Water Technology

Carbon — the broad-spectrum treatment method

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Technical Pages
It will appeal to customers, *if* it's properly applied and monitored.

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Improvements in analytical testing methods and concerns over micro-constituents and emerging contaminants are continuing to drive changes in federal drinking water standards. As this happens, the use of broad-spectrum treatment techniques, like activated carbon, will continue to grow.

The use of activated carbon in treating potable water is not new. In fact, historical evidence indicates the benefits of using charcoal for purifying drinking water date back to 450 B.C.

Today the unique properties of activated carbon are especially attractive to drinking water professionals evaluating technologies to ensure effective reduction of a wide range of potential contaminants.

Activation for adsorption
Activated carbon is typically used in granular or powdered form for water treatment. The range of methods and raw materials for its production is nearly infinite.

Typically, carbon is activated physically or chemically by exposing the raw material to elevated temperatures (over 600 degrees C, or 1100 F) and then exposing the material to an oxidizing gas like oxygen or to a strong acid.

The process creates micropores within the structure of the material that are so small they generate adsorption forces, which are weak intermolecular forces that cause the precipitation of contaminants within the pore structure, effectively removing them from the process stream.

The activation process and raw material selection then becomes a complex matrix of defining whether a specific contaminant, or a broad spectrum of contaminants is to be removed.

Monitoring for breakthrough
As with any treatment technology, activated carbon has inherent limitations that must be carefully considered by the water treatment professional.

The carbon has a limited capacity for removing contaminants. This capacity varies dramatically depending upon the target contaminant, raw material, activation process, and desired removal efficiency.

While accurate predictive information about an activated carbon product often can be provided by the manufacturer, the removal process of individual contaminants is more difficult when a variety of target constituents exist in the source water.

Also, activated carbon typically exhibits a "breakthrough" phenomenon, where effluent (product water) concentrations increase when the adsorptive capacity of the carbon for that constituent is reached.

This tendency requires careful and consistent monitoring to ensure that target water quality concentrations are not exceeded.

Once the adsorptive capacity of the carbon is exhausted, it must either be properly disposed of and replaced, or regenerated and reused.

Effect on water clarity

Neither granular activated carbon nor powdered activated carbon is traditionally used for improving water clarity through filtration. The granular material is generally too large to remove small suspended material, and the powdered material is too small to be used.

Remember that either form of carbon could lead to deterioration of water clarity if not properly monitored.

Powdered activated carbon particles are small enough to pass through conventional mixed media filters if they are not removed through sedimentation prior to filtration. Granular activated carbon will deteriorate with continued backwashing.

The resultant particulate fines generally lead to elevated turbity levels immediately after backwashing operations. While innocuous, these spikes in turbidity must be managed to stay within federal drinking water standards.

Trace contaminants

Determining which process is appropriate for a given user is a complex decision that includes physical location, replacement frequency and amount of carbon usage.

In an example familiar to our firm, officials of the Stones River Water Treatment Plant in Murfreesboro, TN, recently decided to retrofit the plant's old mixed-media filters with granular activated carbon. This was to occur after the plant's new membrane filters were commissioned.

The granular activated carbon will be used as a polishing process to protect the residents of Murfreesboro. It will reduce levels of a broad range of contaminants, including volatile organic compounds (VOCs), synthetic organic compounds (SOCs), personal care products (PCP's) and endocrine disrupting compounds (EDCs).

While these compounds are typically found only in trace quantities in the source water coming into the plant, the other water treatment processes could not significantly reduce concentrations of these contaminants if an excursion occurred.

Such an excursion could be an accidental discharge by the nearby landfill into the surface water source or something as simple as a fuel or oil leak from a nearby motorboat.

Polishing for taste, odor

Also, the granular activated carbon filters will improve the customer's perception of the finished water quality by removing micro-constituents like geosmin and MIB, both of which are produced by species of algae in the water (see the *Water Technology*® "Contaminant of the Month").

These types of compounds can contribute to unpleasant tastes and odors in the drinking water at parts per trillion (nanograms per liter) concentrations, even though they have no significant health effects.

Activated carbon has been a useful tool for water treatment for centuries, and our society's ongoing quest for pure water will undoubtedly ensure its continued use in our field.

It is imperative for the design and installation professional to understand and account for the limitations of this technology to properly apply it to meet treatment expectations.

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