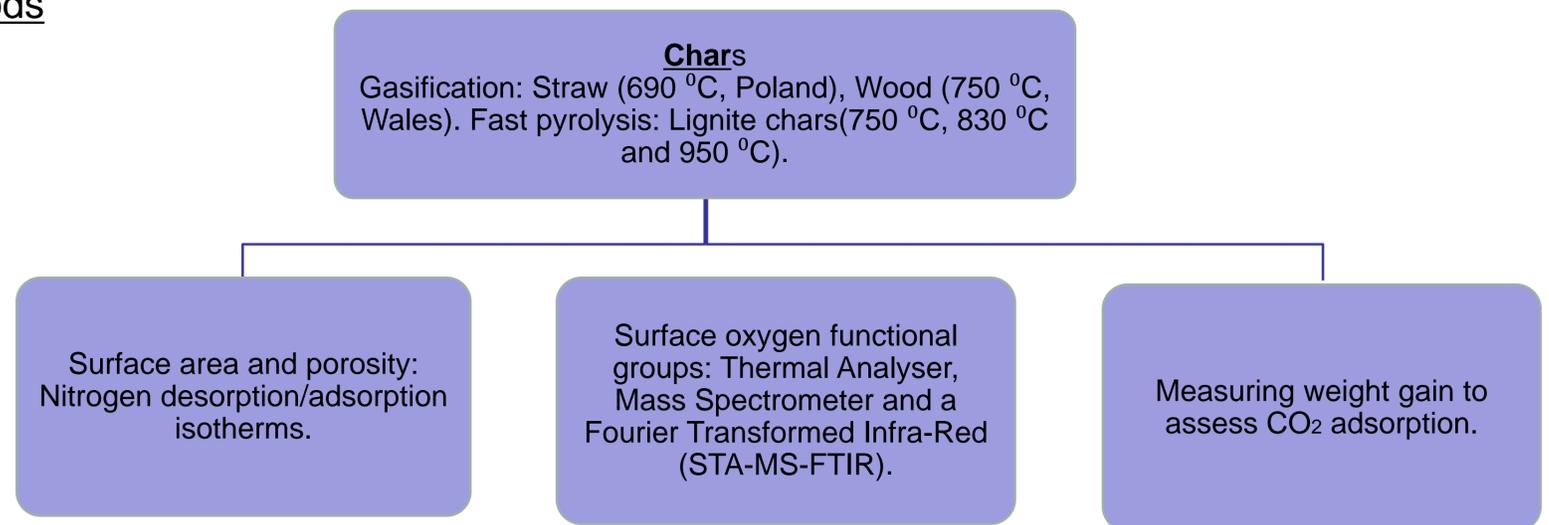


Figure 1: TORBED reactor

Methods



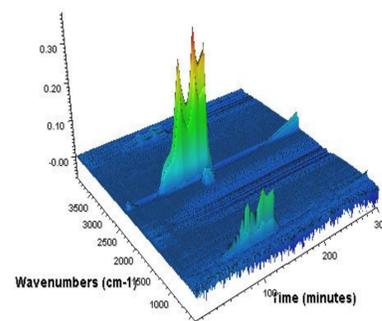
The char which demonstrated the highest surface area was then activated by chemical activation (KOH, 650 °C, 1 hour 2:1 ratio) and physical activation (CO₂, 30 mins, 800 °C), and the same analysis methods repeated.

Results

✓ Wood has the lowest surface area and micropore volume. The straw char has a much higher surface area of 463.43 m²/g.

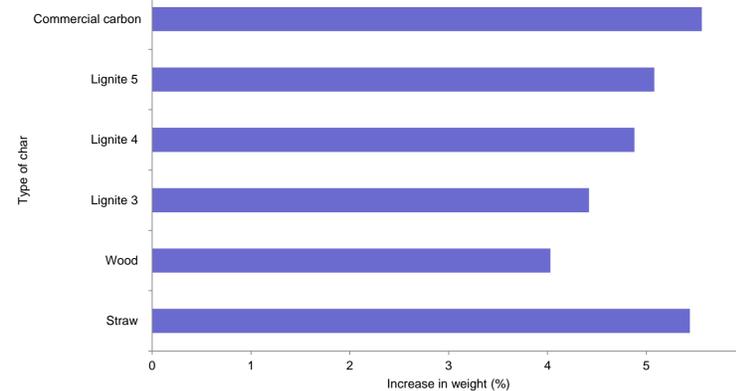
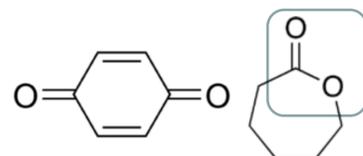
Sample	Surface Area (m ² /g)	Micropore Volume (cc/g)
Straw Char	463.43	1.84E-1
Wood Char	86.51	3.65E-2
Lignite Char 750 °C	489.97	1.92E-1
Lignite Char 830 °C	484.97	1.85E-1
Lignite Char 950 °C	665.20	2.57E-1

✓ From the STA-MS-FTIR, suggestions can be made as to the functional groups present on the surface of the char, depending on the temperature of CO and CO₂ evolution.



✓ Straw and wood chars evolved CO at temperatures characteristic of lactone groups, and CO₂ at temperatures characteristic of quinone/semiquinone groups.

CO	Possible Functional Group	CO ₂ Peak (K)	Possible Functional Group
1160	Quinone/Semiquinone	879	Lactone
		1109	Uncertain



- ✓ Straw char adsorbed the most CO₂.
- ✓ Lignite chars absorbed more the higher the production temperature.
- ✓ Straw show marginally less adsorption than the activated commercial carbon.

	Yield (%)
CO ₂ activation	54.56
KOH activation	71.34

Yields from both activation methods.

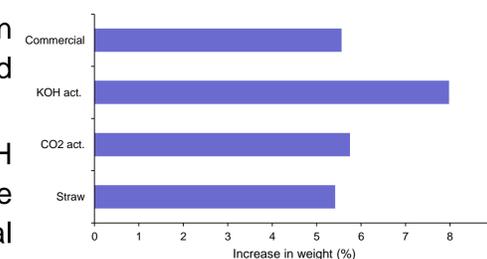
✓ KOH activated char contained a higher number of ultra-micropores (<7 Å).
✓ STA-MS-FTIR suggested the same functional groups as unactivated chars.

✓ CO₂ activation increased the uptake marginally.

✓ KOH activation significantly increased uptake.

✓ Both CO₂ and KOH activation increased uptake above the commercial carbon.

Sample	Surface Area (m ² /g)	Micropore Volume (cc/g)
Straw char	463.43	1.84E-1
CO ₂ act. char	820.11	3.19E-1
KOH act. char	1177.04	4.56E-1



Conclusion

- ✓ Straw char demonstrated the highest surface area and micropore volume.
- ✓ Chemically activated straw char had significantly improved surface area and CO₂ uptake.
- ✓ Physical activation did not significantly improve the CO₂ uptake of the char.

References

- [1] Gaunt, J.L. and Lehmann, J. Energy balance and emissions associated with biochar sequestration and pyrolysis bioenergy production. Environmental Science & Technology. 2008, 42(11), pp.4152-4158.
- [2] Lehmann, J. et al. Bio-char sequestration in terrestrial ecosystems—a review. Mitigation and adaptation strategies for global change. 2006, 11(2), pp.395-419.
- [3] R. Blissett, 'Upgrading low rank coal for metallurgical pulverised coal injection applications', 2015 International Conference on Coal Science & Technology, 2015.