Frostburg, MD

Drinking Water Purification in Frostburg, MD

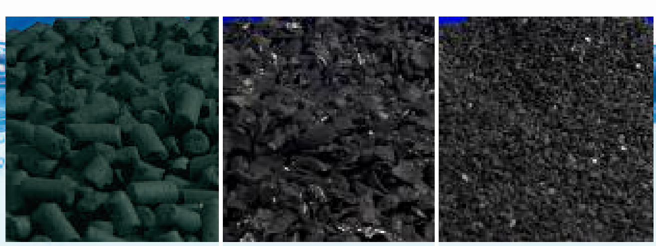
Different Carbon, Different Performance

For the past four decades, bituminous coal has been the standard choice of raw material for activated carbons used in drinking water purification. Bituminous coal is an abundant raw material that has the properties necessary to produce a final activated carbon product with the characteristics that are essential for drinking water purification; e.g., high adsorption capacity, good abrasion resistance, and low ash levels. It is important, however, to note that among bituminous coal-based carbons, there are differences in raw materials and activation methods that influence the final properties of the resultant carbon.

Thermal activation of bituminous coal-based activated carbon products can be accomplished through two methods: reagglomeration or direct activation. The reagglomeration process consists of the following steps:

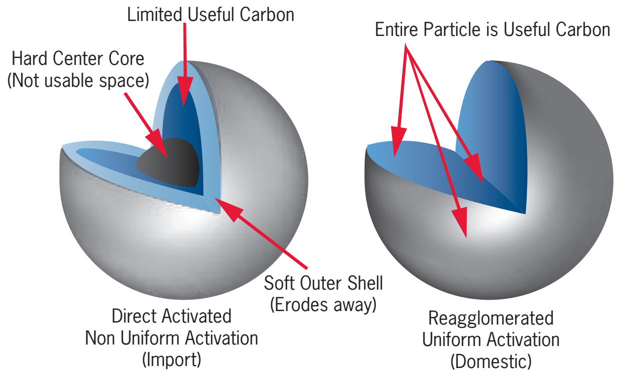
- Pulverize the raw material coal into a powder approximately 50 microns in size
- Add a chemically-inert binder
- Reagglomerate the product into briquettes
- Crush the briquettes
- Size the crushed briquettes
- Bake the crushed briquettes at temperatures up to 800°F in a controlled atmosphere to remove VOCs
- Thermally activate the carbon by exposing it to temperatures up to 1900°F in a controlled atmosphere

The direct activation process skips the initial three steps; the raw material coal is crushed, sized, baked, and activated. While both processes result in an activated carbon product with similar iodine number values, the final properties of this product are significantly impacted by the activation method used. Reagglomeration adds man-made pore structure into the carbon granule which allows for better penetration of gases into the granule during baking and activation, resulting in a more uniformly activated product. Direct activation does not provide these additional pathways for the activation gases, often resulting in granules that are overactivated along the outer edge of the granule and underactivated at the core.



Visual Cross-Sectional Comparison of Reagglomerated and Direct Activated Carbons

While basic activated carbon specification tests, such as the Iodine Number, often show identical values between reagglomerated and direct activated products, actual performance between these two types of carbons in municipal applications can be quite different. A recent case study in Frostburg, Maryland, highlights these performance differences.



Comparison Trial: Frostburg, MD

The city of Frostburg is a small municipality in western Maryland. The current water treatment plant at Frostburg began treating water in 1997, and treats a flow rate of 3 MGD to serve the city and surrounding communities. The city used anthracite coal for filtering their drinking water supply. With impending US-EPA stage 2 DBPR regulations limiting the allowable discharge of disinfection byproducts such as total trihalomethanes (TTHMs - limit of 80 ppb) and the group of five haloacetic acids (HAA5s - limit of 60 ppb), the city began evaluating changes to its treatment process.

One option considered was to replace the existing anthracite filter media with granular activated carbon (GAC). To evaluate this option, Calgon Carbon Corporation provided pilot equipment to test the effectiveness of GAC to remove a variety of organics including TTHMs and HAA5s. While the main purpose of the pilot was to compare anthracite to GAC, the city also wanted to evaluate reagglomerated and direct activated carbons under identical treatment conditions so they would know they were selecting the best activated carbon product for their application.

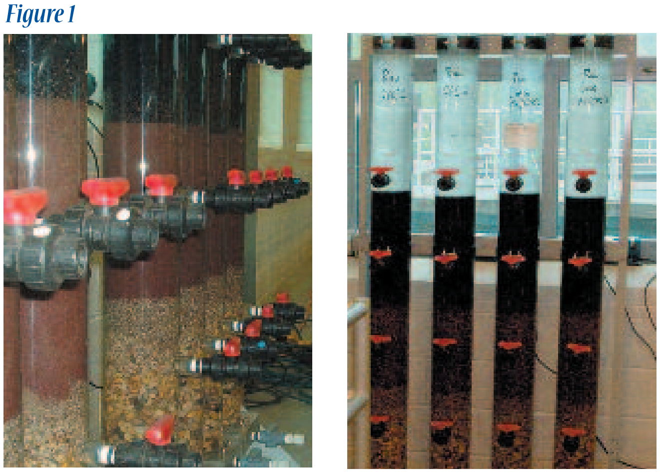
Frostburg, MD

The pilot columns (see Figure 1) provided for treatment of a slipstream of 2.3 liters/min. (0.6 gpm) and a total contact time of 10 minutes through the media (gravel, sand, garnet, and anthracite or GAC). The contact time through the anthracite/GAC step was two minutes[1]. Water quality parameters measured were Total Organic Carbon (TOC), UV_{254} Absorbance, TTHMs, and HAA5s. The columns were allowed to treat nearly 80,000 bed volumes of water during the trial for approximately 180 days.

[1]Normal contact times for GAC in surface water treatment are typically 10 minutes, but since this pilot was studying the replacement of anthracite with GAC, equal volumes of GAC and anthracite were provided, with the lower contact time of the anthracite bed being held constant.

Pilot Column Configuration for Frostburg, MD

Figure 1



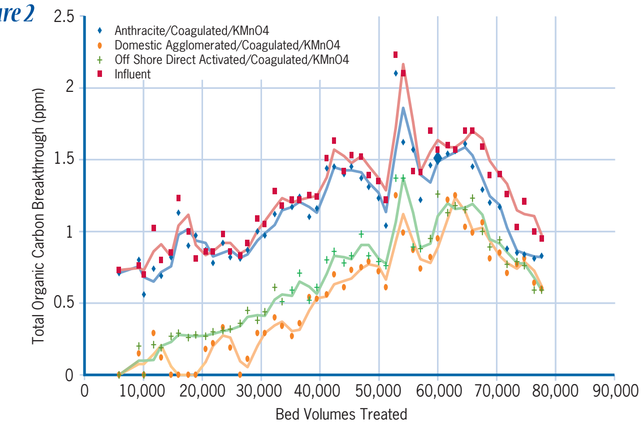
Trial Results

- Both activated carbon products exceeded the performance of anthracite for all of the water quality parameters tested.
- The reagglomerated and direct activated carbons both exhibited similar breakthrough characteristics for TOC and UV_{254}, with the reagglomerated GAC removing approximately 10% more total TOC and UV_{254} Absorbance over the life of the trial (Figures 2 and 3).
- Both products effectively reduced the HAA5 levels to below 5 ppb throughout the trial.
- The most dramatic difference in performance was with the TTHM removal (Figure 4). The reagglomerated product treated double the water volume before reaching saturation for TTHMs. Both products exhibited what is known as "rollover" - the desorption of TTHMs (probably due to adsorption of other, more highly adsorbable species); however, the direct activated GAC more closely approached the maximum contaminant level of 80ppb during this time.

Based on the results of this trial, Frostburg decided to replace their anthracite with domestically produced reagglomerated GAC. Based on the pilot results, the expected bed life of the GAC system is approximately 10 months before exchange of the carbon is required.

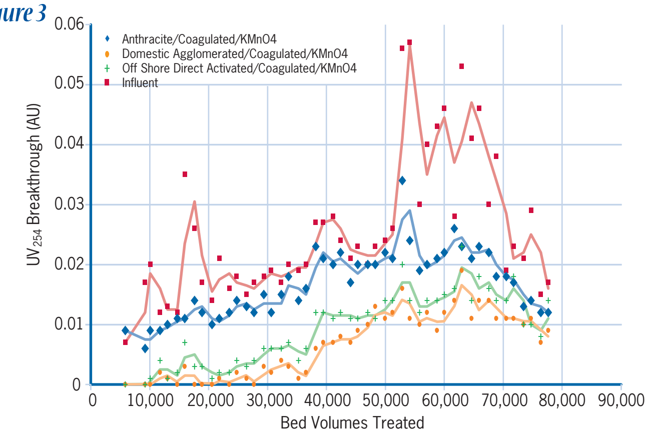
Total Organic Carbon Breakthrough Data

Figure 2



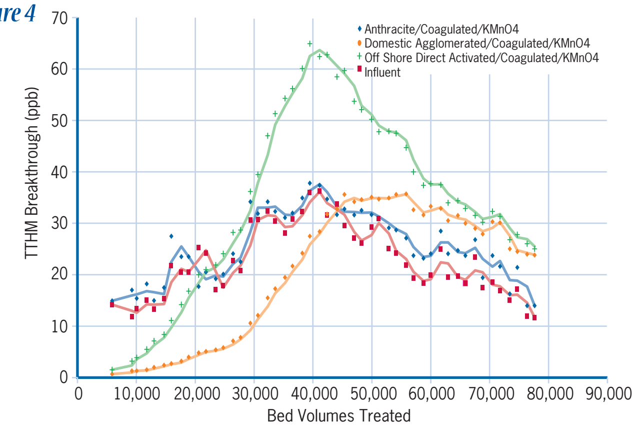
UV_{254} Breakthrough Data

Figure 3



TTHM Breakthrough Data

Figure 4



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