Upgrading of Fast Pyrolysis Byproducts for Material Use with High Value

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Upgrading of Fast Pyrolysis Byproducts for Material Use with High Value

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Outline

- Rationale of using char from fast pyrolysis
  - Example bioliq

- Activation and demineralization of fast pyrolysis char
Fast pyrolysis bio-oil

- Moderate temperature and high heating rate (wood):
  - 60-70 % liquid organics
  - <10 % char

- Char represents byproduct of low quantity

- Current use
  - Oxidation to provide process heat
  - Surplus heat & power as optional products

Adapted from:
Ash-containing feedstock

- Ash increases the yield of (organic) solids
  - Solids contain significant fraction of carbon
  - Use of char becomes more attractive

Fast pyrolysis of wheat straw – product distribution

bioliq\textsuperscript{®} concept for 2\textsuperscript{nd} generation biofuel

- Volumetric energy densification in decentralized units
- Economic production of drop-in fuels and chemicals in industrial scale

Energy density:
- 2 GJ/m\textsuperscript{3}
- 25 GJ/m\textsuperscript{3}
- 36 GJ/m\textsuperscript{3}
Cascaded approach

- Revenue must only compensate carbon losses due to activation (burn off)
- Negligible effects on gasifier design
  - No water gas shift required
  - No solids, less ash

![Diagram showing the cascaded approach from fast pyrolysis bio-oil to disposal via Char/activated carbon and adsorption application.]
Activation procedures

**Chemical (KOH) Activation**
- **Impregnation**
  - (2:1 wt./wt. KOH:char in H$_2$O at 60 °C)
- **Activation @ 700 °C**
  - (1 h @ 700 °C, N$_2$ 50 L h$^{-1}$, 4:1 wt./wt.KOH:char)
- **Washing**
  - (1N HCl and rinsing with H$_2$O)

**Steam Activation**
- **Pelletizing**
  - (fast pyrolysis tar as binder)
- **Activation**
  - (1 h @ 750 °C, steam 4.5 L h$^{-1}$)

**Demineralization**
- (1N H$_2$SO$_4$:HCl 1:1 solution for 24 h at room temperature)

**Char from 5 mm wheat straw**
- (fast pyrolysis at 500 °C, auger reactor with heat carrier)
Results of different activation methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Ash content (%)</th>
<th>BET surface area (m² g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Char</td>
<td>4</td>
<td>39.8</td>
</tr>
<tr>
<td>Demin. char</td>
<td>19.6</td>
<td>24</td>
</tr>
<tr>
<td>Steam Act.</td>
<td>550</td>
<td>38</td>
</tr>
<tr>
<td>KOH Act.</td>
<td>0.7</td>
<td>2900</td>
</tr>
</tbody>
</table>
Characterization of activated carbon

- Steam activation: mesopores
- Chemical activation: micropores
Simplifying activation method

Char from 5 mm wheat straw
(fast pyrolysis at 500 °C, auger reactor with heat carrier)

Demineralization
(1N H₂SO₄:HCl 1:1 solution for 24 h at room temperature)

Impregnation
(2:1 wt./wt. KOH:char in H₂O at 60 °C)

Activation @ 700 °C
(1 h @ 700 °C, N₂ 50 L h⁻¹, 4:1 wt./wt.KOH:char)

Washing
(1N HCl and rinsing with H₂O)

Ash content 40 %

Ash reduction to 20 %

Ash reduction to 15 %

Ash reduction to <1 %
Carbon losses due to activation are <40 %
Summary

- Fast pyrolysis char is a significant byproduct if feedstocks with high ash content are used.

- It was shown that combined activation and demineralization of fast pyrolysis char is possible.
Thank you for your attention!

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