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How to produce a potential high value bio-char from the worst invasive plant in Canada

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Biochar production from the worst invasive plant in Canada

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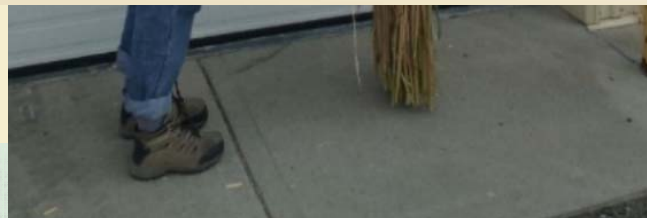
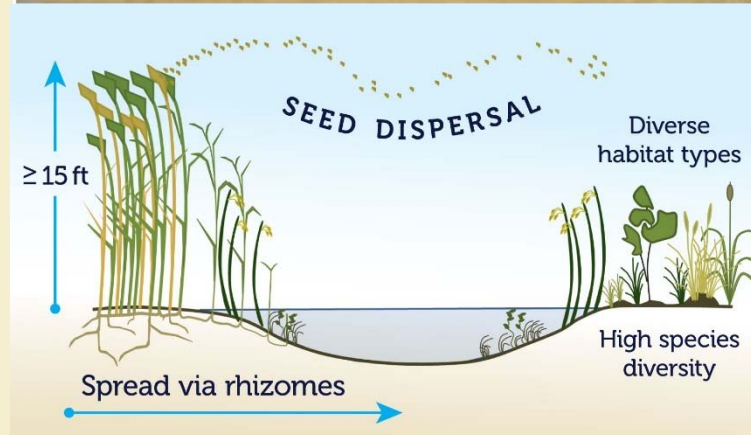
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Preview

- Phragmites
- Pyrolysis
- Pre-treatments
- Results
- Conclusion

What are Phragmites?

Phragmites Australis (European common reed) are an alien, invasive plants.



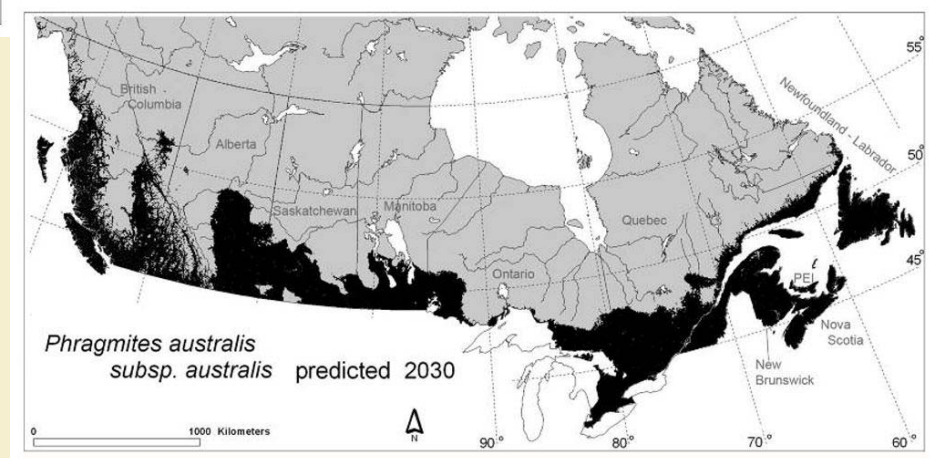
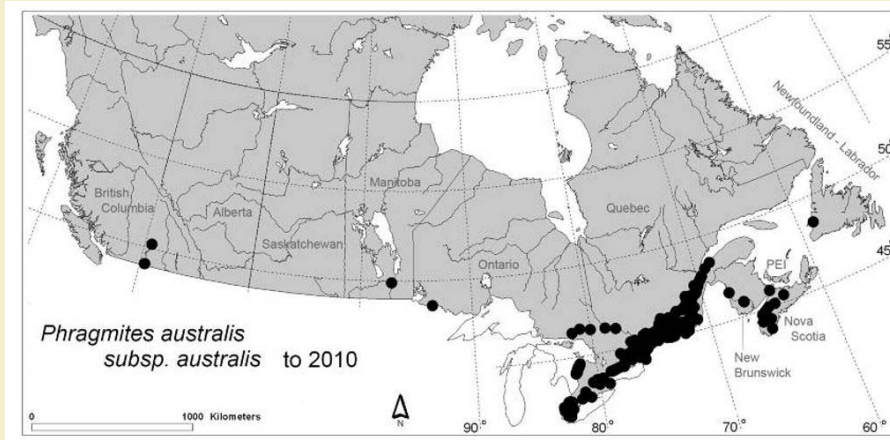
- The stem can grow up to 5 meters tall.
- Extremely dense vegetation (200 plants per square meter)
- Seedhead contains upward 2000 seeds.
- The spread can happen through seed dispersal or via rhizomes

Why Phragmites represent a problem?



- Loss of biodiversity
- Loss of habitat
- Changes in hydrology
- Changes in nutrient cycling
- Increased fire hazards
- Economic and social impacts

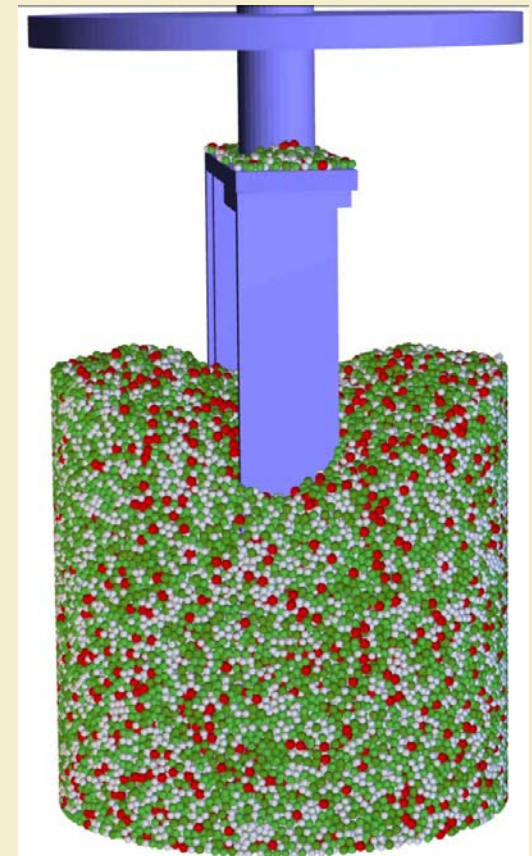
Invasion



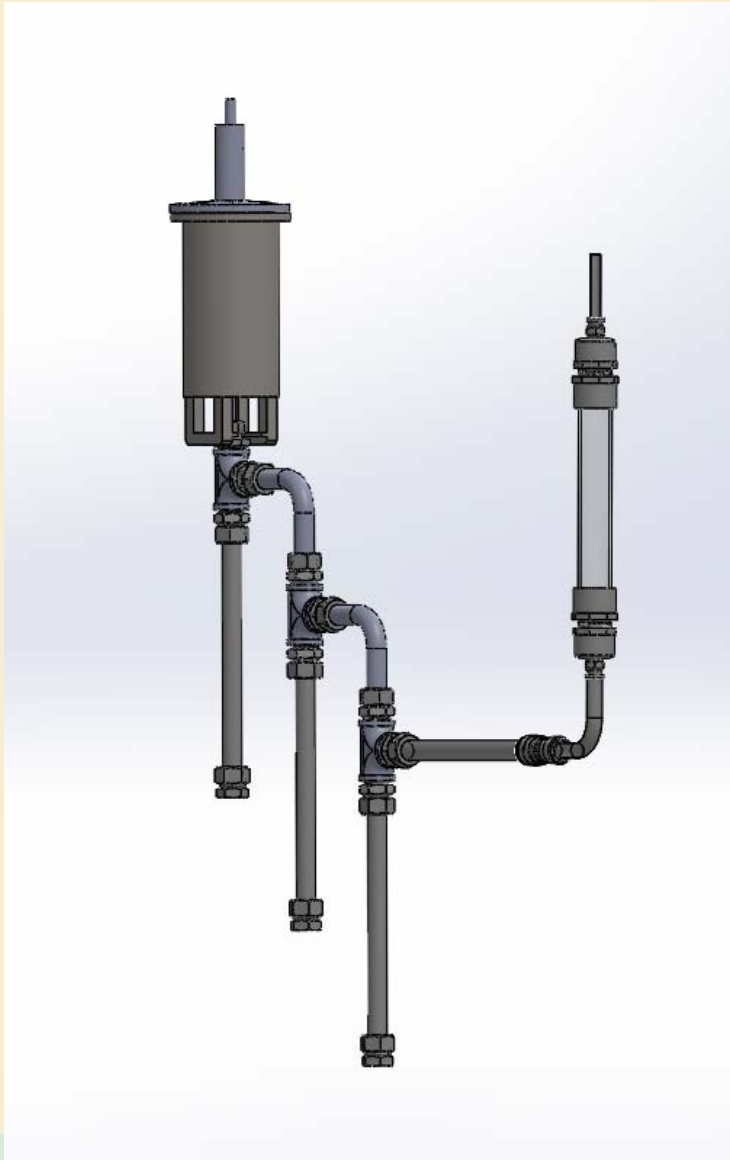
Catling, Paul M., and Gisèle Mitrow. 2011. "The Recent Spread and Potential Distribution of *Phragmites Australis Subsp. Australis* in Canada." *Canadian Field-Naturalist* 125

Pyrolysis

Batch system



Batch system



Main features:

- Batch with progressive collection of products at different temperatures
- Mechanical agitation
- Pure char bed
- No dilution
- Compact

Pyrolysis conditions:

- Temperature = up to 700 °C
- Heating rate = 1 to 15 °C/min
- Biomass = up to 300 g

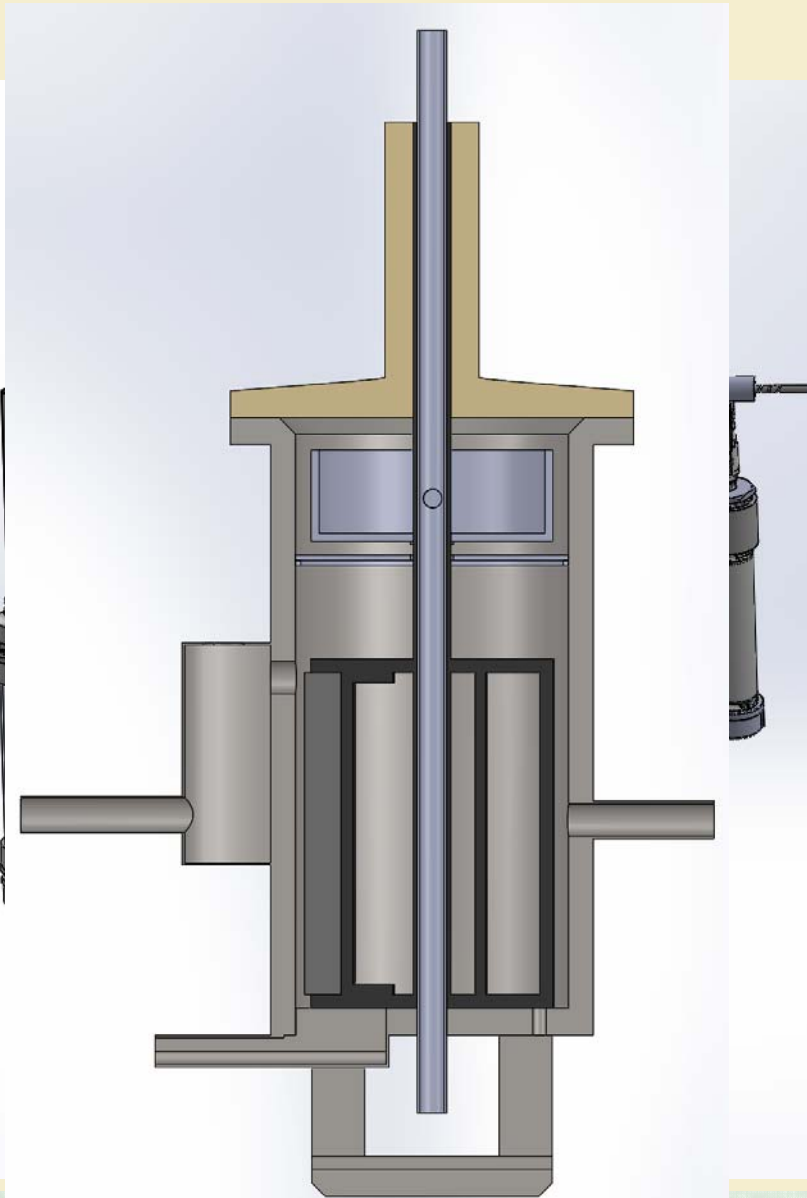


Pyrolysis

Continuous system



Continuous system



Main features:

- Continuous system with collection of product at different temperatures
- Mechanical agitation
- High flexibility on pyrolysis conditions
 - Continuous removal of char
 - Pure char bed
 - Overflow
- Adjustable gas dilution (0 to high)
- Design for post treatment of biochar (activation)
- Chamber to study the effect of bio-char on pyrolysis vapours

Pyrolysis conditions:

- Temperature = up to 900 °C

Scale-up unit developed in ICFAR

**Partial condenser
& electrostatic demister:**

- Dry bio-oil

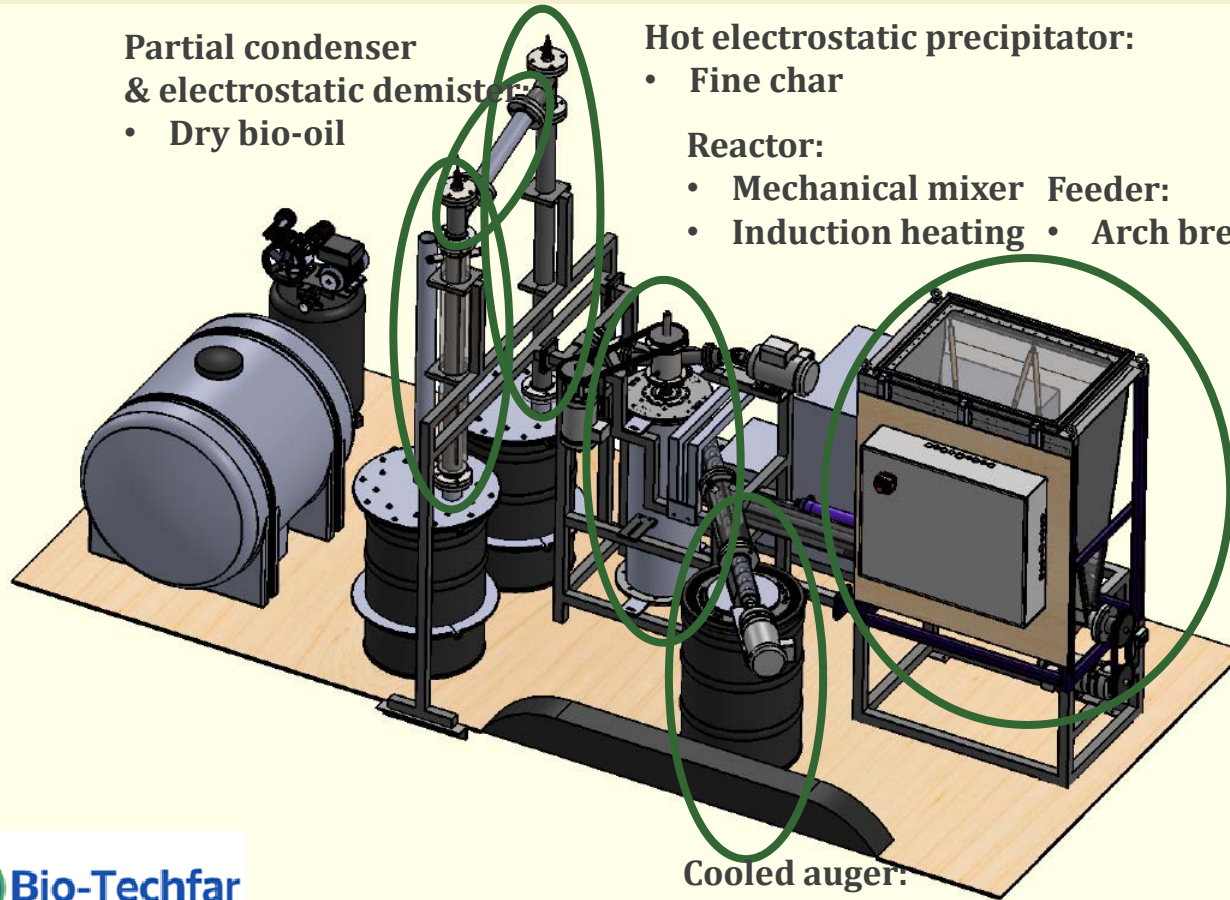
Hot electrostatic precipitator:

- Fine char

Reactor:

- Mechanical mixer

- Feeder:**
- Induction heating
 - Arch breaker



Cooled auger:

- coarse char

2.5 tons/day Mechanically Fluidized Reactor (MFR)



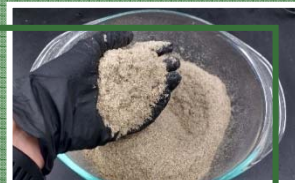
Pretreatments

From the field...

...to the lab...



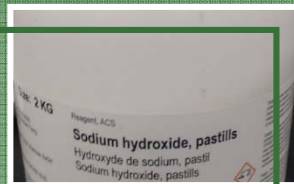
Harvesting



Milling and sieving



acid washing



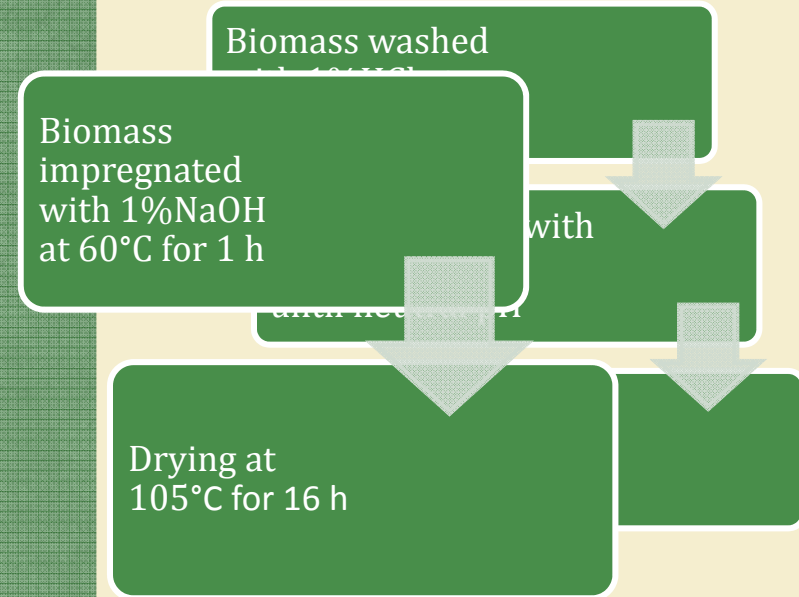
Alkali impregnation



drying

...to the reactor...

- Milling and sieving (1 mm)
- Acid wash: 1%wt HCl
- Alkali impregnation: 1% wt NaOH



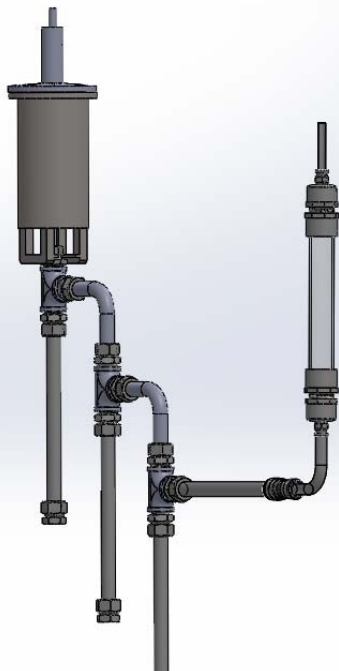
Pyrolysis conditions

Batch system

Pyrolysis conditions:

- Temperature = room T to 500^oC
- Heating rate = 8 ^oC/min
- Biomass = 200 g

Slow pyrolysis

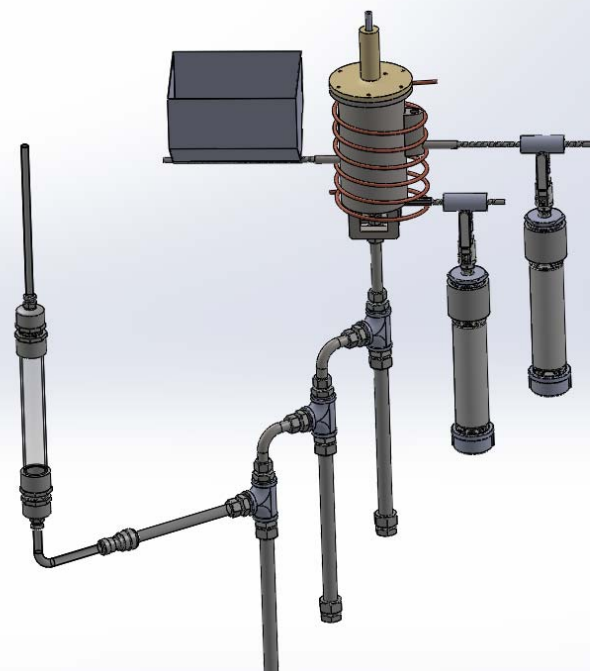


Continuous system

Pyrolysis conditions:

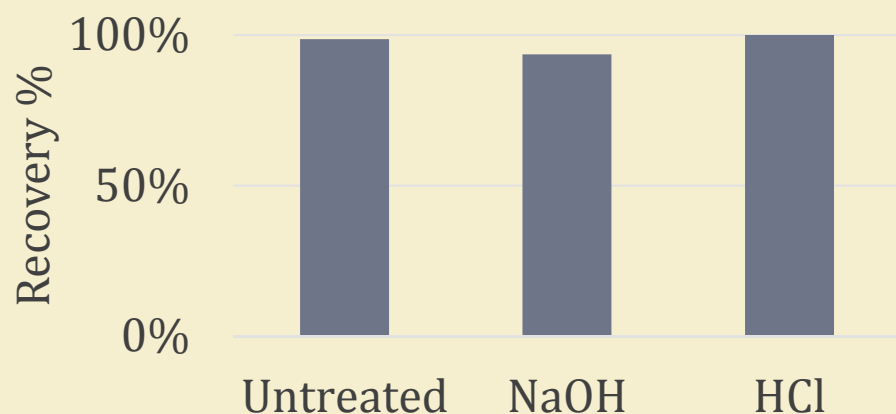
- Temperature = 500^oC
- Biomass = 100 g

Fast pyrolysis



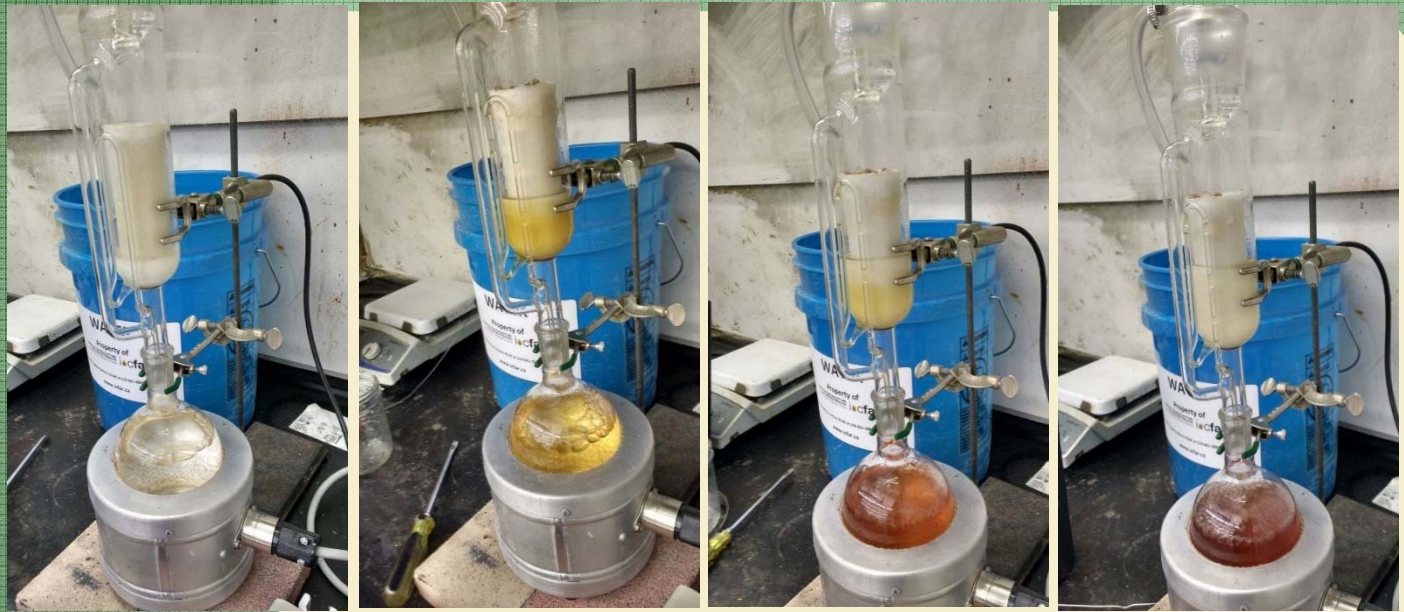
Biochar Characterizations

Ash recovery in char



Sample ID	Yield % dry basis	Ash content % (dry basis)	HHV (MJ/kg)
Untreated	27%	22%	26.8
1% NaOH	30%	22%	26.3
1% HCl	28%	17%	28.3

Sample IDs (mg/kg)	Untreated	1% NaOH	1% HCl
Ca	339.4	3904.9	6134.4
Cd	<0.125	<0.125	<0.125
Co	<0.125	<0.125	<0.125
Cr	3.2	9.2	45.5
Cu	22.1	234.7	81.6
Fe	491.1	50.1	50.4
K	1417.6	3.5	50.1
Mg	116.1	3.9	8.5
Mn	9.6	6.4	1.8
Mo	2.2	6.6	1.7
Na	643.1	1	29.2
Ni	36.5	9.4	1.8
P	1282.5	3.8	9.6
S	740.9	5313.3	13162.3
Si	437.9	308.4	530.2



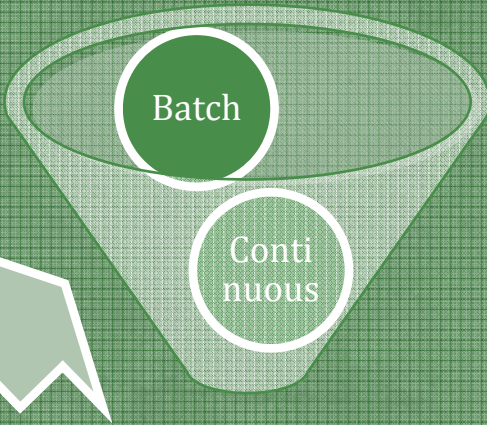
What's next?

Pre-treatments with different equipments

- Soxhlet extractor
- Sonic bath
- Water oven

And chemicals

- NaOH
- HCl
- Acetic acid
- water



Pyrolysis

What's next?





Acknowledgments



Thank you!



Questions?