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The Great Activated Carbon Dilemma

Carbon is not always carbon, as one study shows.

By Neal Megonnell
Calgon Carbon Corporation

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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 is 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 claims were in direct contradiction to what we had experienced and everything that we had been reading for years," one treatment professional recalls.

The results of the study, published in April 1999 in a water quality magazine, detailed how the Fresno Sole Source Aquifer, in Calif., 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 was clearly misleading," says Andy McClure, marketing manager at Calgon Carbon Corp. "The data was 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 re-agglomerated bituminous coal based carbon most water treatment professionals use."

Direct activated vs. reagglomerated

"People who've used both direct activated and re-agglomerated 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.

Re-agglomerated carbons are manufactured through the following process:

1. A high-grade raw material is pulverized to a powder.
2. A binder is added.
3. The product is re-agglomerated into briquettes.
4. The briquettes are crushed.
5. The briquettes are sized.
6. The carbon is baked.
7. Finally, the carbon is thermally activated.

Offshore carbons are often 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 re-agglomeration process—means a lot to us," says John Yoshumara, manager at Stockton EW, in California.

The internal pore structure directly relates to how well a carbon performs. 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," McClure maintains. "Even if the source material was identical, a direct-activated GAC is simply not going to perform the same as a re-agglomerated product."

Differences between high-performance and offshore products affect different applications to varying degrees. Offshore products can initially be less expensive on a dollar-per-pound basis. However, by removing fewer organic contaminants, they generally require more frequent change-outs. 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 to 7 percent for high-performance carbon. Based on fines (lost in backwash) and ash, the offshore products offer 6 percent plus 7 percent equals 13 percent 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 is also extremely relevant.

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

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

"Our top concern has always been the quality of the product," says Yoshumara, whose Stockton California treatment facility remains loyal to high performance carbon. "Some offshore suppliers say they only have one or two sources of carbon, and you always think, 'how many offshore carbon plants are there?' There's got to be more than one or two. We want to verify the quality of the source material."

Another California treatment facility with experience in both types of carbon maintains that it is often a challenge to discover details about offshore carbon.

"Both the offshore and high performance carbons I used were based on coal, but that's about all I know about the offshore product," says Bob Hayward, general manager of Lincoln Avenue Water Co., in Altadena.

The problem that is most often 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," says Little. "At some of our multiple-vessel sites, we've seen one or two of our vessels reach port 4 with detectables, while another vessel is still non-detect at port 2. Supposedly, it's all the same carbon but the offshore performance is widely variable."

A water superintendent at another California treatment facility, who chose to remain nameless, concurs, "We tried using carbon that came from China. One bulk bag would meet the specs and the next five wouldn't. You have to understand there are hundreds of facilities in China that process carbon. You may get a partial load from this facility and a partial load from that facility and the consistency and the quality isn't there. I'm not saying all offshore carbon is bad carbon, I'm just saying I haven't seen it consistently meet the specs the way high performance carbon does."

Re-agglomeration plants take advantage of technology, such as digital readouts to ensure temperature and other variables remain constant. Offshore carbons are often produced using more manual labor.

"It's really the difference between fine-tuning the control of the process—maintaining established quality standards—versus mass production, where you're just cranking out carbon," says McClure.

A clean comparison

At the request of the City of Fresno, Calgon Carbon Corp. duplicated the lignite versus bituminous test using a re-agglomerated bituminous-based product instead of the offshore media.

"We ran column studies using samples of the Fresno water in 1999," explained McClure. This time, the results were much different. "The re-agglomerated 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," noted the researcher.

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

Carbon treatment vessels.

Calgon Carbon's 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 used both," claims Bob Hayward. "The high-performance carbon lasted longer than the offshore carbon—in fact, we experienced twice the carbon life from the re-agglomerated product over the direct activated GAC,". He continues, "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."

"For our purposes, the offshore carbon just didn't work out," says Michael L. Huhn, general manager of Vaughn Water Company in Bakersfield. "We know we get better utilization with the high performance carbon."

"We used to assume 'carbon is carbon,'" says Matt Machado in Ripon. "We know now it isn't."

So, the City of Fresno, the site of last year's lignite versus coal tests? One year after the carbon dilemma began; Fresno switched back to bituminous coal-based GAC. Now, they are taking care to use high performance, reagglomerated carbon. **PE**

Neal Megonnell is senior group leader of Calgon Carbon Corp.

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