Biochar for Desalination Concentrate Management

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Introduction

Approximately 75% of groundwater in New Mexico is too saline for most uses without treatment (Reynolds, 1962). Disposal of desalination concentrate from brackish water remains an environmental concern due to the potential of salts leaching into groundwater aquifers and contaminating surface waters. Recent research at the U.S. Bureau of Reclamation's (BOR) Brackish Groundwater Nation Desalination Research Facility (BGNDRF) has shown that growing halophyte crops irrigated with desalination concentrate is a way to manage concentrate volume while recovering a saleable/usable product. Much of the salt applied in the irrigation water is taken up by the plants, decreasing the risks for soil and water contamination.

Biochar is the carbonaceous solid produced by slow pyrolysis. In the pyrolysis process, the organic components are split between the solid, liquid and gas fractions, while the majority of the inorganic components are concentrated in the char. Past biochar research has shown that the availability/solubility of the inorganic nutrients in the biomass is affected by the pyrolysis conditions: some cations become less available. This observation suggests that some amount of salt could be sequestered in the char on purpose, potentially in combination with the production of bioenergy.

Objectives

- Create chars from halophyte biomass under different pyrolysis conditions.
- Determine how much of the salt can be protected from leaching through pyrolysis.
- Evaluate the potential of a closed system that uses the heat/energy from halophyte biomass pyrolysis to power a multiple effect distillation (MED) brackish water desalination unit, use the desalination concentrate to irrigate halophyte crops, and sequester salt from the soil/concentrate within the halophyte biochars.

Materials and Methods

Biomass from *Atriplex canescens* and *Atriplex lentiformis* were collected from the University of Arizona research plots at BGNDRF in Alamogordo, NM. The biomass was pyrolyzed in a lab-scale reactor at temperatures of 400, 500 and 600ºC, using a 5ºC/min heating rate and holding for 60 min. Biochars were crushed and sieved to 0.25-2 mm, then leached with DI water using a constant head permeameter. The leachates were analyzed for pH, electrical conductivity, and cation content using an inductively-coupled plasma optical emission spectrometer (ICP-OES). Un-leached and leached biochars were acid digested and also analyzed for cation content by ICP-OES. Mass balances were used to estimate the salt present in biochar, the leachable (available) salt, and the salt remaining after leaching.

Initial Results

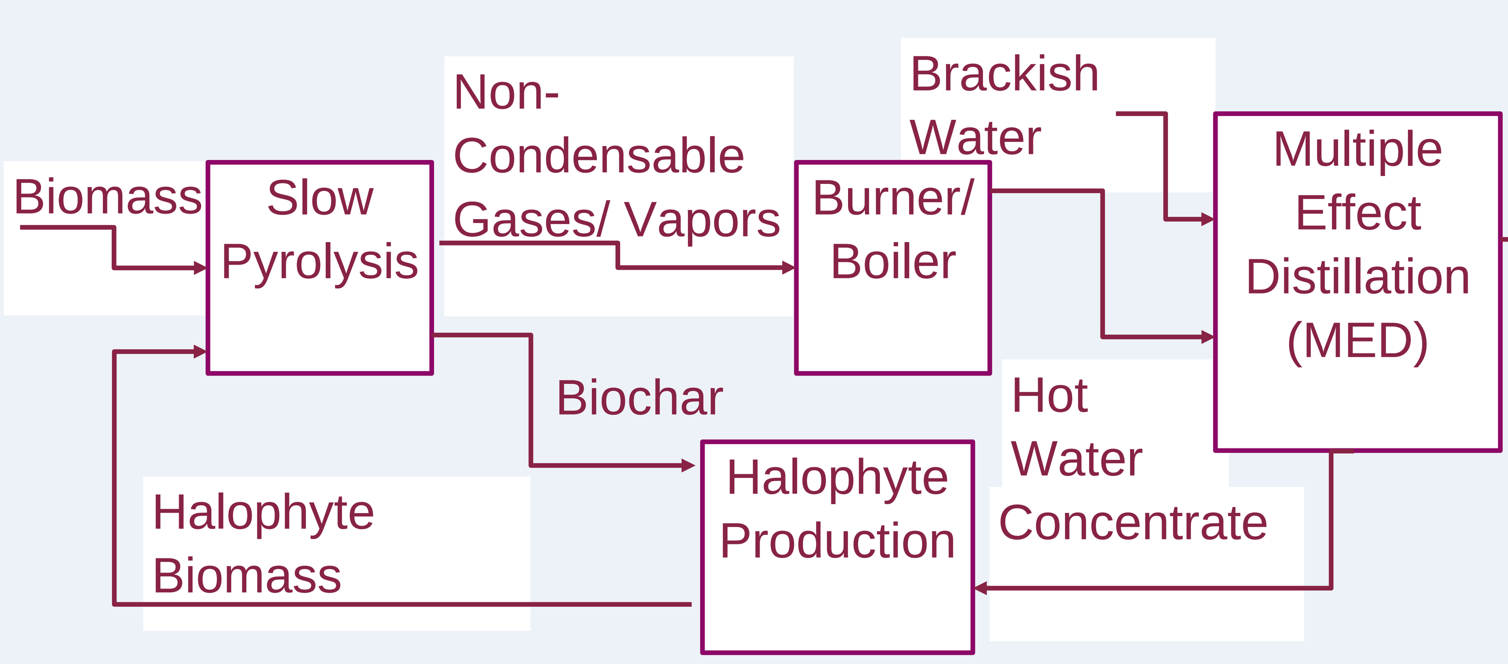
A. canescens 400˚ C Biochar

Element	Before leaching (g/kg)	After leaching (g/kg)	% leached
Ca	0.91	0.80	12
Mg	0.87	0.67	23
Na	0.14	0.13	6
K	4.35	3.10	28

A lentiformis 400˚ C Biochar

Element	Before leaching (g/kg)	After leaching (g/kg)	% leached
Ca	4.30	2.41	43
Mg	1.87	1.01	63
Na	5.94	1.98	72
K	9.33	3.29	64

Overall System Concept



Slow Pyrolyzer

Biochar

Atriplex canescens
Four Wing Saltbush

Atriplex lentiformis
Big Saltbush

Leaching Apparatus

ICP-OES

Preliminary Conclusions

Atriplex lentiformis biomass contains more salt than *Atriplex canescens* biomass, however, at 400ºC, *A. canescens* biochar retains more of its salt when leached.

Future work

- Complete cation mass balances for biochars made under other pyrolysis conditions
- Characterize anions present in biomass and leachates
- Characterize biomass and biochar samples for elemental CHNS analysis and physical properties
- Hypothesize and test mechanisms of salt availability and sequestration relative to biomass salt uptake and pyrolysis conditions

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