Removal of PFAS from Drinking Water with Granular Activated Carbon

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Who is Calgon Carbon?

Corporate Profile

- World’s largest producer of Granular Activated Carbon (GAC).
- Solves customer purification and separation problems with an array of technologies.
- Water treatment is core competency with a diverse product portfolio.

$619.8 million
2017 net sales

75 years
experience

1,400+ employees

25 offices
sales and service

20 facilities
Manufacturing, reactivation, equipment

240 patents

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Removing PFAS for 15 Years

Our Experience with PFAS Removal

• Bituminous, reagglomerated GAC is most effective for removing PFAS.

• We have installed over 45 large installations for PFAS removal in drinking water and remediation applications across the United States.

• We offer a complete solution including accelerated laboratory & pilot studies, activated carbon, equipment, on-site installation and exchange services, reactivation and financing.
Calgon Carbon
PFAS Treatment Locations

45+ Installations Across the U.S.
## Viable Technologies: Pros

<table>
<thead>
<tr>
<th>Technology</th>
<th>Advantages</th>
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</table>
| **Granular Activated Carbon (GAC)** | Most studied technology  
Will remove 100% of the contaminants, for a time  
Good capacity for some PFAS  
Will remove a significant number of disinfection byproduct precursors  
Will help with maintaining disinfectant residuals  
Will remove many co-contaminants  
Likely positive impact on corrosion (lead, copper, iron) |
| **Anion Exchange Resin (PFAS selective)** | Will remove 100% of the contaminants, for a time  
High capacity for some PFAS  
Smaller beds compared to GAC  
Can remove select co-contaminants |
| **High Pressure Membranes**       | High PFAS rejection  
Will remove many co-contaminants  
Will remove a significant number of disinfection byproduct precursors  
Will help with maintaining disinfectant residuals |
## Viable Technologies: Cons

### EPA Issues to Consider

**EPA is evaluating these issues to document where and when they will be an issue**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Considerations</th>
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<tbody>
<tr>
<td>Granular Activated Carbon (GAC)</td>
<td>- GAC run time for short-chained PFAS (shorter run time)</td>
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<td>- Potential overshoot of poor adsorbing PFAS if not designed correctly</td>
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<tr>
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<td>- Reactivation/removal frequency</td>
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<td>- Disposal or reactivation of spent carbon</td>
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<td>Anion Exchange Resin (PFAS selective)</td>
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<td>- Unclear secondary benefits</td>
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<td>- Disposal of resin</td>
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<td>High Pressure Membranes</td>
<td>- Capital and operations costs</td>
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<td>- Membrane fouling</td>
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<td>- Corrosion control</td>
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<td>- Lack of options for concentrate stream treatment or disposal</td>
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Comparison of Various GAC for PFOA and PFOS Removal
Published in American Water Works Association Journal – January 2018

**Goal:** to determine what starting material provides best activated carbon for PFOA and PFOS removal.

<table>
<thead>
<tr>
<th>Carbon Types</th>
<th>Source Material</th>
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<tr>
<td>Filtrasorb – Virgin</td>
<td>Domestic Bituminous Reagglomerated Coal</td>
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<tr>
<td>Coconut 8x30</td>
<td>Imported Direct-activated Coconut</td>
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<tr>
<td>Coconut 12x40</td>
<td>Imported Direct-activated Coconut</td>
</tr>
<tr>
<td>Filtrasorb – React</td>
<td>Reactivated Bituminous Reagglomerated Coal</td>
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</tbody>
</table>
Comparison of Various GAC for PFOA and PFOS Removal: Results

Four Carbon RSSCT PFOS Breakthrough Curves

Coconut-based

Domestic Bituminous

0 50 100 150 200 250 300 350 400 450 500
Simulated Days

0 200 400 600 800 1000 1200
PFOS (ppt)

Virgin Filtrasorb
Coconut 8x30
Coconut 12x40
React Filtrasorb
Feed PFOS
50% Feed PFOS

70 ppt EPA Health Advisory Exposure Limit

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Removal of multiple PFAS using Virgin Bituminous Reagglomerated GAC

**Conclusion:** GAC effectively removes more than just PFOA and PFOS, i.e. “short” chain compounds too.
Is lab data predictive?

Lab-Scale Data: Simulated Days of Operation vs. PFOA breakthrough

- **PFOA In**: Non detect after 620 simulated days of operation
- **PFOA Out**: Non detect after 620 simulated days of operation

PFAS Concentration (ppb, ug/L) vs. Simulated Days of Operation (13 minute contact time)
Customer’s Field Data

Conclusion: Lab-scale testing sufficiently predicted full-scale results.

Permanent Model 12-40 System
13 min. contact time

PFOA Concentration (ppt)

Days of Operation

Influent
Average Influent
Lead Effluent
USEPA HAL

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