



# Activated Carbon | Properties of GAC

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## What are the Properties of Activated Carbon?

Activated carbon products can be characterized by its activity and physical properties. Activity properties include pore size distribution that defines the available pore volume of a carbon over three pore size regions: the micropore, mesopore, and macropore regions.

- Micropore region - less than 100 Angstroms
- Mesopore region - between 100 and 1,000 Angstroms
- Macropore region - greater than 1,000 Angstroms

Pore size distribution properties are key indicators of a carbon's potential performance for removing contaminants (adsorbates) from water. The molecules encountered in gas phase are generally smaller than those in liquid phase applications; therefore, a gas phase carbon has the majority of its pores concentrated in the micropore region.

A broad range of pore sizes must be available, both for ease of movement of adsorbates through the carbon pores and for the adsorption of particular molecular sizes. Liquid phase carbons often contain a broader pore size distribution to remove color bodies and larger organics, while maintaining some microporosity for the removal of taste and odor compounds.

Physical properties include surface area, product density, mesh size, abrasion resistance, and ash content.

*Typical measured carbon properties include:*

**Iodine Number:** standard testing done to estimate the surface area of the activated carbon by measuring iodine adsorption at a given set of standard testing conditions, reported in mg I<sub>2</sub> adsorbed per/g carbon

**Surface Area:** amount of surface available for adsorption for a given mass of carbon, measured using techniques such as BET nitrogen adsorption; reported in units of m<sup>2</sup>/g

**Product Density:** several properties available including apparent density which is the density of the carbon at maximum packing efficiency, reported in g/cc or lbs/cf

**Mesh Size:** measure of particle range of the granular product, usually reported as a range of sieve openings, such as 12 x 40 for a carbon that passes a 12 mesh screen, but is retained on a 40 mesh screen with a specification on the amount that can be retained on the larger opening screen or passing the smaller opening screen; basis is US sieve sizes

**Abrasion Number:** measure of the ability of the carbon product to resist attrition; this important property permits one to understand how durable the activated carbon is in applications where backwashing is required, carbon will be transferred, or treatment velocities are above average

**Ash Level:** a measure of the non-carbon content of the activated carbon; all base materials have a certain ash constituency with the content varying from base material to base material; for example, coconut shell carbon tends to have more alkali earth metals, while coal-based carbons have more heavy metals.

## How Does Activated Carbon Work?

Physical adsorption is the primary means by which activated carbon works to remove contaminants from liquid or vapor streams. Carbon's large surface area per unit weight allows for contaminants to adhere to the activated carbon media.

The large internal surface area of carbon has several attractive forces that work to attract other molecules. These forces manifest in a similar manner as gravitational force; therefore, contaminants in water are adsorbed (or adhered) to the surface of carbon from a solution as a result of differences in adsorbate concentration in the solution and in the carbon pores.



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Physical adsorption occurs because all molecules exert attractive forces, especially molecules at the surface of a solid (pore walls of carbon), and these surface molecules seek to adhere to other molecules.

The dissolved adsorbate migrates from the solution through the pore channels to reach the area where the strongest attractive forces are located. Contaminants adsorb because the attraction of the carbon surface for them is stronger than the attractive forces that keep them dissolved in solution.

Those compounds that exhibit this preference to adsorb are able to do so when there is enough energy on the surface of the carbon to overcome the energy needed to adsorb the contaminant. Contaminants that are organic, have high molecular weights, and are neutral, or non-polar, in their chemical nature are readily adsorbed on activated carbon.

For water adsorbates to become physically adsorbed onto activated carbon, they must both be dissolved in water so that they are smaller than the size of the carbon pore openings and can pass through the carbon pores and accumulate. Besides physical adsorption, chemical reactions can occur on a carbon surface. One such reaction is chlorine removal from water involving the chemical reaction of chlorine with carbon to form chloride ions.