Production of Activated Carbons from Pyrolytic Biochar

Anastasia Colomba  
ICFAR - Western University

Franco Berruti  
ICFAR - Western University

Cedric Briens  
ICFAR - Western University

Ajay Dalai  
University of Saskatchewan

Rambabu Nedunury  
University of Saskatchewan

See next page for additional authors

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Production of Activated Carbons from Pyrolytic Biochar

Anastasia Colomba¹, Franco Berruti¹, Cedric Briens¹, Ajay Dalai², Rambabu Nedunury², Alberto Colomba³, Silvia Fiore³, Giuseppe Genon³

¹ICFAR, Western University, London, Ontario CANADA
²University of Saskatchewan, Saskatoon, Saskatchewan, CANADA
³Politecnico di Torino, Torino, ITALY
Biomass pyrolysis

- **BIOMASS**
- **PYROLYSIS**
  - **GAS** (10-20%)
  - **CONDENSABLE VAPORS (BIO-OIL)** (50-70%)
  - **BIOCHAR** (20-30%)
... in the Old Days.....
Objectives of our Research

- **Bio-Char production** from a variety of **biomass residues and wastes** using different technologies and under different operating conditions followed by **activation**

- **Characterization**

- Studies on the **potential use for adsorption of selected pollutants**
## Biomass selection: 13 biomasses

<table>
<thead>
<tr>
<th>Energy crops</th>
<th>Crop residues</th>
<th>Seeds</th>
<th>Milling residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willow</td>
<td>Wheat Straw</td>
<td>Sorghum</td>
<td>Olive Residue</td>
</tr>
<tr>
<td>Miscanthus</td>
<td>Corn Stover</td>
<td>Sunflower Husks</td>
<td>Bagasse</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>Canola Straw</td>
<td></td>
<td>Birch Bark</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lignin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maple wood</td>
</tr>
</tbody>
</table>
The “Jiggle Bed” Reactor (JBR)*

- Micro-reactor developed for catalyst screening
- Fluidization achieved through jiggling
  - No fluidization gas
  - Ideal to study gas–solid reactions
- Heat provided through induction
  - Excellent temperature control
  - Fast response to changes during exothermic reactions
  - Heating rate can be varied over a wide range

*...also designated as the “James Bond Reactor”

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Western University
Experimental procedure:
PYROLYSIS and ACTIVATION

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Bio-Char Activation

Surface overview for non activated and activated biochar from birchwood

Surface detail for non activated and activated biochar from birchwood
Slow Pyrolysis + Activation (olive residue)

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Feedstocks comparison

![Graph showing the relationship between yield and surface area for different feedstocks. The graph compares Miscanthus, Olive residue, Willow, and Lignin. The x-axis represents yield in %, while the y-axis represents surface area in m²/g. The data points and trend lines illustrate the decrease in surface area with increasing yield.]
Slow and fast pyrolysis

Yield, %

Surface area, m²/g

Lignin
$R^2=0.85$

Olive residue
$R^2=0.92$

fast

slow
Universal relationship (olive residue)

For every feedstock, a unique relationship exists between total surface area and yield!
The distribution of micropores and mesopores depends on the pyrolysis conditions.
Comparison of activated charcoal from different feedstocks

Olive residue
(more micropores)

Lignin
(more mesopores)
Adsorption of Naphthenic Acids

- Lignin - fast
- Lignin - slow
- Best commercial

Activated lignin bio-char
**Key conclusions**

- Bio-Char is a valuable co-product of pyrolysis of residual biomasses and wastes

- In order to increase its value, it can be successfully be activated

- Activation can reduce significantly the mass and increase significantly the porosity: for every feedstock a unique relationship exists between yield and surface area

- Activated Bio-char is an effective adsorbent
Acknowledgments

Thank you.
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An ECI Conference

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Mont Tremblant, Quebec, Canada

Timeline

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Abstracts Reviews and Selection of Presentations: February 15, 2015
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Call for Free-Forum Posters: Ongoing until May 15, 2016