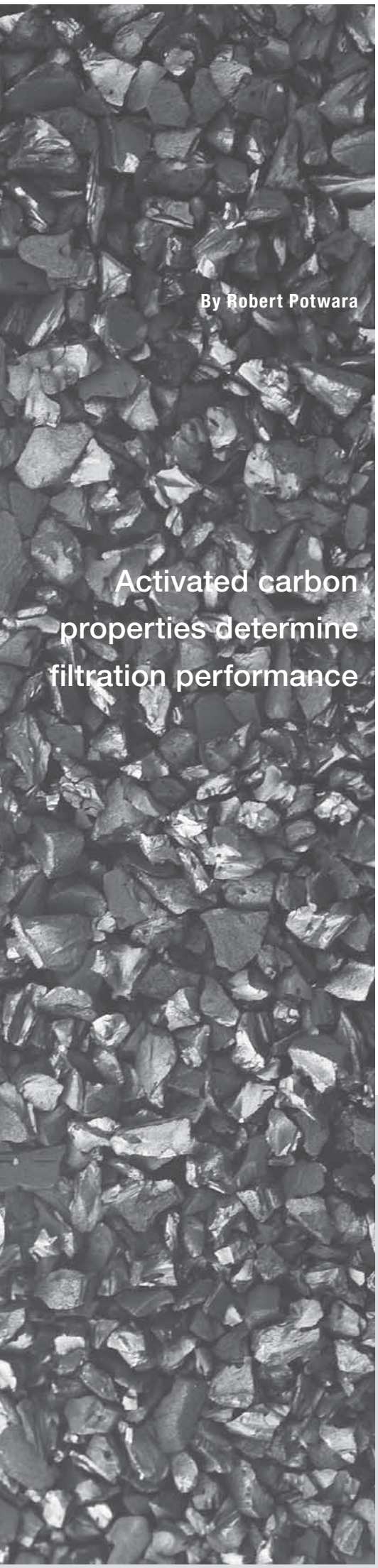

The ABCs of Activated Carbon

Activated carbon (AC) is a common component in many water treatment devices. It removes a wide variety of organic-based contaminants, as well as some inorganic contaminants such as free chlorine and monochloramine. It is common to use AC ahead of reverse osmosis and ion exchange resins to prevent oxidation and organic fouling and to decrease maintenance frequency.

Activated Carbon Properties

The most common raw materials used to manufacture AC for water treatment are coconut shells and coal. The raw material used has a direct impact on an AC's final properties. Table 1 compares the key properties of ACs used for water treatment produced from the most common raw materials: coconut shell, bituminous coal, sub-bituminous coal and lignite coal.

Apparent density. This measurement is used to calculate how many pounds of AC are required to fill a given volume. Lower-density ACs, like those made from sub-bituminous coal, require up to 35% fewer pounds to fill a given volume compared to ACs made from raw materials with higher densities.

Iodine number. This is a common test method to distinguish the micropore volumes of ACs. Coconut shell ACs have the highest iodine numbers, which correspond to a higher capacity to adsorb small molecules, such as volatile organic chemicals.

Molasses number. This test method measures the amount of larger mesopores and macropores. Sub-bituminous coal- and lignite coal-based ACs have the highest molasses numbers; therefore, they have a much higher capacity to adsorb larger molecules like tannins.

Total ash. This is a measurement of the impurity content of an AC. Coconut shell-based AC has the lowest ash content and is the purest type. The overwhelming majority of the ash present in an AC will be insoluble. ACs can be water and acid washed to reduce the ash content. Coconut-based ACs have the lowest ash content after washing, with levels of 1% to 2%, whereas coal-based ACs have an ash content of 5% to 15% after washing.

Hardness number. This is an important parameter for granular activated carbon (GAC). A GAC with a high hardness number is less prone to breakdown during use and generates fewer carbon fines. Coconut shell-based ACs have the highest hardness numbers.

Sizing Up

Loose AC for water treatment uses broken granules called GAC. Pellet- and bead-shaped ACs are also available, but they are used mainly for specialty applications.

For point-of-use AC systems, 20-by-50 mesh size is preferred. This small size allows fast kinetics for adsorption of impurities and chlorine removal while maintaining acceptable pressure drop. Larger point-of-entry systems use 12-by-30 or 12-by-40 mesh sizes. This larger particle size also allows fast kinetics while maintaining acceptable pressure drop.

To reduce the need for the large tanks required for GAC, carbon blocks were developed. These contain "fine-mesh" AC, normally made with 80-by-325 mesh size. The carbon blocks are molded or extruded with binders and additives to form a solid block. They eliminate the black dust that is normally associated with new GAC. The small carbon particles used to make the blocks allow fast kinetics for removal of impurities.

Table 1. Activated Carbon Properties

Base Material	Coconut Shell	Bituminous Coal	Sub-Bituminous Coal	Lignite Coal
Apparent Density (lb/cu ft)	30 - 34	30 - 34	22 - 23	23 - 24
Iodine Number (mg/g)	1,050 - 1,300	850 - 1,000	1,000 - 1,100	500 - 600
Molasses Number	< 200	200 - 230	> 300	> 300
Total Ash (percent)	< 3	8 - 15	10 - 15	16 - 30
Hardness Number	98 - 99	85 - 90	85 - 90	65 - 75

NSF/ANSI Standards

NSF/ANSI standards 42 and 53 are used to evaluate the performance of AC water treatment units. The reduction of aesthetic contaminants such as chlorine, monochloramine, taste, odor, color and particulate matter are covered under NSF/ANSI 42.

Carbon blocks are ranked by their performance in filtering particles from water. There are six classes used for nominal particulate matter removal. The classes represent particle size ranges that are removed with a minimum 85% efficiency. Table 2 compares particle size reduction ranges by class. This is referred to as the nominal size rating. Carbon blocks with a Class VI rating do not remove small-size particles as well as other blocks, but are less prone to clogging. Carbon blocks with the highest rating, Class I, can filter particles less than 1 µm in size.

NSF/ANSI Standard 53 addresses the reduction of contaminants that have known health effects. These include organic chemicals, inorganic chemicals, metals and cysts.

Standards 42 and 53 require a treatment unit to be evaluated to ensure nothing can leach into the water at levels that may be harmful to human health. A list of certified treatment units and their reduction claims can be found on the NSF Intl. and Water Quality Assn. websites.

There are many types of AC available. Selecting the right type is important to ensure proper performance and minimize costs. *wqp*

Table 2. Nominal Particulate Reduction Classes

Class	Particulate Size
I	≥ 0.5 µm to < 1 µm
II	≥ 1 µm to < 5 µm
III	≥ 5 µm to < 15 µm
IV	≥ 15 µm to < 30 µm
V	≥ 30 µm to < 50 µm
VI	≥ 50 µm to < 80 µm

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