GAC CONTACTOR HELPS MEET REGULATIONS AND REDUCES CHEMICAL DEMAND IN CONSECUTIVE WATER TREATMENT SYSTEM

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ABSTRACT

Many buyers of water that resell to their communities are required to meet or exceed the EPA drinking water regulations as if they were treating the source waters themselves. One such small community, the Town of Lowville, New York, buys its water and, by order of the New York State Department of Health (NYS-DOH), is required to provide additional treatment to remove harmful disinfection byproducts (DBPs) prior to distributing within the town's water system.

Treatment systems that incorporate granular activated carbon (GAC) contactors are used to reduce the organics that contribute to DBP formation in the presence of a system disinfectant: namely, chlorine. When GAC is considered, there is often a concern about how long the GAC will last before it becomes exhausted. When this is the case, a small-scale pilot evaluation is conducted to treat a small flow of the source water and monitor the life of the GAC. The results of the study can confirm the selection of the correct type of GAC and determine the dose of chemistry to be applied, the proper empty bed contact time (EBCT), and the anticipated life of the media. From this, a system that is tailored to the application can be designed and built.

The pilot study concluded that a full-scale system could reduce the amount of disinfection byproducts and their potential formation for long periods of time. Results show that when the water is dosed with sodium bisulfite (to reduce the consumption of GAC by neutralizing free chlorine) before flowing through the GAC contactors, both trihalomethanes (THMs) and haloacetic acids (HAA5) are significantly reduced.

The final design included two (2) 7-feet diameter vessels with a straight side height of 13 feet, 11 inches. Each vessel provided a 7.5-minute EBCT for a total of 15 minutes in a lead-lag configuration for a plant flow of 115 gpm. For fast deployment/installation, these vessels were installed and plumbed "ready-to-go" in a prefabricated building prior to delivery.

This paper describes the details of the source water, pilot testing and results, and configuration of the final treatment system built for the Town of Lowville water treatment plant (WTP).

DISCUSSION

For many years, the water purchased by the Town of Lowville contained levels of trihalomethanes (THMs) and haloacetic acids (HAA5) that exceeded the allowable limits of 80 ppb and 60 ppb, respectively. The engineering firm, Bernier, Carr & Associates (BCA) of Watertown, New York, was selected to design a system to treat the water to EPA standards prior to distribution. The raw water disinfection byproducts (DBPs) from the town's source water varied depending on the time of year, but the average for the four samples taken in 2019 were 40.5 ppm total THM (TTHM) and 80.5 ppm HAA5. So, the HAA5 was already in violation when the water was received by the town and just increased from there with more chlorine-contact time.

BCA, with the New York State Department of Health (NYS-DOH), selected a two-stage granular activated carbon (GAC) system, which had to be pilot tested to demonstrate its effectiveness. They selected WesTech to provide a pilot system and began testing in 2018. The pilot was set up by WesTech personnel and monitored by the town. This pilot study monitored the reduction of TTHMs and HAA5 along with the precursors to potential formation of these DBPs. In addition to monitoring the reduction of the DBPs, turbidity and free chlorine levels were monitored throughout the pilot study. The study took place during a four-week period from September to October 2018. Throughout these four weeks, plant employees dosed the influent water with sodium bisulfite to remove chlorine, which can reduce the effectiveness of the GAC. Residual chlorine is also a major contributor to DBP formation. The water then flowed through the GAC contactors to remove TTHMs and HAA5 and their precursors.

The pilot system included two small fiberglass vessels filled with Jacobi AquaSorb CT carbon, and each provided 7.5 minutes of empty bed contact time (EBCT). Running in series, the system provided an overall EBCT of 15 minutes, typical of treating TTHMs and HAA5.

Data was recorded daily to show consistency in the performance of the GAC contactors and samples were collected and sent to a local third-party lab to determine the amounts of TTHMs, HAA5, chlorine demand, and DBP precursors.

Pilot Test Results

Based on the evaluation of the results from the GAC pilot study, the following conclusions were made:

- The GAC successfully reduced the amounts of disinfection byproducts and their potential formation. Lab results show a minimum of 97.4 percent reduction in trihalomethanes. Haloacetic acids were reduced to the point that there was no data for haloacetic acids in the effluent water.
- Turbidity remained constant throughout the pilot study. Turbidity remained below 0.3 NTU and was not affected by the GAC adsorption process.
- The amount of free chlorine in the influent water varied. A dose of 1.9 mg/L of sodium bisulfite successfully reduced the amount of free chlorine. The GAC could remove the remaining free chlorine from the water. Once the sodium bisulfite increased to a dose of 2.1 mg/L, the free chlorine was completely removed from the raw water prior to the GAC contactor.
- There was a slight increase in chlorine demand in the effluent water.
- Throughout the study, at a flow rate of 3.5 gpm, the GAC contactors produced approximately 139,860 gallons between September 20 and October 18.

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With the lab results and data recorded, the pilot study suggests that WesTech's GAC contactors with the sodium bisulfite and Jacobi AquaSorb CT media would be a viable disinfection byproduct reduction treatment process for this water source.

Based on this, a full-scale system could reduce the amount of disinfection byproducts and their potential formation for long periods of time. Results show that when the water is dosed with sodium bisulfite before flowing through the GAC contactors, free chlorine is reduced to extend media life, and both trihalomethanes and haloacetic acids are significantly reduced.

The variability in the water quality coming into the pilot unit and its success in consistently removing the disinfection byproducts make it difficult to predict the lifespan of the media. Comparing to quarterly influent data recorded, the lifespan of the GAC media for trihalomethanes is estimated to be 1,221 days for contactor #1 and 2,819 days for contactor #2. For haloacetic acids, lifespan is estimated to be 148 days for contactor #1. There was no trend that could be established for contactor #2. These estimates were made with the following assumptions: Water will be continuously flowing with an empty bed contact time (EBCT) of 15 minutes, maximum contaminant levels of 80 ppb for trihalomethanes and 60 ppb for haloacetic acids, and proper preconditioning and free chlorine neutralization. With intermittent flow and seasonal shutdowns, the lifespan of the media is expected to increase.

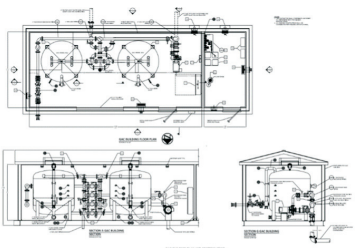
SYSTEM DESIGN

Once submitted to and approved by the NYS-DOH, BCA worked with Koester Associates of Canastota, New York, and WesTech Engineering, Salt Lake City, Utah, to design a package that could contain the GAC contact vessels, pumps, controls, and chemical feeds, which could be quickly deployed to and installed at the site. This saved on-site construction work and installation costs. The WesTech GAC treatment system was designed, built, and shipped to Dakota Pump Incorporated (DPI) in Mitchell, South Dakota, which installed all the equipment in a prefabricated building that could then be shipped in one piece and placed at the jobsite.

Contactor sizing is as follows:

GAC weight (lbs.):	3,300
Total flow rate (gpm):	115
Empty bed contact time (minutes) per vessel:	7.5
Number of tanks required:	2
Tank diameter:	7'
Tank side shell height:	3'-11"
Loading rate (gallons per square foot per minute):	3.0
Backwash rate (gallons per square foot per minute):	12
Tank design pressure (psig):	125
Tank hydrostatic test pressure:	130% of design pressure

The treatment equipment was provided in a prefabricated building as shown in the drawing and photo below:



Once on-site, DPI coordinated with North Country Contractors to install the roof in the field, allowing for an aesthetically pleasing appearance with the fit and finish to match the surrounding area.

INSTALLATION/OPERATION

Startup began in April 2021, with the contractor, North Country Contractors of Calcium, New York, installing the carbon and conducting initial setup and testing of the equipment. Final startup and training were completed in the month following the completion of additional piping and installation.

The system is configured such that water is pumped to the treatment building and can flow through the vessels in a series fashion at a rate of 115 gpm. This is also considered to be a lead-lag operation, whereby the first vessel is removing a large portion of the organics and the second providing additional removal. Sample taps are provided on the side of each vessel to determine the quantity of organics that is either present in the bed or no longer being absorbed. The taps assist in determining when the GAC is exhausted.

Allowing water to flow through both vessels provides a total empty bed contact time of 15 minutes, or 7.5 minutes through each vessel. Manual valves are provided to direct the flow in the correct path.

Both vessels can be run in parallel operation, providing a total flow of 230 gpm (115 gpm per vessel) with an empty bed contact time of only 7.5 minutes. Should it be necessary, flow can be diverted to only one vessel while the other is down (typically during a media changeout), at a reduced flow rate of 57.5 gpm to maintain a 15-minute EBCT and vice versa. The GAC bed can be periodically fluffed to expose new areas on which the organics can be absorbed. Both units have the option of treating the flow stream and sending it to waste.

Sodium bisulfite is fed prior to the GAC contactors, removing chlorine from the water. The GAC contactor removes much of the natural organic matter (NOM), which when combined with chlorine, produces DBPs such as TTHM and HAA5. After the water has passed through the GAC contactors, chlorine is added. The water then goes to the above-grade clearwell and on to the distribution system.

PROJECT COSTS/FUNDING.

The $1.5 million project was approved for funding by several grants and a low-interest loan.

CONCLUSIONS

According to a recent conversation with both the site personnel and engineer, the town immediately noticed a reduction in the chlorine demand after the GAC contactors. As of September 2021, the effluent from vessels #1 and #2 are both still showing non-detect (ND) for both components.

The system will operate for a year, with frequent monitoring of DBP reduction as well as chlorine demand (as required by NYS-DOH). This will help develop a profile of future operation for reference and a guide to the effectiveness and life of the GAC. 💧💧💧