Chionoecetes opilio Pyrolysis: Characterization and Applications of Crab Biochar

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Background

Louisbourg Seafoods Ltd. harvests and sells over 2200 tonnes of snow crab (Chionoecetes opilio) annually. The commercially desired parts are the legs and shoulders, while the bodies and remaining parts (approximately 1000 tonnes/year) are considered waste. Due the increasing costs of processing shell fish waste, this biomass is left to accumulate in local landfills. MacQuarrie is working towards finding environmentally responsible ways of dealing with the biomass, while also creating a new viable product. Crab based biochar was generated by slow and fast pyrolysis and fully characterized. FT-IR and XRD showed there was a significant amount of calcium carbonate in the crab biochar indicating significant potential for various applications from remediation to catalysis.

Pyrolysis

Pyrolysis	Higher Heating Value (MJ/kg)	Water Content (%)	pH
1 (slow)	28.8	12.9	9.8
2 (fast)	27.3	13.6	9.3

- Run 1: Slow Pyrolysis conditions: T: 450 °C, 20 °C s-1, residence time 60 min
- Run 2: Fast Pyrolysis conditions: T: 575 °C, heating rate 70 °C s-1, residence time 5 min

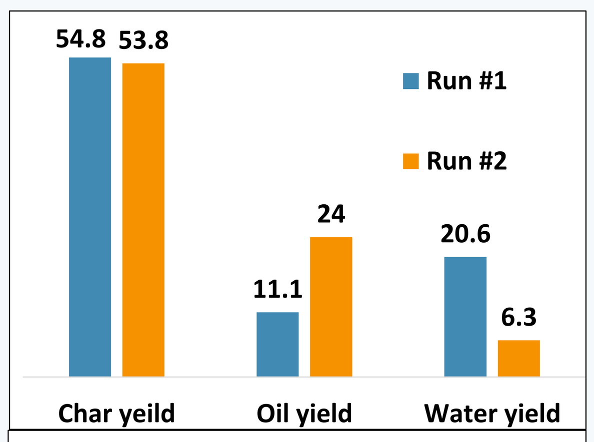


Figure 1. Pyrolysis yields for slow and fast pyrolysis of crab body waste. * N_2 1l/min

Calcium carbonate rich biochar generated from crab waste shows promise in various applications from neutralization of acidic mine water to catalysis

Characterization

Crab Charcoal	pH	BET analysis: Surface Area (m^2/g)	Pore Volume (cm^3/g)	Pore Size (Å)
fast pyrolysis char	9.2	16.8	0.08	188.9
slow pyrolysis char	9.8	28.7	0.13	175.7

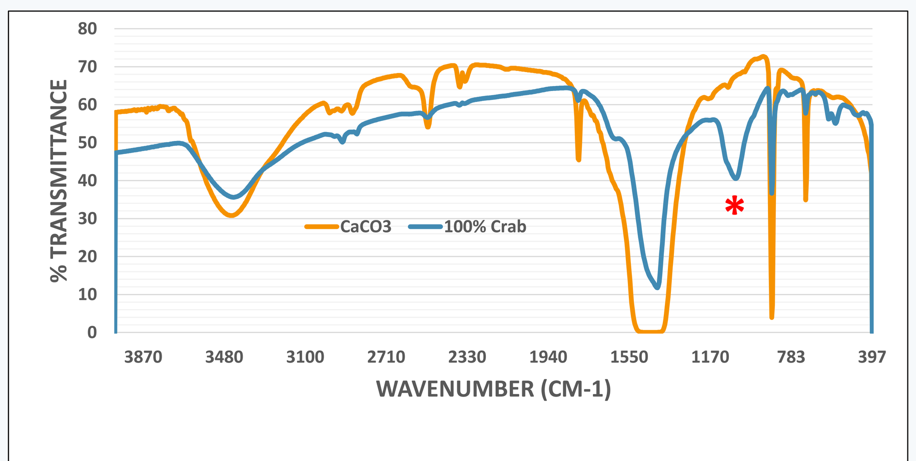


Figure 2. shows the FTIR spectra of Crab Char (blue) generated via fast pyrolysis compared to pristine calcium carbonate (orange). The peaks consistent with CaCO3 are labeled. Significant peak at 1100 consistent with CaO labeled with asterisk.

** Crab shell from Louisbourg Seafoods were dried at 100 °C, then ground with grinder, sieved through 80 meshes (0.18 mm) before use. Chitin and protein contents in crab shell were 35.34% and 31.5%, respectively.

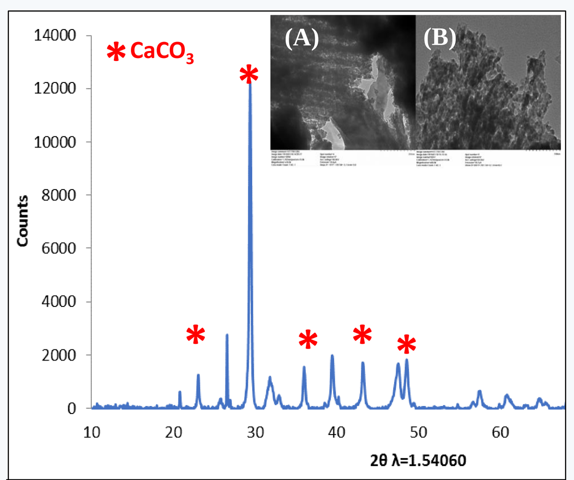


Figure 3. shows the XRD pattern for crab char consistent with CaCO3 in the form of calcite. Inset of crab biochar TEM images indicate areas of (A) order consistent with calcite and (B) disorder due to amorphous carbon.

Parameter	Crab Char
Moisture (%)	6.2
Ash (%)	33.2
Fixed Carbon	28.7
N P K	3.6 0.03 0.61
Ca Mg	23.2 0.96
pH	9.8

Applications

Acid Mine Water Neutralization

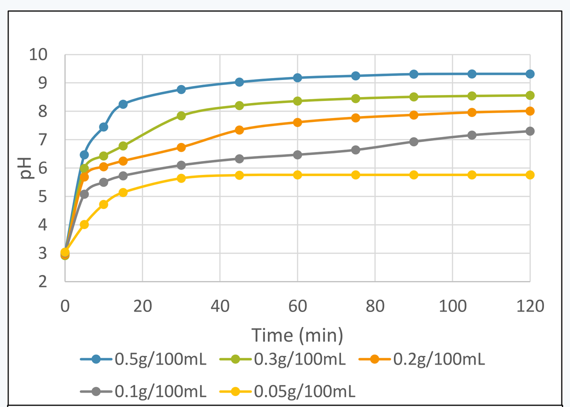
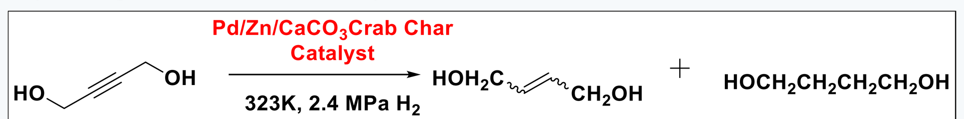


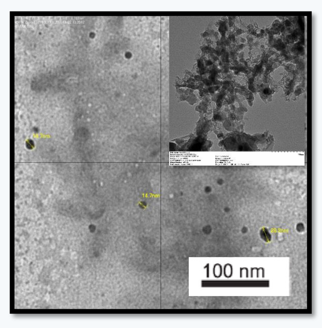
Figure 4. Crab char neutralization of synthetic acid mine water at various loadings over time.

Hydrogenation Catalyst



Scheme 1. Hydrogenation of butynediol with heterogeneous Pd-Zn-CaCO3 crab char catalyst.

Cat. Loading	Conversion	Selectivity	
10 %	49	32	68
20 %	33	46	54



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