INVESTIGATION OF BIOCHAR AS AN ALTERNATE ADSORBENT FOR REMOVING COPPER(II) FROM STORMWATER

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Objective
Heavy metals enter surface water via storm water and are considered toxic to aquatic organisms. Techniques to remediate these are investigated to comply with EPA standards. Activated carbon is currently the most commonly used adsorbent for industrial wastewater applications but is expensive. The adsorption capacity of four different biochar formulations was investigated to determine effectiveness as an alternative adsorbent.

What is Activated Carbon?
- Activated Carbon is a widely used adsorbent because of its ability to adsorb a large variety of organic chemicals.
- Activated carbon is characterized by an extremely high surface area to weight ratio due to the vast network of pores contained in a particle.
- These pores significantly increase surface area available for adsorption processes.

Activated carbon is created in a two step process.
- Step 1 – Pyrolysis
- Step 2 – Activation

Biochar is raw organic material that undergoes pyrolysis but does not undergo an activation step.

Biochar applications include:
- soil additive
- water filter
- remediation of pollutants

Methods
- Mortar and Pestle
- Sieve to 40X50 mesh
- 125 mL batch bottles
- Tumbler (30 RPM)
- Vacuum Millipore filter

Table 3: Isotherms models for natural systems

<table>
<thead>
<tr>
<th>Model</th>
<th>Assumptions</th>
<th>Equations for Adsorption Isotherm</th>
<th>Used in Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>All adsorption sites of the same type</td>
<td>( q = q_m \cdot \left( \frac{C}{K} \right) )</td>
<td>1</td>
</tr>
<tr>
<td>Langmuir</td>
<td>Homogeneous</td>
<td>( q = \frac{q_m \cdot K \cdot C}{1 + K \cdot C} )</td>
<td>2</td>
</tr>
<tr>
<td>Freundlich</td>
<td>Unlabeled</td>
<td>( q = q_m \cdot C^{1/n} )</td>
<td>3</td>
</tr>
</tbody>
</table>

Isotherms
- Provide information about adsorbability of a chemical for a given adsorbent.
- Equilibrium adsorption density \( (q_{eq}) \) is expressed as a function of the dissolved adsorbate concentration \( (C_a) \).
- Predict distribution of adsorbate between the surface and solution for other conditions once established for an adsorbent-adsorbate pair.

Isotherms experiments must be conducted at equilibrium conditions to construct accurate isotherms.

Kinetics
- Kinetic tests were conducted to determine the time it takes to reach equilibrium, \( t_{eq} \) of a particular adsorbent with solution.
- Percent removal of \( Cu^{2+} \) from solution was determined for each bottle as a function of adsorbent contact time.
- \( t_{eq} \) was determined by the day that the percent remaining \( Cu^{2+} \) in solution did not decrease, shown in Figure 7 for each biochar sample.

Future Work
- Investigate pH buffers to maintain constant pH of bottles to prevent \( Cu^{2+} \) precipitation.
- Conduct isotherm tests at lower \( Cu^{2+} \) concentrations.
- Conduct BET analysis on biochar to determine surface area.
- Develop isotherms for Zinc (Zn²⁺) solutions.
- Investigate solutions containing \( Cu^{2+} \) and \( Zn^{2+} \) for possible competition for active sites between the two cation species.

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Biochar applications include:
- soil additive
- water filter
- remediation of pollutants

Methods
- Mortar and Pestle
- Sieve to 40X50 mesh (180-300 μm)
- 125 mL batch bottles
- Tumbler (30 RPM)
- Vacuum Millipore filter
- ICP-AES for \([Cu^{2+}] \)