

## **Glossary of Terms**

### **Activated Carbon**

Activated carbon has been used to purify different products since Roman times. Carbon treatment is primarily based on a naturally occurring phenomenon called adsorption, in which molecules of a liquid or gas are trapped on the internal surface of the activated carbon. The phenomenon is somewhat similar to iron filings being held by a magnet.

Activated carbon is a crude form of graphite, with a random or amorphous structure that is highly porous over a broad range of pore sizes, from visible cracks and crevices to cracks and crevices of molecular dimensions. Three grams of activated carbon have a surface area equivalent to a football field.

Activated carbon can be manufactured from a wide variety of raw materials. The predominant qualification is that the raw material should have a high percentage of carbon content. Commonly used raw materials are bituminous coal and coconut shells.

### **Acid-Washed Activated Carbon**

Carbon that has been contacted with an acid solution with the purpose of dissolving and minimizing ash in the activated carbon.

### **Adsorbate**

That which is adsorbed on the adsorbent.

### **Adsorbent**

Any solid having the ability to concentrate significant quantities of other substances on its surface. Activated carbon is an adsorbent.

### **Adsorber**

A vessel designed to hold granular activated carbon.

### **Adsorption**

The phenomenon whereby molecules adhere to a surface with which they come in contact.

### **Adsorption Isotherms**

A measurement of adsorption determined at a constant temperature by varying the amount of carbon used or the concentration of impurity in contact with the carbon.

### **Adsorption Pores**

The finest pores in the carbon structure. Pores that have adsorption capabilities.

### **Apparent Density**

The weight per unit volume of activated carbon.

### **Ash**

The mineral oxide constituent of activated carbon. It is normally defined as a weight percent basis after a given amount of sample is oxidized.

### **Backwash**

An operating method used to remove suspended solids from the carbon bed. Water is pumped into the bottom of the adsorber, flows upward through the carbon bed, and exits through the backwash outlet. The upward flow expands the bed and removes the suspended solids, carbon fines, and entrained air. The percent of bed expansion and time required for backwashing is a function of the backwash rate and water temperature.

### **Bed Depth**

The amount of carbon expressed in length units, which is parallel to the flow of the stream and through which the stream must pass.

### **BIBO**

Bag In/Bag Out containment housings designed to protect workers from exposure to hazardous contaminants.

### **BSL**

Biosafety Levels that are applicable to clinical, diagnostic, teaching, research, or production facilities in which work is done with indigenous or exotic agents that may cause serious or potentially lethal disease as a result of exposure by the inhalation route.

### **Butane Number**

The volume of butane adsorbed per unit weight of activated carbon after air saturated with butane is passed through a carbon bed at a given temperature and pressure.

**Carbon Column**

A column filled with granular activated carbon whose primary function is the preferential adsorption of a particular type or types of molecules.

**Carbon Tetrachloride Activity**

The maximum percentage increase in weight of a bed of activated carbon after air saturated with carbon tetrachloride is passed through it at a given temperature.

**CBRN**

An acronym for chemical, biological, radiological, and nuclear. It is in common use worldwide to refer to incidents or weapons in which any of these four hazards have presented.

**Chemi-sorption**

Adsorption where the forces holding the adsorbate to the adsorbent are chemical (valence) instead of physical (London's).

**Color Bodies**

Those complex molecules that impart color (usually undesirable) to a solution.

**Contact Time**

Length of time air is in contact with activated carbon. Typically measured in seconds. Calculated as activated carbon bed volume divided by flow rate.

**Containment System**

A special HVAC filter system that is installed wherever the air to be filtered contains the most hazardous contaminants. Containment systems include special features for service and maintenance that provide greater safety for the operator.

**Countercurrent Efficiency**

The unique advantage of a carbon column that permits partially spent activated carbon to adsorb impurities before the semi-processed stream comes in contact with fresh carbon. This allows the maximum capacity of the activated carbon to be utilized.

**Critical Bed Depth**

In a carbon column the critical bed depth is the depth of activated granular carbon that is partially spent. It lies between the fresh carbon and the spent carbon and is the zone where adsorption takes place. In a single column system, this is the amount of carbon that is not completely utilized.

**Cross Sectional Bed Area**

The area of activated carbon through which the stream flow is perpendicular.

**Deaeration**

The process of removing air (gases) from a liquid phase bed of carbon particles. In a volume of 1 m<sup>3</sup> of activated carbon, there is approximately 40% of void space, 40% of pore volume, and 20% of carbon skeleton.

**Desorption**

The opposite of adsorption. A phenomenon where an adsorbed molecule leaves the surface of the adsorbent.

**Empty Bed Contact Time (EBCT)**

A measure of the time during which contaminant media to be treated is in contact with the activated carbon medium in a contact vessel, assuming that all contaminated media passes through the vessel at the same velocity. EBCT is equal to the volume of the empty bed divided by the flow rate.

**Gasket Seal (CM) Filter Clamping Mechanism**

A spring-loaded clamping mechanism that compresses a filter gasket providing a positive seal between the filter face and the sealing surface of the housing.

**Hardness Number**

The hardness number is the resistance of a granular carbon to the degradation action of steel balls in a Ro-Tap machine. It is calculated by using the weight of granular carbon retained on a particular sieve after the carbon has been in contact with steel balls.

**Heat of Adsorption**

The heat given off when molecules are adsorbed.

**High Efficiency Carbon Adsorber (HECA™)**

The HECA™ is a high-efficiency, vertical, deep bed adsorber for corrosive gas control, volatile organic compound (VOC), odor control, and hazardous chemical applications. HECA™ systems are designed for high efficiency vapor phase adsorption and particulate removal, as well as minimized pressure drop and adsorber footprint.

**High-flow VENTSORB® (HFVS)**

Deep bed, rectangular, activated carbon adsorption systems with flow rates of 500 to 5,000 cfm.

**Horizontal Deep Bed (HDB™)**

Activated carbon adsorbers are used primarily for applications with high air flows or high contaminate concentrations and where a long service life is important.

**Impregnated Carbon**

Addition of chemicals to activated carbon that enables the carbon to attract specific contaminants. Specialty impregnated carbons can attract lighter molecular weight gases, acid gases, and other toxic, harmful, or nuisance contaminants.

**Iodine Number**

The iodine number is the milligrams of iodine adsorbed by 1 gram of carbon at a filtrate concentration of 0.02N iodine. It is an indication of surface area and can be used to calculate available capacity or life of carbon.

**Knife-Edge (KE) Filter-Clamping Mechanism**

A clamping arm is designed to manually engage the filter element into a knife-edge flange. The seal is made when the knife-edge flange penetrates a gel-filled channel provided with the filter element.

**Macropore**

Transport pores of approximately 1,000 Å and greater in diameter.

**Make Up Carbon**

Fresh granular activated carbon that must be added to a column system after a regeneration cycle or when deemed necessary to bring the total amount of carbon to specification.

**Mass Transfer Zone**

The adsorption gradient that exists in the carbon bed. It corresponds to the gradual transition of the carbon from “fresh” (or “virgin”) to “spent” (or “exhausted”). Also referred to as the MTZ.

**Mesh Size**

The particle size of granular activated carbon as determined by the U.S. Sieve Series. Particle size distribution within a mesh series is listed in the specifications table on our product literature for each carbon.

**Micropore**

Adsorption pores of approximately 100 Å and less in diameter.

**Moisture**

The percent by weight of water adsorbed on activated carbon.

**NESHAP**

National Emissions Standards for Hazardous Air Pollutants are emissions standards set by the Environmental Protection Agency (EPA) for air pollutants that may cause an increase in fatalities, or serious, irreversible, or incapacitating illness. The standards for a particular source category require the maximum degree of emission reduction that the EPA determines to be achievable. There are over 200 chemicals listed in NESHAP and include benzene, carbon disulfide, mercury, and many other toxic pollutants.

**NQA-1**

The Nuclear Quality Assurance Level-1 (NQA-1) was established by the American Society of Mechanical Engineers (ASME). It is a multi-part standard that includes both requirements and nonmandatory guidance to establish and implement the quality assurance (QA) requirements for any nuclear-related application.

**Particle Density**

The weight per unit volume of granular activated carbon not including the voids between the particles and cracks larger than 0.1 mm. It is determined by the displacement of mercury.

**Particulate**

Tiny subdivisions of solid or liquid matter suspended in a gas or liquid. Sources of particulate matter can be man-made or natural.

**Pore Volume**

The volume of the internal void spaces in a granule, smaller than 0.1 mm and large enough to allow access to helium. It is measured as the difference in the volumetric displacement by granular activated carbon in mercury and in helium at standard conditions.

**Relative Humidity (RH)**

The term used to describe the amount of water vapor that exists in a gaseous mixture of air and water vapor. Relative humidity may affect created carbon capacity for contaminants due to competitive adsorption.

**Real Density**

The density of the skeleton of a carbon granule. This is determined by helium displacement.

**Residence Time**

See Contact Time.

**Specific Heat**

The quantity of heat required to raise the temperature of a unit weight of granular activated carbon through a particular interval of temperature divided by the corresponding quantity for water. For Calgon Carbon's granular activated carbon, this value is 0.25 cal/g°C. It should be noted that the thermal conductivity of granular activated carbon is extremely low.

**Surface Area**

The surface area of granular activated carbon is empirically determined by the Brunauer, Emmett, and Teller Method (BET Method), which uses the adsorption of nitrogen at liquid nitrogen temperature in the calculation. Surface area is usually expressed in square meters per gram of carbon. Our carbons range from 700 to 1,200 square meters per gram.

**Transport Pores**

Pores larger than the largest adsorption pores. They function as a diffusion path to transport adsorbates. Adsorption does not occur in these locations even at near-saturated conditions.

**Void Fraction**

The percent by volume of the open space between activated carbon granules to total bed volume.

**Volatile Organic Compounds (VOCs)**

Organic compounds that have high-enough vapor pressures under normal conditions to significantly vaporize and enter the earth's atmosphere. Volatile organic compounds are numerous and varied. Although ubiquitous in nature and modern industrial society, the sometimes-harmful or toxic VOCs are often regulated by both the state and federal governments.

**Wave Front**

The carbon-loading gradient that exists in the critical bed depth. It corresponds to the gradual transition of the carbon from "fresh" (or "virgin") to "spent" (or "exhausted").

**Example Of Contaminants By Industry**

Industry / Application	Example Of Contaminants Removed
Asphalt Manufacturing	Nitrogen Oxide, VOC, Sulphur Dioxide
Battery Production	Mercury, Acid Gases
Electronic Component Protection	Hydrogen Sulfide, Chlorine
Electronic Systems	Hydrogen Sulfide, Acid Gases, Mercury, Arsine
Fabrication Shops	Sulfur Dioxide, Nitrogen Dioxide, Cutting Oils, Solvents
Foam	Formaldehyde, Isocyanates
Hospitals	Ethylene Oxide, Formaldehyde, Bacteria
Industrial Respirators	Acid Gases, Ammonia, Solvents
Laboratories	Ammonia, Mercury, Formaldehyde, Radionucleotides, Solvents
Military	Chemical Warfare Gases
Mining	Mercury, Acid Gases, Hydrogen Cyanide
Museums	Formaldehyde, Hydrogen Sulfide
Nuclear Medicine	Radioactive Fluorine, Iodine, Technetium, Nitrogen
Nuclear Power Plants	Radioactive Iodine, Xenon, Krypton
Petrochemical	Acid Gases, Hydrocarbon, Solvent Fumes
Poultry Farms, Animal Waste	Ammonia, Hydrogen Sulfide
Semiconductor Industry	Arsine, Phosphine, Solvents