# CO2 Basics for Aquarium Plants

**One of the things that aquarium plants need to live and grow, like all living things, is carbon. Aquarium plants get carbon almost exclusively from carbon dioxide (CO2).**

*By Scott Hieber*

Vallisneria is capable of drawing carbon from mineral compounds in the water. Many things have contributed to making aquatic gardening a successful hobby for so many people. One is the willingness of experts to share what they have learned through their diligent efforts over the years. Another is the improvement in fluorescent lighting, especially compact fluorescent tubes, which made it practical to fit enough light over our aquaria to grow aquatic plants well. A third is the realization of the usefulness of adding CO2 to the water. One of the things that plants need to live and grow, like all living things, is carbon. Plants get carbon almost exclusively from carbon dioxide (CO2). There is a lot of CO2 in the atmosphere (several hundred parts per million or ppm) and a little bit in water (just a few ppm). Some plants, like Vallisneria, can draw carbon from mineral compounds in the water called carbonates. Vallisneria is a genus that grows underwater. Most of the aquatic plants that aquatic gardeners like to grow naturally occur along creeks and river banks, and sometimes grow submerged only when waters run high. When immersed (leaves out of water), plants can get CO2 from the air where it is relatively plentiful. When submerged, only the CO2 that is dissolved in the water is available. If you boost the amount of CO2 in the water, just about any submerged plant will grow faster. In fact, adding CO2 can give nearly as much boost as increasing the lighting from relatively low to high lighting levels.

CO2 enters water from contact with the atmosphere, but only a few parts per million (ppm) can be absorbed. Some CO2 comes from the respiration of fish in the aquarium. If the CO2 content of the water is below normal, bringing it into contact with the air will increase the CO2 content, but only up to a few ppm. If the CO2 content is higher than a few ppm, the air contact will cause the "excess" CO2 to be shed from the water. While good circulation is important in a planted aquarium, vigorous surface agitation is not desirable if you are boosting the CO2 content. With vigorous surface agitation, the CO2 will be shed from the water as quickly as it's added. An air pump and air stone are neither necessary, nor desirable in a well-planted aquarium with added CO2.

Is CO2 Necessary?
Q. I have a 55-gallon aquarium with a 9-inch albino oscar and a few live aquatic plants. I do not know what types of plants they are, but they are very common in my local pet stores. Is it necessary for me to add CO2 to this aquarium? If so, I have heard of a method of making a homemade yeast system. How does this system work, and how would I set one up? The tank is equipped with a 32-watt bulb and a Whisper 300 air pump.
Robert DeSantis
Staten Island, N.Y.

A. Robert raises several issues about aquatic gardening. One that leaps out for more experienced gardeners is that oscars are notorious for wreaking havoc on live aquatic plants. If you have found one that does not find them teething material, you are lucky.

Robert mentions lighting. Lighting should be about 1.5 to 2 watts per gallon (wpg) for a slow-growing aquarium and 2 to 3 wpg for a fast-growing, higher-maintenance aquarium. A mere 32 watts on a 55-gallon tank is not enough, except perhaps for a few plants that can tolerate deep shade. Otherwise, add two more 32-watt bulbs to grow aquatic plants.

Another issue is which live aquatic plants can benefit from added CO2. Most stores only carry a handful of different plants, and the variety tends to change from store to store. Whatever plants Robert has, if they will grow underwater, they do not require, but can benefit from, added CO2. You can add CO2 using one of two methods. One way is to have a fermentation container with an air line going from the container to the aquarium (a by-product of fermentation is CO2 gas). A second way is to use a compressed-gas tank of CO2. There is too little space here to cover both methods at once, so I will leave the compressed gas method for another time.

The least expensive way to set up for adding CO2 is with a fermentation container, sometimes called a yeast reactor. Take a half-gallon water bottle, and put a hole in the cap. Glue a piece of rigid air line tubing into the hole, run the air line tubing from the cap to the intake of a powerhead or canister filter, or to a commercially manufactured device made for "injecting" CO2. Any of these devices prolong the time that the CO2 is in contact with the water, allowing the CO2 to be absorbed. If you just put the air line bare into the aquarium, the CO2 will bubble quickly to the surface and be lost to the

atmosphere.

What goes in the container? The ingredients are a pinch of yeast as a starter culture, sugar, water and for best results, a little protein powder and some baking soda. Leave several inches of air space between the water surface and the top of the bottle. Fermentation containers tend to foam a bit and the space will keep the foam from being pushed out of the bottle and into the tubing. A good recipe is shown below for a 2-quart container; adjust the amounts to the size of your container.

- 1 cup sugar
- Dechlorinated water
- 1 to 2 tsp. protein powder from your favorite drug store or supermarket
- 1 tsp. baking soda (yeast prefers nonacidic conditions)
- A pinch of yeast

You don't need more sugar than that. Make sure you don't use too much sugar. Yeast turns the sugar into alcohol, and yeast can tolerate only about 10 to 18-percent alcohol, depending on the species.

Wine yeasts work best because they tolerate relatively high alcohol levels, and your batch will last longer the more alcohol the yeast can tolerate. Wine yeasts can be purchased from winemaking/beer making supply houses. Aquatic hobby stores sell a system with a ready-made fermentation container, output device and yeast mixture, and will usually sell the yeast itself, as well. But any yeast will work; all yeast turns sugar into alcohol and CO2. It will take a few hours or overnight for the yeast population to grow large enough to produce noticeable amounts of CO2. After two to four weeks, the CO2 output will subside as the food is depleted and the alcohol content of the container rises. Pour out nearly all the contents, but leave a little of the stuff at the bottom of the container. The yeast in that remainder will multiply rapidly and replenish the yeast population overnight. Add more sugar, protein, baking soda and water. You don't have to add more yeast, unless the mixture becomes contaminated with an unwanted bacterium or mold; in that case, wash out the container, and rinse thoroughly and start a new batch.

When CO2 is dissolved in water, it makes the water slightly more acidic, unless you have something buffering the acidic effects. You can add a buffer simply by adding baking soda. Because CO2 tends to reduce pH, and carbonates tend to increase it, you can tell the CO2 level by measuring the so-called "carbonate hardness" (or KH level) and the pH. You cannot easily test CO2 levels directly, but the KH and pH tests are easy and inexpensive. The math for deriving the CO2 levels is a bit complicated, but you can just look up the values on the table shown:

KH values are listed at the left of each row, and pH values are at the top of each column. Find the column that corresponds to your aquarium's pH value, then trace down that column to the row that corresponds to your aquarium's KH value. The value shown there is the approximate amount of CO2 in the water in ppm. For example, at pH 7 and KH 7, the CO2 level is 24 ppm.

An ideal CO2 level is 15 to 30 ppm. However, to allow for inaccuracies in measurements, you should target about 20 to 25 ppm. If you get a lot higher than 30 ppm, your fish will be stressed, and they could die if the CO2 is around 50 or more. It's hard to get lethal levels of CO2 into the aquarium, especially with a fermentation container. Lower than about 15 or so ppm, you will not see much effect on your plants. If you use something other than a carbonate to buffer your water, that can throw off the accuracy of the table.

But even at 20 ppm, added CO2 may not increase plant growth enough to keep up with an oscar's proclivity to redecorate.