Influence of Operating Parameters on Biochars produced from Native Scottish Wood

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INTRODUCTION

- Biochars are the black carbonaceous residues of thermochemical conversion of biomass in an inert atmosphere[1].
- Availability of feedstock, diverse physical and chemical properties give biochars a wide range of potential applications[2].
- Produced primarily through pyrolysis from biomass and wood substrates[2].
- Product characteristics influenced by operating parameters such as gas flow rates, residence time, pyrolysis temperature, heating rate.

MATERIALS AND METHODS

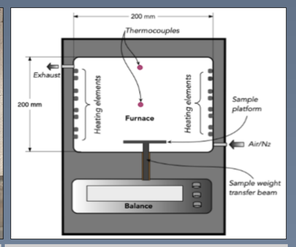
1. Samples from Sustainable Thinking Scotland C.I.C. (Kinneil Estate, Bo'ness, Scotland).

2. **Design of experiments** study. Variables: Contact time, pyrolysis temperature and activating gas flow rate. Full factorial design for experiments.

Response variables:
Yield, surface area, functional groups on biochar surface.

Sample	Wood type	Species
A	Predominantly softwood	Ash, Birch, Oak, Scots Pine, Sitka Spruce, Western Red Cedar
B	Predominantly hardwood	Ash, Downey Birch, Oak, Scots Pine, Sitka Spruce, Western Red Cedar
C	100% Softwood	Scots Pine, Sitka Spruce, Western Red Cedar

Sample position inside furnace (Precursor ~ 30 g).



Sample position – schematic diagram

RESULTS

Exp (#)	Sample code	Yield (%)	Surface area (m^2/g)	$V_{micropore}/V_{total}$ (%)	Wood type
1	250S6-20A	21.8	462	70.9	A
2	250S6-60A	20.7	531	60.0	A
3	250S85-20A	17.7	498	66.7	A
4	100S85-60A	14.7	515	66.4	A
5	250H6-20B	25.3	384	72.7	B
6	250H6-60B	23.2	467	65.8	B
7	250H85-20B	17.2	584	59.6	B
8	100H85-60B	15.1	662	59.7	B
9	250S725-60C	17.7	538	62.1	C
10	100S725-60C	17.6	513	58.0	C
11	250S725-20C	20.3	493	65.5	C
12	100S725-20C	21.0	495	59.4	C
					RR = 30°C/min
13	250S725-60/30C	14.7	592	47.9	C
14	100S725-60/30C	12.2	553	54.9	C
15	250S725-20/30C	20.3	422	74.9	C
16	100S725-20/30C	20.2	477	60.9	C

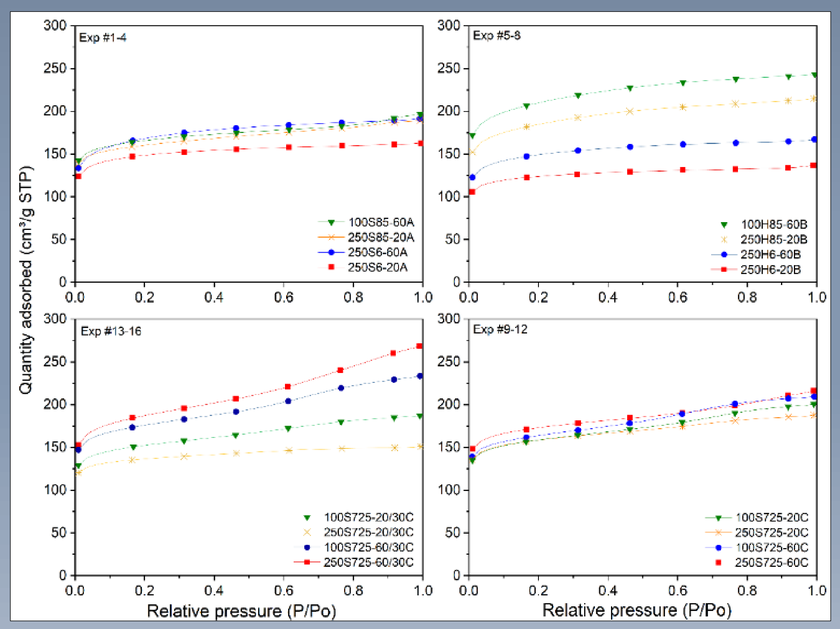
Nomenclature

250/100: Gas flow rate

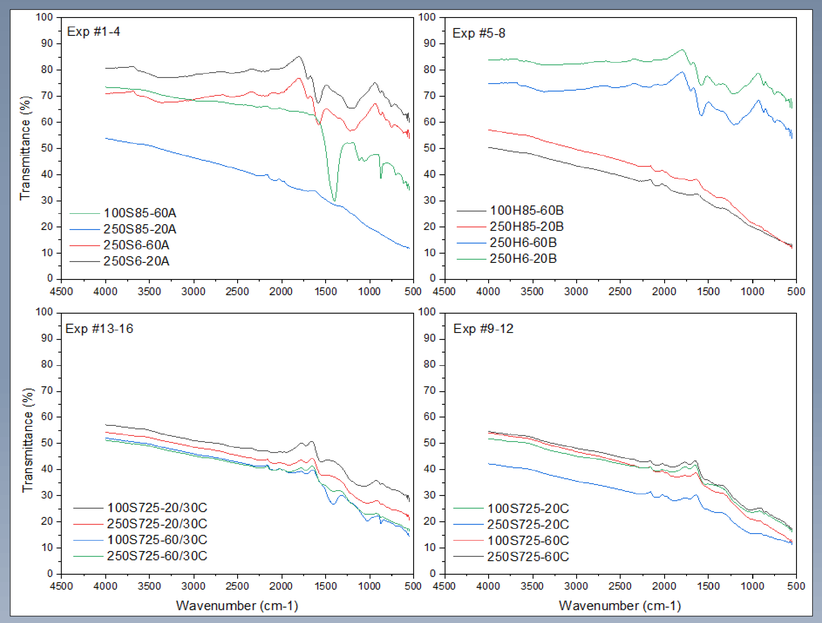
S/H: Softwood or hardwood

6/85/725: Temperatures (600, 800 or 725)

20A/60B: Residence time and wood batch for precursor.



Adsorption isotherms obtained for biochars



Infrared spectrum obtained for biochars

1. High gas flow rate + high temperature = increased surface area
2. High residence time = increase in surface area and mesoporosity
3. Mesopores in tandem with micropores in produced biochars.
4. High temperature = layered carbon structure; low temperature = aromaticity
5. Potential to vary parameters to produce biochars catered to specific applications such as adsorption of pollutants, soil remediation or carbon capture.

References

1. Y. Sun, B. Gao, Y. Yao, J. Fang, M. Zhang, Y. Zhou, H. Chen and L. Yang, *Chemical Engineering Journal*, 2014, **240**, 574-578.
2. L. Leng, Q. Xiong, L. Yang, H. Li, Y. Zhou, W. Zhang, S. Jiang, H. Li and H. Huang, *Science of The Total Environment*, 2021, **763**, 144204.