

That Old Black Magic

Carbon, Carbon Everywhere

By Jeff Swanson, Circuit Rider

Magic is defined as a term for various supernatural, mystical, and paranormal practices. Black magic or dark magic is a type of magic that draws on malevolent powers. It is used for malevolent acts or to deliberately cause harm in some way. But stop here - until we go much further, I would like to clarify; the type of black I am referring to here is coal, and the magic is the astonishing way that carbon-based products can help us in the water treatment industry. One form of carbon used in the water treatment process is anthracite coal.

Anthracite: is formed from organic sedimentary rocks. These form from the build up and decay of plant and animal material. This usually forms in swamp regions in which there is an abundant supply of growing vegetation and low amounts of oxygen. The vegetation builds so quickly that new layers of vegetation bury the dead and decaying material very quickly. The bacteria that decay the vegetation need oxygen to survive. Because these decaying layers are buried so fast the bacteria use up what oxygen there is available and can not finish the decomposition of the vegetation. The overlaying layers become so heavy that they squeeze out the water and other compounds that aid in decay. This compressed vegetation forms coal. The longer and deeper that coal is buried makes it of higher quality. Peat is the first stage of coal formation. Lignite is the next grade of coal followed by bituminous and the highest grade, anthracite.

Anthracite is known as a metamorphic rock and is the most pure and clean burning coal product making it ideal for forging steel. It contains about

92%-98%
actual
carbon
content.

In gravity
filters, it is
typically
the upper
most
media
layer in a



multi-media filter. Due to its geometrically configured size, it helps to deflect small particles entering the filter down and more evenly dispersed throughout the filter. This application allows for more uniform buildup down through the filter rather than just on the top layer such as with a slow-sand filter. Filters can lose up to 1" – 2" of anthracite per year during the backwash process. Therefore it is important to keep track of the "freeboard" level of the filters and add the anthracite periodically. Unit Filter Run Volumes (UFRV) can be reduced when anthracite is lost. As it is lost, filter rate decreases. The rule of thumb is that the UFRV should be somewhere around 5,000 gal./sq.ft. run volumes between backwashes. Therefore, if you have a 10 sq.ft. filter, the filter run volumes should be unit measurement of around 50,000 gallons between backwashes. With even more filter optimization, these run volumes can run much higher. Do you know how much water is flowing through each square foot of your filter media between backwashes? Some of the filters I see are only filtering 2,000-3,000 gallons per square foot. Since we spend many \$\$\$ on chemicals and electricity to filter our water, it would only seem wise to not use that same clean water and waste it as backwash water more often than necessary.

Activated carbon: is made from the less pure and softer bituminous coal. This is an organic sedimentary rock containing about 60%-80% carbon content. When you put the fresh piece of wood or paper on a hot fire, the smoke you see is those volatile hydrocarbons evaporating from the wood. They start vaporizing at a temperature of about 300 degrees F (149 degrees Celsius). If the temperature gets high enough, these compounds burst into flame. Once they start burning, there is no smoke because the hydrocarbons are turned into carbon dioxide and water (both invisible) when they burn.

This explains why you see no smoke from a charcoal fire (or a fire that has burned down to embers). Charcoal is created by heating wood to high temperatures in the absence of oxygen. That is, you take wood and put it in a sealed box of steel or clay and you heat it to about 1,000 degrees F (538 C). This process drives off all of the volatile organic compounds and leaves behind the carbon and the minerals (ash). When you light the charcoal, what is burning is the pure carbon. It combines with oxygen

to produce carbon dioxide, and what is left at the end of the fire is the ash -- the minerals. Thus, by burning coal, wood, and some other exotic vegetation such as coconut shells in the absence of oxygen, the resulting activated carbon material is created. Activated carbon has an average surface area of about 1,000 square meters per gram. A tennis court is about 260 square meters. The large amount of surface area is due to the everlasting honeycomb of pores in each puffed up piece of activated carbon.

When certain particles pass by the carbon, a process of adsorption takes place. This means there is an ionic-like attraction for the particle to adhere to the carbon and slowly work its way down into the maze of pores. Absorption, on the other hand, is the actual process of a liquid or particle being trapped inside of another material. The significance in water treatment is based on the different types of carbon.

Powdered Activated Carbon (PAC) is used in pretreatment to remove undesirable tastes and odors. It is made up of crushed or ground activated carbon. Due to its small size, the surface content is based on the total quantity of external surface area. It will adsorb gases and other volatiles thus reducing the undesirable tastes and odors derived from organic materials such as algae. It is then filtered out or settles depending on the type of filter. It can cause an accelerated head loss requiring more backwashes. That is also the primary process to remove it – backwashing.

Granular Activated Carbon (GAC) is a larger sieve size and derives most of its surface area from the internal porosity. I have heard it said that 1 cubic foot of activated carbon can adsorb 1 ppm of chlorine out of 1,000,000 gallons of water. It is also used in the adsorption of gases and other volatile organics. Unfortunately, in the water industry, certain organic compounds related to Disinfection By-Products (DBPs) such as Trihalomethanes (THMs) cannot be removed by activated carbon and have to be removed (or prevented) by other methods. Head loss is not often a problem with activated carbon due to its relatively large sieve size. However, it does have (although large) a limited capacity. Usually it is replaced by hauling it to landfills but has the ability to be regenerated by both chemical and heating processes. At a certain point it will have to be disposed of.

Impregnated carbons are porous carbons containing several types of inorganic materials. They can be impregnated with iodine, silver, and cations such as Al, Mn, Zn, Fe, Li, Ca. These impregnated carbons have been prepared for specific applications in air pollution control especially in museums and galleries. Silver loaded activated carbon is used as an adsorbent for purifications of domestic water. That is to say, once a carbon filter has removed ‘your’ chlorine from the municipal water supply, bacteria can once again live and multiply within the filter. A heavy metal such as silver is impregnated within the carbon to aid in the destruction of bacterial growth. You should be aware that when referring any types of point of use (POU) water treatment devices for your customers, that these are devices used “on the premises” and public relations are important. However, the liability issue should always be considered as well.

Polymer coated carbons are smooth on the outside and are coated with a biocompatible polymer. Hemoperfusion is a treatment technique where the human bloodstream is passed over the carbon. As the patient’s blood passes through the adsorptive substance, toxins can be removed from the blood.

Activated carbons come in pellet form and solid form. Some applications are toxic wastes where large drop boxes are filled with GAC and as contaminated water flows through the large vessels, the cleaned water is returned in the form of “groundwater recharge”. Other forms of carbon include impregnated cloth and fibers. Capsules filled with activated carbon can be taken orally in the event certain types of poisons or toxins have been accidentally ingested into the body (consult your physician).

Once again having researched a subject such as the “C” word - Carbon, I feel as though I only scratched the surface. And knowing just how much surface



area is associated with activated carbon – that is indeed an

understatement. Several things have certainly been borne out in this short but exhilarating and stimulating article. Carbon is extremely Old! It is quite Black! And if I should ever decide to accept another "Mission Impossible" to explore the great unknown on the darker side, I'm sure I'll find the Magic as well. It's "That Old Black Magic" (Song 1942). In that same era and in the immortal words of the great Jimmy Durante, "Good night, Mrs. Calabash, wherever you are."