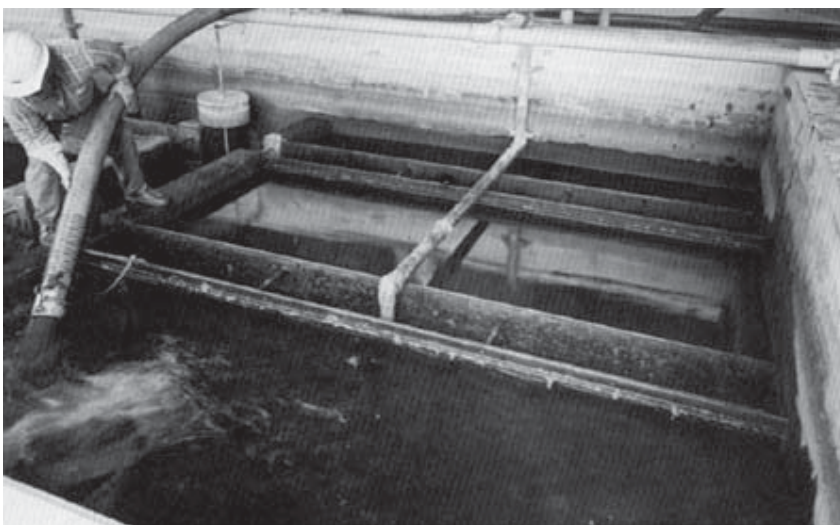


Application Bulletin

GAC VALUE EXCEEDS EXPECTATION

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It appears that the time span in which GAC will remove THMs can be measured in months - perhaps even years - at the Davenport, Iowa, water treatment facility. Research by EPA, the American Water Works Association, and other groups on the adsorptive capacity of granular carbon for trihalomethanes had indicated that removal of THMs by GAC is short-lived - measured in weeks. Therefore, it was of great interest to find the results at Davenport illustrated in **Table 1**. The THM reduction of 23 and 31 percent was achieved by an activated carbon* that had been on-line for more than 2 years and had processed more than 1 MG/cu.ft. of settled water. To check this result further, a pilot column was loaded with the spent carbon; tests (**Table 2**) again indicated a 25 percent reduction in THMs.



Carbon Changeout: Here Calgon Filtrasorb GAC is loaded into one of the plant's 20 gravity filters. Filled to a depth of 24 in., each filter contains approximately 16,000 lb. of GAC.

Table 1
Davenport Water Company

Date: 1978	Location	Trihalomethanes (µg/l)				Total	THM Reduction (%)
		CHCl ₃	CHBrCl ₂	CHBr ₂ Cl	CHBr ₃		
5/8	Settled water effluent basin 1	93	4	<1	<1	97	
5/8	Settled water effluent basin 2	97	4	<1	<1	101	
5/8	Plant effluent	71	3	<1	2	76	23
7/20	Settled water basin 1 and 2	104	5	<1	<1	109	
7/20	Filter 2 GAC*	73	2	<1	<1	75	31
7/29	Filter 9 PWS	42	1	<1	<1	43	61
7/20	Plant Effluent	42	2	<1	<1	44	60

*Calgon FS 400 Potable Water Service

The granular carbon in the 20 plant filters was changed in July and August of 1978, and the percentage of THM reductions then ranged from a high of 60 percent to a low of 19 (**Tables 1 and 3**).



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Table 2
Davenport Water Company
Pilot Column Test Exhausted GAC*

Date: 1978 10/10	Location	Trihalomethanes (µg/l)				TTHM	THM Reduction (%)
		CHCl ₃	CHBrCl ₂	CHBR ₂ Cl	CHBr ₃		
	Mississippi River Water	12	<1	<1	<1	12	
10/10	Settled water effluent basins 1 and 2	107	2	<1	<1	109	
10/10	Pilot Column Effluent	81	1	<1	<1	82	25

*Calgon FS 400

Use of granular carbon at Davenport also has helped reduce need for chlorine. Specific types of organics that exhibit chlorine demand are effectively removed by GAC. This reduces chlorine demand and allows for easier maintenance of chlorine residuals. At Davenport, chlorine feed has been reduced by 18 percent over a five-year period.

Table 3
Davenport Water Company

Date	Filter Location	Trihalomethanes (µg/l)		End	Reduct
		Quenched	Potential		
Nov 1978	Influent	152	87	239	
	Effluent	120	15	135	44
Dec 1978	Influent	93	56	149	
	Effluent	97	8	105	30
Jan 1979	Influent	71	26	97	
	Effluent	62	7	69	29

Davenport is also realizing a significant savings in backwash water. With sand used as a filter medium, 15-17 Gpm/sq.ft. of finished water is needed for backwashing. With GAC, however, the maximum backwashing requirement has been 14 Gpm/sq.ft. This translates into a 15 percent backwash-water reduction over a five-year period.

Another benefit of granular carbon as used at Davenport is improved removal of turbidity. Raw water turbidities fluctuates from 0 Ntu to highs of 150-200 Ntu at other times. Normal levels are in the range of 18-20 Ntu. In the treatment process, most solids are settled out by sedimentation using cationic polymers to help coagulate the solids.

By the time the water reaches the GAC filters, turbidity levels are generally less than 3 Ntu; after passing through the GAC, the polished water is at a level of 0.32 Ntu.

Because of a strong soil conservation program on the farmlands north of Davenport, the amount of naturally occurring clays and other suspended solids in the Mississippi River has decreased. This reduces turbidity in the plant's raw-water intake, which is good. However, lowered turbidity in the river allows more sunlight and more heat to penetrate the river and cause more heat- and light-sensitive algal bloom. Thus, reduced turbidity can result in greater taste and odor problems at the Iowa plant.



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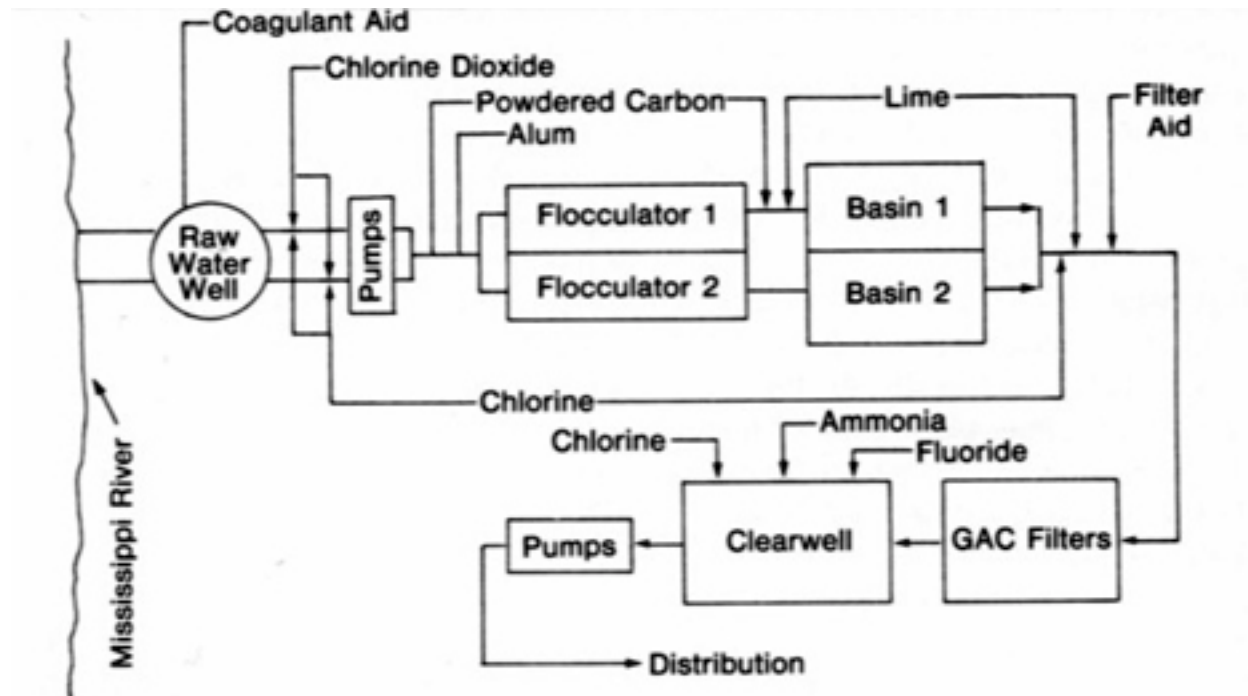


Figure 1. Flow Diagram - Davenport Water Company, East River Station.

Another cost-effective advantage is related to the comparative use of powdered and granular carbon. Over a three-year period, Davenport’s management estimates it saved 24 percent by using GAC instead of PAC (\$5.18/MG of finished water produced). Also GAC is thought to do a better job of controlling taste and odor than does PAC. Unlike PAC treatment, which must be constantly adjusted to compensate for changing water conditions, granular carbon treatment requires no changes once it is in place. Due to GAC’s reserve adsorption capacity, emergency treatment responses to sudden shifts in water quality are unnecessary.

Just before its 1973 GAC installation, Davenport experienced threshold odor number (TON) of 8-10 in influent water. At the time, plant personnel relied on powdered activated carbon (PAC) and sand filtration for control.

A significant taste and odor reduction followed the GAC installation, despite increased organic loadings in 1975 when new chemical plants went on-stream north of Davenport (Table 4).

Table 4
Taste and Odor

Year	Influent	Effluent (TON)
1973-74	4.0 "Musty"	<1
1975	3.5 "Musty"	1.5 - 2
(First GAC Changeout)		
1976	4.5 "Musty"	<1
1977	5.0 "Musty"/"Grassy"	2
1978	5.5 "Musty"	<1
(Second GAC Changeout)		



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Based on previous PAC operation at Davenport, management has concluded that GAC gives more uniform results, and is easier to handle. Recently, Davenport plant operators developed a system to complete unloading of carbon from the truck (with hoppers and eductors) to the filter in just 2 1/2 hr., and to load spent carbon back into the truck in just 2-hrs. per filter. The system makes use of a 1,400-Gpm pump and a fire hydrant pressured to 120 psig to pipe the carbon slurry.

Davenport modified a 3-in. sand eductor and found that it could take the carbon out of the filter without putting a man in. During carbon removal, the eductor is kept flooded at all times by introducing backwash water. The backwash water keeps the carbon moving in a slurry. It flows downward and inward toward the mouth of the eductor, which creates a vacuum effect. The appearance is like that of a miniature volcano. This new operation requires just two men (a 50 percent reduction). Use of granular activated carbon at the Davenport Water Company has produced taste-and-odor effluent threshold odor numbers consistently less than one; a THM in the effluent of less than 100 ppb and effective filtration of turbidities (to less than 1 Ntu).



Valuable Lab “Equipment”: A common test for taste and odor involves sniffing of water. Howard Thompson, water quality supervisor at the Davenport lab, compares the odor of a sample against a sample of odor-free water.

In taste-and-odor control, the primary function of the GAC installation, the following results have been achieved:

1. Saving in backwash water (and an increase in saleable water)
2. A 16.2 percent reduced overall cost for taste-and-odor control
3. Clean, simple operation that requires no adjustments as the level of raw-water taste-and-odor changes.

Facts and Figures

The Davenport plant treats an average of 18-20 MGD (maximum 30 MGD).

Algae blooms, upstream industrial pollution, agricultural runoff and accidental spills are the major sources of organic contaminants that contribute to taste, odor and turbidity problems at Davenport. The plant must also contend with trihalomethanes (THMs).

The 106-year-old facility is located 200ft. from the river and utilizes a treatment sequence that includes pre-chlorination, coagulation and aluminum sulfate and cationic polymer, sedimentation, filtration and granular activated carbon (GAC), post-chlorination, fluoridation, and pH adjustment with lime (**Figure 1**).

Davenport’s taste and odor problems were chronic before conversion of 20 gravity sand filters to granular carbon in 1973. Filtration rate at Davenport is 2 G-m/sq.ft. Carbon contact time is 7.5 min. Individual filters are backwashed every 24 hr.

The initial 1973 GAC installation, which eliminated the need for continued PAC (except as backup in emergency situations), had a filter bed depth of 6-in. sand and 18-in. GAC. In 1975, GAC in the 20 plant filters was replaced for the first time and new carbon installed to the total depth of 24 in. Then, in 1978, Davenport Water signed a three-year contract, ** which specified periodic changeout of used carbon and various analytical and monitoring services.

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Since the GAC installed at Davenport is used primarily for taste-and-odor control, this THM reduction is a secondary benefit. It may not be cost-effective to install GAC solely for THM removal.



A 40,000 lb capacity dump truck delivers granular carbon to the Davenport Water Company plant on the Mississippi River. The facility supplies clean and safe drinking water to 126,000 consumers in Davenport, Riverdale and Bettendorf, Iowa.

by Clarence Blanck
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