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Information Bulletin

UNDERSTANDING CARBON MESH SIZE

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Smaller granules equal bigger performance.

Carbon filters for domestic water treatment are increasingly popular, but many water treatment professionals may not realize the impact carbon's "mesh size" can have on a filter's performance.

Mesh size, which indicates the range of particles sizes in a particular carbon product, is an important physical consideration. Other physical properties of activated carbon include its apparent density, which refers to its weight-to-volume ratio; and its abrasion resistance, which refers to its ability to withstand degradation during handling, backwashing and reactivation.

Mesh Size 20 x 50 ***U.S.Sieve Series***
Maximum amount larger than 20 mesh screen **3 %**
Maximum amount smaller than 50 mesh screen **1 %**

Activated carbon products can also be characterized by "activity" properties including iodine number and molasses number, which indicate carbon's capacity to adsorb compounds of varying molecular sizes. Nonetheless, particle size is one of the most important influences on carbon's performance in home drinking water treatment devices.

Optimum mesh sizes enhance organic adsorption and speed chlorine conversion to reduce taste and odor. Mesh size also determines treatment system pressure drop. Understanding mesh size and its effect on carbon performance is therefore essential for designing and installing carbon water treatment systems.

Openings per Square Inch

Mesh size refers to the number of open spaces in a square inch of screen through which particles pass. Activated carbon particle size distribution is expressed as the relative percentage, by weight, of different-sized particles within the carbon mix. The more intermediate-sized screens used in the analysis, the more precise the range of particle sizes becomes. Usually, the number of screens is few and the resolution is limited to two divisions, typically expressed as the maximum and minimum sieve sizes the carbon can pass through (see above table).

For example, the "20" in the "20x50" sieve size refers to the largest mesh screen the carbon particles pass through. Likewise, the "50" refers to the smallest mesh screen the carbon particles pass through.

Mesh size is defined by two types of standard sieve scales: United States standard and Tyler standard. Both scales are observed by the United States Bureau of Standards, American National Standards Institute and American Society for Testing and Materials. The U.S. standard is most commonly used in the U.S.

Dechlorination for Taste

Using activated carbon to remove residual chlorine from drinking water is popular because many municipalities add chlorine disinfectants to water. About five parts per million (ppm) chlorine gas is injected into water to produce free chlorine that destroys and deactivates pathogenic and other organisms through oxidation. The residual free chlorine provides continued disinfection as water is piped to homeowners, but causes undesirable taste and odor.

Visit our website at **www.calgoncarbon.com**, or call
1-800-4-CARBON to learn more about our complete range of
products and services, and local contact information.

TECHNOLOGIES FOR PURIFICATION, SEPARATION, RECOVERY AND SYNTHESIS

Activated carbon de-chlorinates drinking water through a chemisorption process whereby residual chlorine (hypochlorous acid) catalytically reacts with the carbon surface and is transformed into ionized hydrochloric acid. The reaction at pH levels typically found in drinking water is:

$$HOCl + C^* \longrightarrow H^+ + Cl^- + CO^*$$

C^* and CO^* represent activated carbon and the surface oxide on the carbon, respectively.

Because the reaction occurs on the carbon's surface, its surface area influences de-chlorination tremendously. Smaller carbon particle sizes allow quicker access to carbon's surface area, so a 20x50 mesh carbon de-chlorinates more efficiently than a 12x40 mesh carbon. Both have the same de-chlorination capacity given enough contact time, but de-chlorination is faster with the smaller mesh size.

This was shown by a de-chlorination study where the same feed water was run through four one-inch activated carbon columns in parallel. The carbons used were identical with the exception of mesh size. The column with the smaller particle size was able to maintain the treatment objective of one ppm chlorine throughout the entire 60-hour experiment, but water treated by the larger mesh product exhibited chlorine breakthrough above the treatment objective after three hours.

This came idea holds true for removal of chloramine, another type of drinking water disinfectant, but the reaction between chloramine and carbon is slower. A larger treatment system or longer contact time is required for complete chloramine taste and odor control.

Organic Removal

De-chlorination is only half the story. Activated carbon also removes industrial and agricultural pollutants like volatile organic compounds (VOCs), synthetic organic compounds (SOCs) and natural organic matter. Organics are removed through an adsorption process rather than a chemisorption process.

Adsorption is a phenomenon by which contaminants are held to the surface of activated carbon by molecular forces - the same ones that cause gases to condense to liquids and solids to precipitate from solutions. The primary difference in adsorption forces is that they occur between different molecular species, namely the activated carbon surface and the contaminant molecule.

Physical adsorption the is primary means by which activated carbon removes organic contaminants from water. Carbon's highly porous nature provides a large surface are for contaminants to collect and be held in place by molecular forces.

Two types of pores exist within activated carbon: transport pores and adsorption pores. The pores are named for their function and cover a million-fold size range from a visible to a molecular scale.

Transport pores are the largest pores within a carbon particle and consists of a variety of different sizes and shapes. There is approximately a 100,000-fold range of transport pore sizes within an activated carbon particle. Transport pores are too large to adsorb, but act as paths to pass contaminants to adsorption sites.

Adsorption pores are the only regions in the carbon particle with significant adsorption forces or any adsorption properties. They are the smallest pores within the carbon particle and cover only a five-fold range in size.

To be physically adsorbed, a contaminant must first migrate from the outer surface of the carbon particle through the maze of transport pores. The adsorption rate is dictated by the path which an adsorbate molecule must take. If the path's length is decreased by using a smaller particle size, the adsorption rate increases. The faster the adsorption rate, the more efficient the treatment system.

Activated Carbon

Particle Size Table

To determine approximate mesh size of an activated carbon sample, check the table below. Example - a carbon mesh size designated as U.S. sieve 8 x 30 will fall through an opening of screen size 8 (.094 inches) on the U.S. scale and remain on a screen with an opening of U.S. size 30 (.023 inches).

		Standard Mesh Opening	
Tyler	**U.S.**	**mm**	**inches**
4	4	4.75	0.187
6	6	3.35	0.132
8	8	2.36	0.094
10	12	1.70	0.094
12	14	1.40	0.056
14	16	1.18	0.047
16	16	1.00	0.039
20	20	0.85	0.033
24	25	0.71	0.028
32	35	0.50	0.020
35	40	0.425	0.017
42	45	0.355	0.014
48	50	0.300	0.012
60	60	0.250	0.010
65	70	0.212	0.008
80	80	0.180	0.007
100	100	0.150	0.006

Mesh size, therefore, has the same effect on organic adsorption as it does on de-chlorination: decreasing particle size increases contaminant removal efficiency in applications where contact time is a controlling factor.

Because contact time in home water treatment devices is short, mesh size can greatly influence an activated carbon unit's performance. Smaller mesh carbons are better suited to home water filter applications, but higher removal efficiencies must be balanced against the pressure drops they can create.

by Steven Spotts

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