Cabot Norit Activated Carbon for Aquariums

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Agenda

1. Activated carbon
2. Feedstocks and properties
3. Activated carbon in water treatment
4. Sources of pollutants in Aquariums
5. Granular Activated Carbon (GAC) treatment
6. Recommended products
7. Contacts
What is activated carbon?
A highly porous carbonaceous material with very strong adsorptive capacity

- Very high surface area
- 1 teaspoon of carbon (5 g) has the same surface area as a football field (≈ 1,000 m²/g)
Activated Carbon Feedstocks

Steam or chemical activation manufacturing processes opens up the porosity

RAW MATERIALS

- Coal
- Peat
- Wood
- Coconut shells
- Olive pits
- Peach stones
- Various waste by-products

Once granular activated carbon (GAC) has been used and is loaded with impurities, it can be returned to the manufacturer where it is reactivated (cleaned) and then re-installed at customer’s location. GAC has an infinite service life if properly cared for.
Activated Carbon Pore Structure

- Varies by feedstock
- Modified by manufacturing processes to meet treatment objectives for specific applications

**GAC Surface**

- **Coconut-based**
  - A Macro pores \( r > 25 \text{ nm} \)
  - B Meso pores \( r 1-25 \text{ nm} \)
  - C Micro pores \( r < 1 \text{ nm} \)

- **Coal-based**
  - A Macro pores \( r > 25 \text{ nm} \)
  - B Meso pores \( r 1-25 \text{ nm} \)
  - C Micro pores \( r < 1 \text{ nm} \)
Adsorption Process

Micro pores < 1 nm
Meso pores 1-25 nm
Macro pores > 25 nm
Activated carbon treatment objectives in water applications

**ACTIVATED CARBON IN WATER TREATMENT**

- Remove hydrophobic compounds, dissolved organics, non- and poorly biodegradable compounds
- Treats relatively low concentrations of contaminants (polishing)

**TREATMENT OBJECTIVES**

- Taste & odor causing compounds
- Organic micro-pollutants (pesticides)
- Natural organic matter (NOM)
- Biodegradable organics (AOC, BDOC)
- Disinfection by-products (DBPs)
- Ammonia (though nitrification)
- Suspended matter (via filtration)
- Residual oxidizing agents ($O_3$, $H_2O_2$)
- Color
## Cabot Norit Activated Carbon Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>GAC</th>
<th>PAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquarium water</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Potable water</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Beverages</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Industrial process water</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Ultra-Pure water</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Wastewater</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Pool water</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Point-of-Use water filters</td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>

- **OVERVIEW**
  - In use for almost all water types globally
  - EPA Best Available Technology (BAT) for purifying municipal drinking water
  - Widespread use from purifying wastewaters to ultra pure water used in semiconductor industry

Aquarium water application uses Granular Activated Carbon (GAC), not Powdered Activated Carbon (PAC)
Aquariums
Fish living in their own water
Sources of Pollutants

- **Fish Food** (liquid, or flakes)
  - Amino Acids, Proteins

- **Live Plants**
  - Pigments, Phenolic Compounds

- **Invertebrates**
  - Pheromones, Organic Acids

- **Fish**
  - Hormones, Ammonia waste

**Organic Pollutants**
Copper Sulfate
Used to control algae growth and fish parasites in aquariums

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication</td>
<td>• Protozoa</td>
</tr>
<tr>
<td></td>
<td>• Algae growth</td>
</tr>
<tr>
<td>Problem</td>
<td>• Highly toxic to freshwater fish</td>
</tr>
<tr>
<td></td>
<td>• Toxic to invertebrates and live plants</td>
</tr>
<tr>
<td></td>
<td>• Prolonged exposure may cause anemia, kidney and gill problems</td>
</tr>
<tr>
<td>Solution</td>
<td>• Activated adsorbs copper from water</td>
</tr>
<tr>
<td></td>
<td>• Works best in a chelated or complexed form and/or at pH 5-7</td>
</tr>
</tbody>
</table>

Free copper that is dissolved is toxic for fish and it is not adsorbed well by GAC.
# Ozone Effects

Used to improve water quality (colors, odors) by breaking down dissolved organic compounds into simpler forms that can be consumed by bacteria

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<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication</td>
<td>• Disinfectant, antibacterial, antiviral, antiprotozoal</td>
</tr>
<tr>
<td></td>
<td>• Oxidizes organics</td>
</tr>
<tr>
<td>Problem</td>
<td>• Can burn mucus membranes of fish, invertebrates</td>
</tr>
<tr>
<td>Solution</td>
<td>• Run ozonated water through activated carbon before returning it to the tank</td>
</tr>
</tbody>
</table>

\[
C^* + 2O_3 \rightarrow C^*O_2 + 2O_2
\]

Particularly applicable in large aquariums where it is impractical to change the water frequently. Ozone is a strong oxidant and GAC removes it very effectively from water.
GAC Treatment Scenarios and Ozone Effects

OZONE > GAC

\[ \text{BrO}_3^- \rightarrow \text{Br}^- \]

Reduces DOC

GAC > OZONE

Removes \( \text{BrO}_3^- \)

Reduces DOC

Ozone enhances protein skimmer performance via foam generation

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<thead>
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</table>
| GAC                    | • Filtration and adsorption  
                          • Color, organic compounds, chemotherapeutics, suspended solids             |
| Protein Skimmer        | • Removes ozone used for foam creation to enhance performance                 |
| Live Rock or Berlin    | • Nitrate control (biological), chlorine, and chloramine removal              |
| System                 |                                                                              |
## Recommended Products

<table>
<thead>
<tr>
<th>Market</th>
<th>Type</th>
<th>Available Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquariums</td>
<td>Lignite</td>
<td>DARCO® 4x12, HYDRODARCO® 610 / 614</td>
</tr>
<tr>
<td></td>
<td>Bituminous</td>
<td>NORIT® GAC 816 / 820</td>
</tr>
<tr>
<td></td>
<td>Peat</td>
<td>NORIT® PK 1-3, NORIT® PK 3-5</td>
</tr>
<tr>
<td>Ponds &amp; Water Gardens</td>
<td>Lignite</td>
<td>DARCO 4x12 / 6x10</td>
</tr>
<tr>
<td></td>
<td>Bituminous</td>
<td>NORIT® GAC 410</td>
</tr>
<tr>
<td></td>
<td>Peat</td>
<td>NORIT® PK 1-3, NORIT® PK 3-5</td>
</tr>
<tr>
<td>Swimming Pools</td>
<td>Lignite</td>
<td>DARCO GACs (larger mesh)</td>
</tr>
<tr>
<td></td>
<td>Bituminous</td>
<td>NORIT® GACs (larger mesh)</td>
</tr>
<tr>
<td></td>
<td>Peat/Wood</td>
<td>NORIT® RO 0.8, PK 1-3</td>
</tr>
</tbody>
</table>
Contacts

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Thank You