Graver Technologies

Technical Brief

TB–007

Carbon Filter Questions and Answers

What is the main purpose of a carbon filter?

Carbon filters are best at removing chlorine, taste, odor, color and various other organic compounds from the fluid. They are generally not effective at removing inorganic compounds or other contaminants such as microbes, sodium, nitrates, fluoride, lead, heavy metals and hardness. Specialty carbon filters are available for removal of cryptosporidium and giardia cysts from drinking water (CarbTEC™ CYST+).

How do carbon filters work?

A carbon filter is made from activated carbon and its primary function is the chemical adsorption of contaminants and impurities. The activated carbon in the filter also has a pore structure and so particulate removal is accomplished as well.

What is activated carbon and how is it made?

Activated carbon is made from a variety of carbonaceous base materials such as coal, coconut shells, peat or wood. First the base material is exposed to high temperatures in an oxygen-deficient environment to carbonize the material. The carbonized material is then activated by exposing it to an oxidizing agent at high temperature. The activation process creates the three-dimensional nooks and crannies in the material that provide the adsorptive sites and high porosity.

What is adsorption?

Adsorption occurs when a molecule is chemically attracted to a material surface and attaches to it, thereby becoming trapped.

What affects the adsorption in the filter?

Adsorption usually increases as pH and temperature decrease since at these conditions many organic chemicals are in a more adsorbable form. Exposure time is also important to ensure adsorption. Reducing the flow rate through the filter increases the contact time between the chemical contaminant and the carbon, thus improving the removal rate.

What is extruded carbon block?

Extruded activated carbon filters consist of virgin carbon powder, a thermoplastic binder, and speciality adsorbents such as zeolites or oxidizing filtration media. The filters are manufactured as continuous lengths of rod, tube, slab, flexible flat sheet, or as other complex shapes using a proprietary solid-state extrusion process. The resulting products are highly porous and extremely uniform, providing high-performance adsorption and particulate reduction at low flow resistance when fabricated into finished filter elements. Extruded activated carbon filters meet exacting performance requirements and/or claims, and specific models are registered as meeting the requirements of NSF International.

What does NSF Certification mean?

NSF or National Sanitation Foundation International is a product certification organization. A filter that meets NSF material requirements has been certified to not leach chemicals in excess of established standards. All the filter components are tested during the evaluation.

What advantages does an extruded carbon block filter have over a granular activated carbon (GAC) filter?

CarbTEC extruded carbon block filters will outperform conventional GAC filters in almost every application because of the higher adsorbent capacity and contaminant reduction, low pressure drop, high dirt capacity, elimination of carbon fines, higher integrity and strength, and overall ability to produce the highest possible effluent quality. All of these high-quality attributes are achieved by a process that is more automated and productive than any other solid carbon manufacturing process.

1. **Radial flow direction** — Water flows through an extruded filter element in the "radial" direction (from the outside of the filter element to the inside). As a result, the entire exterior surface of the filter is presented to the incoming fluid, not just one edge of the filter as in a GAC filter. With the GAC filter, fluid flows at high velocity through the entire length of the filter, often about 8 inches of carbon. In an extruded filter element, the fluid flows slowly through the approximately ½ inch of wall thickness. While the contact time between the fluid and carbon are basically identical in both cases, the extruded element displays almost ten times less pressure drop when the adsorbent particles are the same size. Together, these two effects result in a total reduction of pressure drop of almost 100 fold so that an extruded carbon filter manufactured with fine powdered carbon displays essentially the same pressure drop at a given fluid flow as a GAC filter filled with coarse particles of activated carbon.
2. **"Blowout" of GAC is eliminated** — Extruded activated carbon filter elements are structurally rigid and of great strength. If the filter element is clogged by particulate contamination, the carbon cannot be released to the downstream water. Extruded filters can withstand higher levels of pressure than most GAC filters, without collapsing. In some cases, clogged GAC filters can "blowout" and release activated carbon into the product water.
3. **No release of carbon fines** — Extruded filter elements do not release activated carbon particles ("gray water") during start-up or operation. Extensive flushing or "activation" of extruded filter elements is not required. Some GAC carbon filters will release carbon fines even after the filter elements have been in service for an extended period of time.

4. **No channeling, fluidizing, or bypassing** — Extruded filter elements cannot channel, bypass, or fluidize because extruded carbon is a rigid structure that prevents movement of the adsorbent particles or the formation of channels and defects in the adsorbent structure. GAC filters consist of loose beds of particles that are often loosely packed into a non-rigid plastic tube. Bypass of the carbon is common because the plastic container often expands away from the carbon when under pressure, leaving a sorbent-free zone. At sufficient flow, the entire bed will fluidize and the integrity of the adsorbent bed will be lost. GAC filters cannot be operated in a horizontal arrangement because the carbon will settle, leaving an open channel along the top of the filter.

What other advantages do CarbTEC extruded carbon block filters offer?

Low binder content and high dirt capacity — CarbTEC extruded carbon blocks provide great physical strength, that is entirely free of attrition and media migration, retains nearly the full capacity of the original activated carbon; and displays the best possible dirt holding capacity and low pressure drop. This is made possible because only a small amount of thermoplastic binder is used in the extrusion process — about one-half of what is used in a molded carbon block. Low binder content results in low carbon fouling (essentially negligible), maximizes the porosity of the extrusion, resulting in the lowest possible flow resistance and the greatest dirt holding capacity. Extruded carbons have 2–4 times more dirt capacity than conventional molded carbon blocks and often do not require protection by a prefilter. CarbTEC filters have one or more layers of melt-blown and spun-bonded polypropylene filter media on the exterior surface to provide the best possible prefiltration of the incoming fluid.

Explain how CarbTEC filters are installed

CarbTEC filters come with double open end caps and can be installed in single or multi-round filter housings designed to accept double open end filters. At this time no other end configurations are available.

What are some of the target applications for CarbTEC filters?

Water
Carbon filters are extensively used to remove chlorine, taste, odor and organic contaminants from water.

Food/Beverage
In the manufacturing of soft drinks, beer, bottled water, it is essential to remove chlorine, taste and odor contaminants from the feed stream water so as not to impact the characteristics of the final product.

Carbon is used to remove unwanted odor or color compounds from glycerin, remove unwanted color from fruit juices and to debitter food products.

Distilled Beverages
Carbon filters can be used to filter organic impurities from vodka and whiskey. Since the activated carbon does not bind well to alcohols, the percentage of ethanol is not significantly affected, but the carbon will bind to and remove many organic impurities which can affect color, taste, and odor.

Metal plating/Purification of electroplating solutions
A variety of organic chemicals are added to plating solutions to enhance the process. Over time, due to passage of direct current and electrolytic reactions of anodic oxidation and cathodic reduction, the electroplating chemicals become contaminated with unwanted organic byproducts and metal finishing residues. Their excessive build up can adversely affect the plating quality and physical properties of deposited metal. Activated carbon treatment removes such impurities and restores plating performance to the desired level. ***Check compatibility of the plating bath chemistry and temperature with the polyethylene binders used in CarbTEC filters***

Carbon is effective for color removal from liquid chemicals such as Tannic Acid*

Carbon is effective at removal of organic contaminants from liquid chemicals* such as:

- **Alum**
- **Cadmium cyanide**
- **Hydrochloric acid**
- **Lithium**
- **Phosphoric acid (<40%)**
- **Soda Ash**
- **Sodium chloride (Brine solution)**
- **Sodium Nitrite**
- **Sodium tri polyphosphate (STP)**
- **Zinc acid, Zinc acid chloride**

**** Always obtain detail on all fluid components and contact us to confirm compatibility with polyethylene binders used in CarbTEC filters.***