



## Activated Carbon

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Activated carbon is one of the most misunderstood filtration media available to the hobbyist. Virtually every filter system sold in the aquarium trade contains activated carbon or a section for its use. However, there are many misconceptions about what activated carbon can and cannot do. The purpose of this month's column is to explain some of the basics about activated carbon. More detailed information can be found in two articles I have written on this subject for Aquarium Fish Magazine (May 1993 and May 1998).

Activated carbon (or just carbon for this article) can be made from almost any organic based material such as wood, coal, peat, coconut shells, and many others. Activating the material means increasing its internal surface area and getting rid of impurities. This is done through a special process which involves heating the material to nearly 2,000°F in a controlled environment. So the first incorrect myth is that one can reactivate their carbon by placing it in the kitchen oven. This will not work, so don't waste your time and make a mess of the kitchen.

The best carbon for use in water filtration to remove the dissolved organics is bituminous coal based carbon. While there are some who would argue with this statement, the facts support my declaration. Bituminous coal-based carbon is used extensively for filtering drinking water and in many other applications. Carbons made from other base materials have their place, but bituminous coal based carbon is by far the most widely used in the liquid filtration field. The reason for this is that the internal surface of bituminous coal based carbon contains a large amount of transitional pores which have a size between 40 and 5,000 angstroms. The majority of the pores one gets with other base materials are either much smaller (called micropores) or larger (called macropores). Without getting more technical, the size (i.e. type) and amount of the internal pores determine how well a carbon will remove a substance. Extensive research by carbon manufacturers has shown that bituminous coal based carbons have the right mix of pore size and internal surface area such that they remove more pollutants per gram of carbon than any of the other types of base materials in liquid applications.

## DrTim's Aquatic Library Contribution

Carbon removes a class of material called dissolved organic compounds (DOC). These compounds are produced by many different processes in the aquarium. The two major categories of organic substances that carbon removes are tannins and phenols. Tannins give the water a yellow-brown color. They are produced mainly by the breakdown of plant material, but there are other sources too. Phenols give a fish tank that characteristic "fishy" smell. Carbon can also remove chlorine and some heavy metals through other processes.

Carbon does not remove ammonia, nitrite or nitrate from water. It also does not have an effect on water hardness or alkalinity. Some carbons will leach phosphate into the aquarium water. The phosphate can be a naturally occurring part of the carbon or it can be from phosphoric acid which is sometimes used in the activation process. In either case, the phosphate is not toxic; rather it can contribute to eutrophic conditions in the aquarium water and may lead to algae blooms. If you are concerned about phosphates, switch brands of carbon. There are several bituminous coal based carbons available from reputable companies that are phosphate-free.

There is much written about the use of carbon in seawater aquaria. Some authors recommend against the use of carbon in seawater aquaria because carbon will remove trace elements. As with most situations in the aquarium hobby, the correct response to the claim that activated carbon removes trace elements from seawater is yes and no-- mostly no. By definition, trace elements are those elements found in the ocean with a concentration of less than 1 ppb. These are elements such as cesium, chromium, cadmium, selenium, cobalt, silver, lead, tin, helium, lanthanum and cerium. For these elements, it has never been shown that they are really needed in the aquarium. In fact, adding some to the water would really be poisoning the tank. Further, these elements are rather insoluble at the pH of seawater, so activated carbon cannot remove them from the water. Thus the correct technical answer is that in the normal marine aquarium, activated carbon will not remove trace elements. However, if one wanted to remove some of the above listed trace elements from seawater with activated carbon it could be done by changing the pH and some other factors to get the elements in the soluble form but this would render the seawater uninhabitable.

So what elements might carbon removes from seawater that would be of interest to the marine hobbyist? These elements would be copper, iodine, iron and molybdenum which, by definition, are called minor elements. However, once again, how much of any of these elements carbon might remove depends upon the element's solubility in seawater. Most of these elements are not in the soluble form in seawater and, as such, cannot be removed from the seawater by carbon. The bottom line is that activated carbon is going to have no effect on the majority of elements found in seawater.

## DrTim's Aquatic Library Contribution

Activated carbon should be part of every aquarium filtration system. This is another statement that some have disagreed with me about. However, personal experience with using activated carbon for years along with data collected in my laboratories supports my claim. Carbon has been used continuously in all types of freshwater tanks, saltwater fish-only tanks, reef tanks and large display systems in the labs and never has there been a problem.

The reasons given for not using carbon or not using it continuously include: the carbon causes some diseases, it removes beneficial elements/substances for the water, and eventually the carbon will de-adsorb everything killing the tank inhabitants. None of these reasons have ever been supported by experiments or tests. Rather, they are myths. And as myths, they circulate through the hobby growing a life of their own which becomes hard to kill.

The reason to use carbon is that it removes dissolved organic compound from the water. This has been shown experimentally. Removing the dissolved organics will increase the effectiveness of the biological filter. Again published studies have demonstrated this. Plus, removing the dissolved organics will make the water look cleaner because it will be clearer.

For most filters, GAC comes conveniently pre-packaged so that it can be easily removed from the filter and replaced. The most efficient method is to get as much of the water to go through the carbon on each pass through the filter. This can be done by spreading the carbon out in a thin layer rather than letting it pile up in a bag.

A problem with recommending the use of activated carbon is that there are no easy guides for answering the common questions regarding the use of carbon. Questions such as how much carbon is needed in a tank and how often it should be changed can only be answered definitively by using it in your aquarium. This is because every aquarium is different and how they are maintained is different. Because of the individual differences in tanks, these guidelines are, at best, educated guesses.

But general guidelines will work and those that I recommend are based on the observations of many aquaria run for long periods of time. Thus, for most situations, if your tank is not overcrowded or overfed, then changing the carbon once a month is sufficient. If you have big fish or a lot of fish, change the carbon every 2 or 3 weeks.

To get the most out of your carbon make sure to mechanically filter the water before it reaches the carbon, as this will keep the carbon from clogging with debris. A good practice is to rinse the carbon under water for a few seconds each week to get rid of particulate material. This will keep the water paths open and help you get the full benefit of the carbon.

## **DrTim's Aquatic Library Contribution**

Carbon is not a substitute for water changes. You cannot stop doing other maintenance chores. It is only one part of the filtration system. Most filters make using carbon easy and carbon is not that expensive. Carbon will help you get the most enjoyment from your aquarium and provide a healthy environment for your fish. Good fishkeeping!

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