Application Bulletin

COUNT ON CATALYTIC CARBONS FOR HYDROGEN SULFIDE

by Shedrick Saunders and Michael J.Urbans

They can help you handle its offensive odors.

Summary
When homeowners have sulfide in their water supply, they want it removed - immediately and permanently. A sulfide treatment alternative to traditional methods of combining post-filtration with chlorination, aeration, or ozone is to use chemically active activated carbon, also known as "catalytic carbon."

Dealers have a new weapon against sulfide, one of the most offensive residential water problems encountered. That weapon is catalytic carbon.

In the typical pH range of drinking water, sulfide exists as either H_2S (hydrogen sulfide) or HS^- (bi-sulfide). Catalytic carbon is an alternative worth investigating because it combines the adsorption capabilities of traditional activated carbon with significantly enhanced catalytic functionality. In residential water treatment, it promotes the oxidation of sulfide with dissolved oxygen present in the water.

Designing a System
To capitalize on catalytic carbon's optimum efficiency, it is crucial that dealers design and install adsorption systems with regard to sulfide and dissolved oxygen levels, required empty bed contact time (EBCT) and system backwash capability. The first step is to measure sulfide and dissolved oxygen.

Most dealers are put off by the prospect of measuring even sulfide levels, let alone dissolved oxygen (DO). But there are many easy-to-use and inexpensive kits available for detecting sulfide and DO. Obtaining some estimate of both is critical for selecting an effective treatment.

DO is an important factor in catalytic carbon's effectiveness for sulfide removal. DO reacts with the sulfides, oxidizing them to elemental sulfur and sulfate. A minimum DO level of 4 parts per million (ppm) is necessary for effective removal of H_2S. Higher DO levels are required at higher sulfide concentrations. Insufficient DO levels result in premature breakthrough of sulfide in the effluent.

In water sources where the DO is less than 4 ppm, levels can be increased by the addition of air or an oxidant such as ozone or peroxide. Catalytic carbon facilitates the breakdown of both of these to form the required dissolved oxygen.

Calculate Contact Time
The second factor in system design is empty bed contact time (EBCT). EBCT is the amount of time it takes for water to travel from the top to the bottom of an "empty bed" (where the volume is occupied by carbon). If the water travels through the carbon too quickly, premature breakthrough can occur.

Catalytic carbon requires a minimum EBCT of three minutes to contain the mass transfer zone. To achieve a reasonable carbon use rate, a design contact time of five minutes is recommended.

To calculate EBCT, use the following formula:

$$\text{EBCT (minutes)} = 5.87 \times (\text{Tank Diameter (ft.)})^2 \times \text{Bed Depth (ft.)} \text{ Ö } \text{Flow Rate (gpm)}$$

For example, an average home with two bathrooms and 1/2-inch plumbing typically has a peak flow of 4 to 6 gallons per minute (gpm). If you input 4 gpm into the formula with a proposed bed size of 2 cubic feet (cu. ft.), you obtain an EBCT of 3.7 minutes - slightly more than the required minimum. Based on these figures, optimum catalytic carbon results would be obtained using a 2 cu. ft. system with a 10 by 54-inch mineral tank an a backwash valve capable of at least 4 gpm.

Adsorption of organic chemicals by catalytic carbon affects its performance by reducing the number of catalytic sites available to react with the sulfides. Typically, most ground water has low organic levels, so adsorption of the organic chemicals doesn't seriously affect catalytic carbon.

For example, a sulfide concentration of 2 ppm and a flow rate of 4 gpm through 2 cu. ft. of carbon would lead to a bed life of 2,636 days at a daily water consumption of 150 gpd. These rates are, however, highly dependent on water usage, DO and organic levels.

How Much Carbon to Use

This table is a guide for determining the volume of carbon required to achieve a minimum empty-bed contact time (EBCT) of 3 minutes.

Flow Rate (GPM)	< 2.5	2.5 to 5	5.1 to 7.5	7.6 to 10	10.1 to 12.5
Carbon Vol. (cu ft.)	1	2	3	4	5

Backwashing the Bed

The third design consideration for catalytic carbon is backwash capability. Backwashing is critical to remove any precipitated or filtered material.

Catalytic carbon must be backwashed at 8 to 10 gpm per square foot (gpm/ft^2). At this rate, backwashing will expand the bed by 30 to 40 percent, depending on the water temperature and carbon particle size. A gravel support bed with gravel size of 1/4 by 1/8 inch or 1/16 by 1/8 inch is suggested to provide proper distribution during backwashing. For sites with particularly high sulfide levels, backwashing with treated water is recommended.

Life Expectancy for Catalytic Carbon Based on Sulfide Influent

Catalytic Carbon Bed Life (Days) for 1 cu.ft.Bed

Sulfide(ppm)	25 GPD*	50 GPD	100 GPD	125 GPD	150 GPD	200 GPD	250 GPD	300 GPD
0.5	31,623	15,811	7,906	6,325	5,270	3,953	3,126	2,635
1.0	15,811	7,906	3,953	3,126	2,635	1,976	1,581	1,318
1.5	10,541	5,270	2,635	2,108	1,757	1,318	1,054	878
2.0	7,906	3,953	1,976	1,581	1,318	988	791	659
2.5	6,325	3,162	1,581	1,265	1,054	791	632	527
3.0	5,270	2,635	1,318	1,054	878	659	527	439
3.5	4,518	2,259	1,129	904	753	565	452	376
4.0	3,953	1,976	988	791	659	494	395	329
4.5	3,514	1,757	878	703	586	439	351	293
5.0	3,162	1,581	791	632	527	395	316	264
5.5	2,875	1,437	719	575	479	359	287	240
6.0	2,635	1,318	659	527	439	329	264	220

** Gallons Per Day*

To calculate bed life for carbon volumes other than 1 cu.ft., multiply value in table by actual carbon volume (in cu.ft.). A minimum of 4 ppm of Dissolved Oxygen is required for efficient removal for all sulfide concentrations listed above.

Usage rates are based on a maximum total organic carbon (TOC) loading of 10 percent by weight. For higher loadings, the usage listed in the table will increase and bed life and volume treated will decrease.

Iron Removal

Many dealers know from experience that “where there’s hydrogen sulfide, there’s iron.” Preliminary results using catalytic carbon for iron removal are good. Catalytic carbon exhibits an oxidation-reduction reaction (redox) that converts ferrous iron (Fe^{+2}) to ferric iron (Fe^{3}) in the presence of dissolved oxygen.

Ferric iron is insoluble and precipitates from solution. The ferric iron is then mechanically filtered by the carbon.

When removing both iron and hydrogen sulfide with a catalytic carbon, dealers must compensate for the additional load on the carbon by increasing bed size and backwash frequency. While catalytic carbon customers report successfully treating water with up to 1.5 ppm of ferrous iron, it isn’t generally recommended for levels greater than 1 ppm.

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