By Neal Megonnell, Calgon Carbon Corp.

The Great Activated Carbon Dilemma

Fresno Discovers Big Difference Between Reagglomerated Carbon and Direct Activated Carbons

Drinking water treatment professionals have long held fast to the belief that granular activated carbon (GAC) based on bituminous coal provides the best performance for their demanding application. That's why, when an article in 1999 cited evidence that a lignite-based GAC outperformed a bituminous-based carbon, industry experts were surprised and more than a bit skeptical.

The results of the study published in the article detailed how the Fresno Sole Source Aquifer in California selected lignite-based carbon after reviewing a manufacturer's comparison test. It offered evidence that lignite-based GAC treated 35 percent more water than the bituminous GAC before reaching saturation. Furthermore, the test showed that lignite GAC had a 30 percent longer life than bituminous GAC.

"The study clearly was misleading," says Andy McClure, marketing manager for Calgon Carbon Corp. "The data were 100 percent correct, but what the report didn't say was that the study compared lignite-based carbon with bituminous-based carbon that was produced offshore through a direct activation process. That's a totally different product than the reagglomerated bituminous coal-based carbon most water treatment professionals use."

Just the Facts

Location: Fresno Sole Source Aquifer in Fresno, California.

Problem: Lignite-based granular activated carbon was claimed to outperform a bituminous-based carbon, resulting in Fresno's investing in the lignite-based product.

Solution: Retesting the lignite versus bituminous carbons using reagglomerated bituminous-based product instead of the offshore media.

Results: The reagglomerated bituminous carbon outperformed the lignite material by a factor of three. Fresno Acquifer counts on bituminous coal-based GAC for its water treatment.

Direct Activated Versus Reagglomerated

"People who have used both direct activated and reagglomerated carbons believe there's a difference," says Bob Little, water quality supervisor for the City of Fresno. Most of that difference can be attributed to how a GAC is made.

Reagglomerated carbons are manufactured through the following process.

- A high-grade raw material is pulverized to a powder.
- A binder is added.
- The product is reagglomerated into briquettes.
- The briquettes are crushed.
- The briquettes are sized.
- The carbon is baked.
- The carbon is thermally activated.

Offshore carbons often are produced through a cost-cutting manufacturing process. Direct activation begins with an inexpensive raw material and proceeds directly to crushing, sizing, baking and activation. To save production costs, the pulverizing, binding and reagglomerating steps are eliminated. While direct activation results in a lower price-per-pound carbon, it compromises long-term product performance in most applications.

"The extra steps in making high performance carbon—the reagglomeration process—means a lot to us," says John Yoshumara, manager at Stockton EW in California. "How well a carbon performs is directly related to its internal pore structure."

The internal pore structure of a carbon granule can be compared to the infrastructure of roads in the United States. There are superhighways (macropores), highways (mesopores), regular roads and dirt roads (micropores). The larger pore structures (super highways and highways) provide faster access to where the organic removal occurs. The tighter pore structure (regular roads and dirt roads) is where the majority of the organic molecules are removed through adsorption. By eliminating the steps of grinding, binding and reagglomerating, offshore carbons exhibit fewer superhighways and highways that allow organics to travel to the dirt roads, where adsorption takes place. In many demanding applications, the lack of additional carbon pore infrastructure equates to reduced performance and shorter bed life.

"The activation process obviously controls how the carbon performs. Even if the source material was identical, a direct activated GAC is simply not going to perform the same as a reagglomerated product," McClure states.

Differences between high-performance and offshore products affect different applications to varying degrees. Offshore products initially can be less expensive on a dollar-per-pound basis. However, by removing fewer organic contaminants, they generally require more frequent changes. The adsorption capacities of many offshore carbons are significantly lower. Typically, they are less resistant to abrasion, which results in higher transfer losses (backwash) and fines. The offshore products have approximately 6 percent fines, compared to 0.2 percent for high-performance carbon. In addition, offshore carbons can have higher ash content, resulting in more leachables and lower adsorption capacities. They have approximately 14 percent ash, compared to 5–7 percent for high-performance carbon. Based on fines (lost in backwash) and ash, the offshore products offer the following equation.

> 6% + 7% = 13% unusable product
> or 13 percent higher cost based
> on pounds

Whether choosing offshore or high performance activated products, buyers should be aware that any activated carbon not manufactured in ISO-certified facilities offers no guarantee of ingredients or other materials that may have been mixed in.

Source Material

Bituminous coal, anthracite, peat, wood and coconut each affect a carbon's inherent pore structure, influencing its properties and performance. Nevertheless, the consistency and quality of the source material also is extremely relevant.

"Water treatment professionals need to go beyond simply specifying coal-based carbon for their job," advises Dennis Bitter, industrial account manager for Calgon Carbon. "They need to know the source of the base for any activated carbon under consideration."

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Carbon suppliers always should disclose the source of the starting base of their products along with details on their manufacturing process so that buyers can make intelligent comparisons.

"Our top concern always has been the quality of the product," says Yoshumara, whose Stockton California treatment facility remains loyal to high performance carbon. "We want to verify the quality of the source material."

Another California treatment facility with experience in both types of carbon maintains that often it is a challenge to discover details about offshore carbon. "Both the offshore and high performance carbons I used were based on coal," says Bob Hayward, general manager of Lincoln Avenue Water Co. in Altadena.

Performance You Can Count On

The problem that most often is associated with direct activated carbon performance is uniformity. "At Fresno, we've seen a lot of offshore carbon situations where one load will last 15 months at a station and the next load will last 22 months—and nothing's changed as far as the water quality or concentration of the contaminant," Little says. "At some of our multiple-vessel sites, we've seen one or two of our vessels reach port four with detectables, while another vessel is still non-detect at port two. Supposedly it's all the same carbon, but the offshore performance is widely variable."

Performance inconsistency is most likely caused by lack of control and adherence to standards during the carbon activation process.

Reagglomeration plants take advantage of technology such as digital readouts to ensure temperature and other variables remain constant. Offshore carbons often are produced using more manual labor. "It really is the difference between fine-tuning the control of the process—maintaining established quality standards—versus mass production where you're just cranking out carbon," McClure says.

A Clean Comparison

At the request of the City of Fresno, Calgon Carbon duplicated the lignite versus bituminous test using a reagglomerated bituminous-based product instead of the offshore media. "We ran column studies using samples of the Fresno water in 1999," McClure explains.

This time, the results were much different. "The reagglomerated bituminous carbon was outperforming the lignite material by a factor of three when the column test concluded—and it was still running at the time," a researcher noted.

Although the original study was undertaken as a way to show the advantage of lignite over coal, it actually succeeded in proving the true difference between offshore, direct activated GAC and high performance reagglomerated carbon.

Learning from the Past

The test results come as no surprise to many California water treatment professionals. The experiences of Altadena's Lincoln Avenue Water Co. attest to the performance of reagglomerated carbon. "We had used both. The high performance carbon lasted longer than the offshore carbon—in fact, we experienced twice the carbon life from the reagglomerated product over the direct activated GAC," Hayward claims. "We suspected from the start that the offshore carbon wouldn't deliver the same kind of performance as the product we had been using, but I guess we had to experience it for ourselves."

One year after the carbon dilemma began, Fresno is taking great care to use high performance, reagglomerated carbon. Based on the test results, Fresno again is purchasing bituminous coal-based GAC to product its high quality water. WQP

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