Water Utilities Turning to GAC

Improving water quality and public trust.

By Gary Westerhoff, Kirk Nowack, and Brian Leto

Drinking water utilities have a complex mission and responsibility to provide water that is safe and protective of human health, and constantly available in quantities that allow for adequate fire and other emergency protection; all in a financially responsible manner. Across the nation, drinking water utilities have responded well to these responsibilities, and their consumers benefit from some the safest and most reliable water supplies in the world.

One of the many potential risks impacting the safety of drinking water is the presence of trace-level contaminants. These include disinfection byproducts (DBPs), which have lately been receiving a great deal of attention within the water industry. DBPs are formed when natural organic matter (NOM) reacts with chlorine, and they are suspected to cause adverse health effects in humans. The recent Stage 2 Disinfectants and Disinfection Byproducts (D/DBP) Rule, effective for large utilities in 2012, includes stringent criteria for DBP compliance. As a result, numerous water systems are being forced to find ways of reducing DBP concentrations in their distribution systems. Given the potential unintended consequences of converting from the use of free chlorine to chloramines for secondary disinfection (e.g., heightened lead corrosion rates and coliform outbreaks due to nitrification), there is growing interest in treatment technologies that can reduce DBP formation by means of removing the precursors (NOM) to these compounds.

Advances in the science of drinking water analysis have led to the continual discovery of trace-level chemicals in drinking water that were previously unmeasurable. These chemicals originate from a variety of sources, including wastewater treatment plant outfalls, sur-

Rotary kiln GAC regeneration furnace at City of Phoenix Lake Pleasant Water Treatment Plant.

Pump station in front of GAC treatment plant at City of Scottsdale Central Arizona Project (CAP) Water Treatment Plant.

face runoff, and naturally-occurring materials. Some of them are being categorized by regulatory agencies as Emerging Contaminants (ECs), due to their suspected, yet currently undetermined impacts on human health and the environment. Many people are concerned that certain ECs may have toxic properties and a tendency to accumulate in human and animal tissue. Included in this category are pharmaceuticals, personal care products, endocrine disrupting compounds, pesticides, and various nanomaterials.

Granular activated carbon (GAC) has long been used in surface water treatment plants for removing taste-and-odor-causing compounds and protecting against organic contamination. It can be implemented in the form of post-filter contactors (basins or vessels containing GAC after a filtration process) or filter adsorbers (where GAC is installed in a typical granular media filter). The 1986 Federal Safe Drinking Water Act identified GAC treatment as a best available technology for the removal of organic contaminants from water supplies. The Greater Cincinnati Water Works, in Cincinnati, OH, was, in 1992, the nation's first major drinking water treatment system to use post-filtration GAC treatment as a barrier against a broad spectrum of organic contaminants (*Government Engineering Journal*, March-April 2009). Now, 16 years after the Cincinnati GAC facilities began operating, the following benefits of GAC treatment have been realized by the city:

- Effectively removes a wide range of organic contaminants. Ongoing research is demonstrating that GAC is one of few technologies that can eliminate a large percentage of the currently recognized ECs from drinking water.
- Lowers DBP levels by reducing the concentration of organic precursors in the water. This can allow for the continued use of free chlorine as a secondary disinfectant (as opposed to converting to chloramines).
- Lowers chlorine demand, which reduces the cost associated with chlorine addition.
- Serves as a barrier against taste-and-odor-causing compounds such as 2-methylisoborneol (MIB) and geosmin.
- Post-filter GAC treatment systems can provide for additional turbidity reduction and are awarded log-removal credit for Cryptosporidium under the Long Term 2 Enhanced Surface Water Treatment Rule.
- Provides a foundation for enhancing the trust and confidence of customers and elected and appointed officials, as a result of its significant positive impact on the safety of drinking water.

As utilities across the nation consider how they can best comply with the Stage 2 D/DBP Rule and address the issue of emerging contaminants, the use of GAC treatment is gaining widespread interest. This is based to a large degree on the concept that it is better to remove contaminants from water (i.e., via adsorption onto GAC) rather than adding additional chemicals that might have unintended consequences. The following utilities are among the systems that have elected to implement GAC treatment.

Scottsdale, AZ, has installed post-filtration GAC contactors at its 75-mgd CAP Water Treatment Plant and at its 27-mgd Chaparral Water Treatment Plant. GAC was chosen as the primary approach to reducing DBP formation so as to avoid the potential unintended consequences of converting to chloramines for secondary disinfection. The decision to use post-filter GAC contactors to provide the best available treatment and highest quality water for the city was based on extensive input from elected and appointed officials and public forums.

Phoenix, AZ, has installed post-filtration GAC contactors at its new 80-mgd Lake Pleasant Water Treatment Plant, and GAC filter-adsorbers at its 100-mgd Deer Valley Water Treatment

Plant. The city is also planning for the use of GAC at its other three water treatment plants. The varying forms of GAC treatment at each of the plants reflect the unique needs of these facilities, which were determined during studies of these systems. In each case, GAC is helping Phoenix meet more stringent state and federal water quality regulations.

Birmingham Water Works Board, Birmingham, AL, has just completed a year-long study involving four demonstration-scale GAC filter adsorbers, aimed at evaluating the feasibility of utilizing this treatment technique for achieving Stage 2 D/DBP Rule compliance. The board is implementing a Water Quality Master Plan that addresses the need for GAC treatment at each of its four filtration plants.

Baltimore, MD, has just completed a year-long pilot study to develop preliminary design criteria for a new 120-mgd water treatment plant. The results have prompted the city to select GAC treatment as the primary approach to achieving Stage 2 D/DBP Rule compliance.

Northern Kentucky Water District will include post-filtration GAC treatment at its 44-mgd water treatment plant and two ten-mgd water treatment plants.

Glendale, AZ, has installed GAC filter adsorbers at its 30-mgd Cholla Water Treatment Plant and 15-mgd Oasis Water Treatment Plant.

Chandler, AZ, has installed GAC filter adsorbers at the 60-mgd Chandler Surface Water Treatment Plant.

Utilities considering GAC treatment, either as part of a new filtration plant or as a retrofit at an existing facility, should consider developing a Water Quality Master Plan (WQMP). A WQMP is a comprehensive strategy for improving overall water quality, and the process of developing a WQMP enables a utility to select a GAC treatment approach that best fits its specific needs. Preparing a WQMP typically involves:

- Quantifying source water capacity and quality.
- Outlining current water production and treatment practices.
- Considering the impacts of existing and anticipated future water quality regulations.
- Assessing existing water quality goals; developing new goals as needed.
- Identifying and evaluating alternate strategies for achieving water quality goals.
- Recommending a long-term strategy and developing a planning-level estimate of the associated costs.

Water utilities that incorporate GAC treatment as part of their long-term operating strategy will garner the numerous water quality benefits of this powerful treatment technology, and thus further enhance their capability of producing the highest quality water. GE

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Pilot study facilities for City of Baltimore Fullerton Water Treatment Plant design criteria.