

Application Bulletin

CATALYTIC/ADSORPTIVE CARBON CREATES MEDIA "BREAKTHROUGH"

Reprinted from the June, 1995 issue of Water Conditioning and Purification Magazine

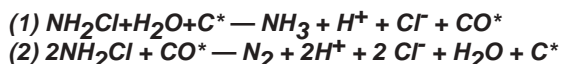
New Carbon Promises Great Changes in Efficiency, Longevity and Chloramine Removal

Sometimes you *can* teach an old dog new tricks. Just when you thought you knew everything about carbon, someone comes up with a new twist. Since March, 1994, Garland Beverage Company has served as a trial site for a revolutionary type of activated carbon - catalytic/adsorptive carbon.

All activated carbons have some natural catalytic properties. Through a manufacturing process that modifies the electronic properties of the carbon surface, catalytic carbons combine the adsorption capabilities of traditional activated carbon with significantly controlled and enhanced catalytic functionality. These catalytic properties allow catalytic carbons to be used in applications where activated carbon was not previously effective. For other applications, these catalytic properties can extend carbon life over traditional activated carbons. One such application is chloramine removal, where catalytic carbons fulfill the need for an activated carbon product that removes chloramines and lasts longer than traditional activated carbon.

Chloramines exist in water in three forms: monochloramine (H_2Cl , at $\text{pH} > 7$), dichloramine (NHCl_2 , $\text{pH} 4.4-7$) or trichloramine (NCl_3 , $\text{pH} < 4.4$). In most water treatment applications, monochloramine is the predominant species. Monochloramine, an unreactive compound, is the most difficult type of chloramine to remove using activated carbon.

Chloramine removal using activated carbon is catalytic in nature. Since all activated carbons possess some natural catalytic functionality, they all have some ability to remove chloramines. The proposed reaction mechanism for chloramine removal on carbon is a two-step process:



where C^* = surface carbon active site
 CO^* = surface carbon oxide
 NH_2Cl = monochloramine

Initially, the first reaction predominates until a sufficient number of surface oxides build up onto the carbon surface. Eventually, the second reaction occurs as the carbon system remains online. The time period during which the first reaction predominates is known as the induction period. The length of this induction period and the ratio of these two reactions at steady state conditions are not known and are a function of specific water chemistry and field conditions.

Because the proposed reaction mechanism restores the carbon active site (C^*), the chloramine removal process is a true catalytic reaction which, in theory, continues indefinitely. Several factors can combine to reduce chloramine removal efficiency over time. First, other organic compounds in the water can physically adsorb onto active sites and reduce catalytic ability. In most potable water applications, adsorption of organic compounds is not significant enough to cause a problem. Second, oxidation of the carbon surface occurs over time, forming stable surface groups which will not participate in the chloramine removal reaction. The exact nature of these surface groups is not known and depends on specific conditions of any particular application.

Because catalytic carbons possess far more active sites, the amount of time required to use up these sites, either by adsorption of organic compounds or formation of stable surface groups, is far greater than for conventional activated carbons. As a result, the life of a bed of catalytic carbon will extend over the life of an equal size bed of traditional activated carbon for chloramine removal applications. In the beverage industry, activated carbon lasts approximately one year for free chlorine removal applications. For chloramine, however, breakthrough for conventional activated carbon occurs anywhere from two months to one year, depending on several factors, including the concentration of chloramine in the water, bed depth of the carbon and temperature of the water.



Visit our website at www.calgoncarbon.com, or call 1-800-4-CARBON to learn more about our complete range of products and services, and local contact information.

**Chemviron
Carbon**

Test Site Parameters

“Even before catalytic carbon was officially introduced, we were anxious to try it,” recalled John Brittan, Vice President of Process and Technology for Denver-based Western Filter Company, a distributor of activated carbon products.

Western Filter helped to conduct a side-by-side comparison of catalytic carbon versus bituminous carbon, but couldn't locate a two-tower site in need of fresh carbon. Because Garland Beverage had such detailed documentation of their experiences with conventional coal-based carbon, the Texas soft drink manufacturer was selected as the next best thing to a direct comparison.

“Garland was chosen for catalytic carbon trials for two reasons: First, the company had a history of high frequency of carbon changeouts due to chloramine breakthrough. Their change-out schedule was very erratic. It averaged about every five or six months,” said Brittan. “The second reason for selecting Garland was their willingness to adopt a detailed set of monitoring parameters. We were confident in their ability to record the catalytic carbon's performance and compare it with their previous data on the coal-based media.”

How the Trial Was Set Up

Garland Beverage installed 250 ft³ (10,000 lbs.) of catalytic/adsorptive carbon in the spring of 1994. At that time, the product was not commercially available. The catalytic/adsorptive carbon was placed in a vessel that had housed standard bituminous coal-based carbon, which most recently experienced chloramine breakthrough after five months, treating 20 million gallons of water.

Garland Beverage processes an average of 250,000 gallons of influent water every day for the production of soft drinks for Kroger supermarkets nationwide. Their water is supplied by the City of Garland, Texas, as suburb of Dallas. Upstream of the carbon, Garland Beverage treats the municipal water with lime, ferric sulfate and chlorine. The water is also passed through a UV light. Chlorine is utilized as a disinfectant and is not used to oxidize the chloramine. Influent readings taken at the carbon bed inlet show chloramine levels of between 1 and 4 ppm. Contact times are on the order of 7.5 minutes at a surface loading of 8 gpm/ft².

Garland monitors carbon performance using a Hach test kit to measure free and total chlorine. They collect the following data: gallons treated, influent and effluent chloramine levels, free chlorine levels, total chlorine levels, influent temperature and pH. To ensure product quality, Garland measures effluent total chlorine levels every two hours.

“When water is your main ingredient, it is critical to have a consistent reliable treatment system,” said Gary Upchurch, Lab Leader at Garland. “An unacceptable chloramine level results in noticeable fluctuations in our flavor base and that affects the taste and smell of the soda.”

Output Stable Despite Spikes in Chloramine

For the past 13 months, the catalytic carbon system has succeeded in keeping the chloramine level below 0.1 ppm with no signs of breakthrough. However, erratic spike levels of chloramine which peaked at 0.4 ppm were periodically detected by the beverage company. The chloramine spikes were consistently short-lived; after running the system overnight or backwashing, the chloramine concentrations always dropped off below 0.1 ppm. These spikes caused Garland concern.

“After examining the data, we noticed that, in every occurrence, the spikes in chloramine levels corresponded with upstream treatment problems,” said Duane Kirkham, Quality Assurance Manager at Garland. For example, problems with the lime coagulation system upstream of the carbon coincided with the spikes. “I can correlate human or mechanical factors to every one of the spikes,” said Kirkham. “I can't exactly explain why they occurred, but each time the readings went back to normal when the equipment problems were corrected.”

Garland Trial Results

The catalytic carbon bed has been on-line for over a year with no consistent signs of breakthrough. At the end of March 1995, the catalytic carbon has treated 45 million gallons of water, compared with 20 million gallons treated with the previous bed of conventional activated carbon. Final conclusions on catalytic carbon's performance at Garland Beverage, however, cannot be drawn until carbon breakthrough occurs. Garland is clearly satisfied with the catalytic carbon's performance. So much so, in fact, that they would be willing to purchase it in the future for the treatment of chloramine



Calgon Carbon Corporation
P.O. Box 717
Pittsburgh, Pa 15230

Chemviron Carbon
Zoning Industriel C
B-7181 Feluy, Belgium

The logo for Chemviron Carbon, with "Chemviron" in a stylized, bold font above the word "Carbon" in a simpler, bold font.

Sulfur Removal Too

“We were at the end of our rope. It was a last ditch effort. “That’s how Paul Jansen, regional manager for Culligan Water Conditioning of Lancaster, Ohio, describes Calgon Carbon’s new Centaur catalytic/adsorptive carbon.

“We had a customer whose well water was so contaminated with H₂S and iron that nothing we tried was able to produce acceptable results for long.” The influent measured 5 ppm of sulfur plus 3 ppm of iron.

“Because you’re dealing with a gas-like sulfur, every time the barometric pressure goes down, the sulfur goes up. The manganese green-sand couldn’t handle the high sulfur spikes. Breakthrough was hard to predict.” Jansen said, “It seemed like we were constantly changing media.”

Catalytic/adsorptive carbon was installed in 9" tanks, using 1 cu ft. of carbon per tank. The system handles 6 gpm and the carbon is backwashed once a week.

Jansen said it worked very well. “It takes care of both the sulfur and the iron.” Periodic measurement of the site revealed 0 ppm sulfur and 0 ppm iron.

“Upfront it’s a little more expensive than standard media,” Jansen said, “but because it doesn’t require chemicals for regeneration, it works out to be comparable cost wise. “Of course, when you’re comparing something that works with something that doesn’t, that level of disparity is hardly relevant,” he added.

A Media “Breakthrough”

The studies above show that the new catalytic/adsorptive carbon is a beneficial innovation, presenting efficient solutions for chloramine, sulfur and iron removal.

by Steve Spotts and Andy McClure is an Applications Engineer with the Commercial Business Unit.
Steve Spotts is a graduate of Carnegie Mellon University Chemical Engineering.



Visit our website at www.calgoncarbon.com, or call
1-800-4-CARBON to learn more about our complete range of
products and services, and local contact information.

**Chemviron
Carbon**