ALKALINITY – WHERE DOES IT COME FROM AND WHERE DOES IT GO?

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We know that pH is the measure of whether water is acidic or basic. A pH below 7 is acidic and a pH above 7 is called basic. The pH of fish blood is about 7.4. The blood comes into close contact with the surrounding water in the fish gills. If the pH of the water is drastically different from the pH of the blood, then the fish has to work very hard to maintain its blood pH. At extreme water pH, the fish is unable to maintain its blood pH and will die. Therefore, the optimum water pH is about 7.4, koi/goldfish can effectively deal with a water pH of about 6.5 to 9.0, and they quickly die when it is below 5 or above 10. The water coming from our tap varies a little but is usually pH 7.2 to 7.8. That is ideal. One of the good things about Hawaii.

Things start to change once we put water in our fish ponds or tanks. The feed is broken down by the fish and bacteria and one of the major by-products is carbon dioxide (CO_2) liberated into the water by their respiration. The carbon dioxide reacts with the water to form carbonic acid. This could make the water acidic and we would expect the pH to slowly decline as we add feed day after day and the fish and bacteria continue to respire and release carbon dioxide. But, in actual practice, we find that the pH fluctuates from day to night, but changes very little overall from one day to the next. So, where is all that carbonic acid going?

Besides having a desirable pH, our tap water has a desirable amount of alkalinity. Depending on the area, alkalinity in our tap water is generally between 100 and 150 ppm. As we will see, you should worry about low alkalinity when it is below about 50 ppm. At very high alkalinity (200 to 300 ppm) the color of koi does not develop properly. As a general rule, high alkalinity makes beni (red pigments) weak and prone to disappearing all together. However, high alkalinity often makes sumi (black pigments) develop very well. Our alkalinity is in a good range to compromise these two opposing forces.

Alkalinity is also called “buffering capacity”. The alkalinity or buffering capacity refers to the waters ability to neutralize acids. As the fish and bacteria respire and release carbon dioxide and the carbon dioxide becomes carbonic acid, the acid is neutralized by the alkalinity. Alkalinity can be thought of as a reserve of bicarbonate. Another familiar type of bicarbonate is those chalky antacids like Tums or Rolaids that we take for heartburn. The bicarbonate neutralizes the acids in our stomachs or our fish ponds.

As long as there is a reserve of alkalinity, the pond water pH remains somewhat stable. However, the alkalinity reserve will eventually be depleted. When the alkalinity is depleted there is no longer anything to neutralize the acids being produces and the pH will plummet. The pH can drop to dangerously low levels almost overnight. Some call this a pH “crash”. Terrible things happen in a pond during a pH crash. The fish are stressed or killed along with the bacteria in the biofilter.

There are several ways to replenish and maintain alkalinity. In a pH crash emergency, you can add baking soda (also called bicarbonate of soda) which will quickly react with the acids to immediately raise the pH. However, for routine use baking soda is not a good choice. As alkalinity is replenished baking soda also raises the pH higher than we may like. It is not uncommon for the pH to reach 8.4 after adding baking soda to a pond. A better way to slowly replenish alkalinity is to have some oyster shells or clam shells in the system. Oyster shells are composed of calcium carbonate and they can be kept in a filter chamber or anywhere that water flows over the them. The oyster shells will slowly dissolve (over years) as acids in the pond water attack the shell. Oyster shells will not raise the pH above that of our tap water yet they will constantly replenish alkalinity. You can use whole shells or the crushed shell sold at feed stores for poultry grit. Most koi and goldfish keepers replenish alkalinity without realizing it when they do

water changes. The amount of water change required to maintain alkalinity at acceptable levels depends on the feeding rate and fish load, but is generally in the range of 20 to 50% per week.

So, how do you know if you have sufficient alkalinity? Well, you can routinely measure the pH and look for signs of a falling pH and a looming pH crash. Just be careful because when the crash happens it happens fast. A safer approach is to measure the alkalinity directly using a test kit although the alkalinity kits are much more tedious to use than a pH kit or meter. Good brands of alkalinity test kits, like LaMotte and Hach, cost about thirty bucks but Salifert, Red Sea or Seachem brand kits cost about half as much. You can find one in a local pet store. If you have a routine water exchange schedule and a steady feeding rate you will not have to measure alkalinity often. If your alkalinity is still about 100 ppm just before your routine water change, then you have nothing to worry about. If your alkalinity has dropped to 50 ppm before the water exchange then you may want to consider adding oyster shell or changing water more frequently.